Anthropology of Science:

Astronomy as a form of life

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PREFACE

This volume presents selected papers written by Bulgarian and Russian B.A. students during the 16th annual Plovdiv University STS Summer School that took place at The Bulgarian National Astronomical Observatory Rozhen, settled in the Rhodope Mountains.[1]

The Plovdiv University STS Summer Research Practice is a hallmark of the STS training at Plovdiv University that was established as a rather "orthodox" program based on actor-network theory approach to contemporary science and technology practices.[2] Since the year 2000, it has taken place alternatively in sites of large technical systems and big research infrastructures. Every year it has different research topic – Sociology of laboratory life, Sociology of large technical systems, Innovation studies. We have been studying the energy sector, biotechnology, machine building, heavy and light industries, etc. As a methodology the practice follows the classical STS patterns (à la Latour and Knorr-Cetina[3]) where students are immersing for about a week into daily life of scientists and engineers. Upon preliminary agreements with the managements of the research and tech sites, the students (in small groups of two or three) are usually attached to individual scientist, engineer or technician (or small group of them) and conduct participant observations, take interviews, collect documents, photo and

[1] See more at https: http://easst.net/article/the-plovdiv-university-sts-summer-school/

[2] See more on Plovdiv STS school at https://easst.net/article/sts-in-south-east-europe-the-plovdiv-university-school/

[3] See (Latour, B. Woolgar, S. 1979; Latour, B. 1987; Knorr Cetina, K. 1995)

video data. By applying STS concept and methods as a tool for understanding and describing everyday life of scientists and engineers, the practice aim to unravel "confined" communities of scientists and engineers and to describe "anthropologically" their world. This provides the students the opportunity to carry out their first case studies and defend their own thesis at the annual student conference in STS.

The 16th annual Plovdiv University STS Summer School, entitled Science and Technology as Way of Life and Identification: Observing the Practices at Confined Research Stations and Large Technical Systems in High Mountains, and held at the Rozhen National Astronomical Observatory (NAO Rozhen), Bulgaria, from 22 of June to 1 July 2015, was the first international one. It was supported by the European Association for the Study of Science and Technology (EASST), and co-funded by the Plovdiv University and the Tomsk State University.

During the fieldwork sixteen B.A. sociology students from Plovdiv University (Bulgaria), together with twelve anthropology students from Laboratory for Social and Anthropological Research (LSAR), Tomsk State University (Russia), spent a week in the research community of the astronomers and supporting engineering staff at NAO Rozhen and took part in research activities. They were attached to particular researchers and observed their daily work, taking interviews, analyzing documents and technical artifacts, and collecting photo and video data. Working in a nice and friendly environment students have the opportunity to encounter the modern science and technology as a specific form of life, passion and identification. It helped students to develop basic skills in applying STS knowledge to the study of research and engineering practices in particular scientific organizations.

Students' groups collaborated with each other and collected rich data about different aspects of the life of the heterogeneous community of NAO Rozhen. The productive teamwork continued after the fieldwork finished and proceeded in the analyzing phase, and resulted in an exciting bunch of research articles.

Depending on the data they collected about the studied heterogeneous communities, each team chose its own topic of interest to focus on and revealed different aspects of the life inside these communities. Some teams concentrated on the reflective change in the position of the researcher, immersed in the studied community, and analyzed everyday practices and public perception of astronomy using Shutz' distinction of social knowledge. Other teams discovered strange similarities between sociology and astronomy, using Weber's understanding of science as a vocation. Some focused on anthropology of scientific practices, studying the everyday life norms, as well as the activities that occur in situations of crises. Most of the articles in the volume try to link these different approaches in coherent description of the corresponding heterogeneous community, each of which, in the language of Actor-Network Theory, comprises a specific 'actor-world'. The examination of the scientific community as a network of actors, with its focus on the interaction between humans and non-humans (their conflicts and couplings), and also on the hybrids that stabilizes "the state of affairs", reveals the ways in which scientists and engineers conduct their daily "struggles" to achieve "the matters of facts" of modern science.

The students' efforts documented in this volume provide bold evidences that classical STS are still an appealing endeavor and the fieldwork in research labs can still surprise us, to provide new matters of fact that bring

forth fresh theoretical and methodological challenges. For most of them this volume brings their first scientific publication. And we are convinced that for many of them this will not be the last one. It's enough to say that for sixteen years the STS summer practice in Plovdiv have given birth (or at least provided the initial impetus) to dozens of undergraduate thesis, number of research articles in national and international social science journals, and several books. This is STS in life and it will go on.

This volume would not be possible without the support of people and institutions. First of all, we would like to thank to the people, who participated in the research practices: to our students for their enthusiasm and dedication in the exploration of such hard object of study; to Nikola Petrov and to all of the astronomers and staff of the National Astronomical Observatory Rozhen, who not only helped us, but also were extremely kind and friendly and even became partners in our research; and last but not least, we thank to Gergana Dimitrova for her exclusive support in organizing the summer school.

We are equally indebted and thankful to EASST Board that supported our STS Summer School under its network grant program that made possible the publication of this volume. We would also like to thank the Laboratory for Social and Anthropological Research (LSAR) at Tomsk State University (Russia) that financed the visit of Russian students to NAO Rozhen[4], the Institute of Astronomy at Bulgarian Academy of Sciences, Plovdiv University Paisii Hilendarski, and Tomsk State University.

Ivan Tchalakov, Tihomir Mitev, Irina Popravko

[4] Written in the framework of the project "Man in a Changing World. Problems of Identity and Social Adaptation in History and at Present" (the RF Government grant No. 14.B25.31.0009)

INTRODUCTION

THE ASTRONOMY AS A SCIENCE. NATIONAL ASTRONOMICAL OBSERVATORY ROZHEN

Nikola Petrov and Grigor Nikolov[5]

The astronomy is that part of Physics, which studies the fundamental nature of the Universe we live in. Astronomical studies answer some of the biggest questions we may ask, e.g. How the Universe formed, How big it is, How old it is, What's its future? The astronomy as a science gives us the information framework of our place in the Universe, but it also is an important part of the humanity culture. Anyone lacking the general knowledge of Astronomy is culturally handicapped, in the same way as if not knowing literature, music or art. When astronomers

[5] The authors work at National Astronomical Observstory at *Institute of Astronomy and National Astronomical Observatory, Bulgarian Academy of Sciences.*

announce new discoveries for the Universe they enrich intellectually the lives of millions of people.

Since the dawn of the civilization the astronomy has stimulated humanity development. The calendar and calendar days came right from the astronomy. Trigonometry branch of mathematics is developed by the Greek astronomer Hipparchus. Logarithm in modern calculus has emerged in medieval times for solving astronomical problems and celestial navigation. Calculus, which is the foundations of modern science and engineering, is first developed by Sir Isaac Newton to be applied for astronomical calculations. Naval astronomy gives us the means of navigation, used even today in seafaring and flights. Radioastronomy is stimulating development of low-noise radios, making possible satellite communications nowadays. Various image reduction methods, first used in astronomy, are now used in applied medicine, enabling noninvasive methods of examining internal organs. High requirements for the equipment of modern astronomical observatories lead to developing of better instruments, in areas such as electronics, mechanical engineering, computer sciences, etc.

Astronomy has always been a cornerstone of the technological advancement throughout the human history. Now we cannot imagine how it will progress, but fundamental research not always reaches a final satisfactory answer - most likely we will be surprised.

Scientific research topics in the Institute of Astronomy with National Astronomical Observatory (IA NAO) are related to studying of fundamental laws and processes in the Universe. New knowledge in astronomy reveals new opportunities for science and technology, and expands the boundaries of our knowledge of the Universe. It is highly important to the human knowledge, that at this

stage of scientific progress, the modern methods of astrophysics are the one and only means of understanding and investigating processes and states of matter, inaccessible for any laboratory on Earth, for example: high densities and temperatures, ultra-high vacuum, extremely powerful gravitational and magnetic fields, relativistic velocities and temperatures close to the absolute zero. Studying of the physical processes in celestial bodies contributes to environmental protection of the Earth from global catastrophes and explanation of climate change. Understanding the processes in our Sun and solar activity, discovering and follow-up monitoring of potentially hazardous asteroids and comets, studying the streams of cosmic rays bombarding Earth, are directly related to the two hot topics of the past decade - space climate and cosmic risk, which are of immediate relevance for broad range of technological activities and for the life on Earth.

In the past decades we find the relationship of the astronomy with the current problems of mankind - the global climate changes on our planet. Crucial for Earth's climate are astronomical and orbital factors. Global climate change might be the indirect result of gravitational resonances from the giant planets in the Solar system and the Sun, or the crossing of the galactic plane of our Milky Way. These factors are also related to the luminosity of the Sun; to the position of the Earth in the Solar system; to the rotation of the Earth around its axis and orbiting around the Sun; to the orbiting of the whole Solar system around the galactic center; to the interactions between the systems Earth-Sun and Earth-Moon; interactions with the other planets in the Solar System and peculiarities of the Earth's orbital motion. All those influence directly or indirectly the evolutionary process of Earth: its internal and crust dynamics; geoidal eustasy; gravitational and magnetic

potential; climate dynamics; eustatic fluctuations in the sea level; biosphere evolution, etc. The most common feature of astronomical and orbital effects on Earth is the cyclic nature of fundamental geological processes (including climate), that shape the Earth.

Institute of Astronomy with National Astronomical Observatory create competitive scientific product in the field of astronomy and work towards quality education in this fundamental knowledge. An essential part of the Institute's mission is maintenance and efficient exploitation of NAO Rozhen, its modernization development as a national, regional and European center for astronomical research and education.

Development of astronomy in Bulgaria in brief

Every nation and every culture in human history carry some legends and myths that are associated with various celestial phenomena. Either an impressive solar or lunar eclipses, appearance of comets or "shooting stars", Bulgarian history also traces some natural phenomena in historical records. Many celestial events have determined the outcome of battles, have affected the rise and fall of great rulers. Now in our times, we can accurately date back these events, since using the language of mathematics, modern astronomy allows precise historical dating. An example of an important event and its associated celestial phenomenon can be found in a copy of Saint Paisius of Hilandar's "History of the Slavo-Bulgarians" from 1765, made by prof. Yordan Ivanov in 1914. There is written of appearance of two comets just before the Battle of Adrianople in 813, between the armies of Khan Krum and Emperor Michael I Rhangabe

(Rodgers, R. F.: Newly-discovered Byzantine Records of Comets, JRASC, 1952, Vol. 46, pp. 177-180). This event is maybe on of the first celestial phenomena recorded in the history of Bulgaria.

Teaching astronomy in Bulgaria began in 1815 as part of teaching physics in the town of Svishtov, where the first secular school was founded by Emmanuel Vaskidovich. There the lessons begin with teaching a textbook by the Greek scholar Constantinos Vardalaho, where two descriptive chapters devoted to astronomy were included. Astronomy is also taught in lessons of physics at Aprilov's schoold in Gabrovo (1835). The first Bulgarian astronomer is Dimitar Koyuv Vitanov (~1846-1877), who studied in St. Petersbourg, Russia, then specialised in the observatory in Malta. But perhaps the most distinguished Bulgarian in natural sciences and astronomy before the liberation of Bulgaria is Dr. Petar Beron. His "Fish Primer" is the first Bulgarian textbook for modern education, his was the first known telescope in the country. Dr. Beron requested the first star chart in Bulgaria in 1854-1855, produced and engraved in France.

Modern history of astronomy in Bulgaria starts with founding of the first university in 1888 - the Sofia University "St. Kliment Ohridski" (with official university status since 1904). Astronomy is introduced as an observation course in the Faculty of Physics and Mathematics. Head of the Astronomy Department in the Sofia University is prof. Marin Bachevarov, who graduates astronomy in Moscow University, Russia. In 1897 he establishes the first observatory in Bulgaria. Under his leadership began the first regular astronomical observations in Bulgaria, in the Sofia University observatory - observations of sunspots (Fig. 1).

Fig.1. Students observing sunspots in the University Observatory, Sofia, 1921.

In time, astronomy in Bulgaria gains popularity. There quite a few followers of this topic and attempts to build a new, modern observatory are becoming more and more insistent. Regarding this, in December 1941 prof. Nikola Bonev said: "... Enough said about "poverty" of the country! Enough we cultivated a sense of inferiority within us! We must finally create something worthy of Bulgaria … We need to reach and surpass our neighbors, at least, and as we have an Courthouse, a National Theatre, a National Bank, etc.,

which are not present in all countries, so we need to have one, worthy of us and Bulgaria's central place on the Balkans, moderately equipped Astronomical Observatory …"

In 1952 the Departament of Astronomy in the Faculty of Physics of the Bulgarian Academy of Sciences (BAS) was created, and in 1958 - Section of Astronomy, an independent branch of BAS. As a successor of this Section, in 1995 the Institute of Astronomy is founded. Many distinguished Bulgarian astronomers put efforts that lead to opening of the National Astronomical Observatory Rozhen in 1981 (Fig. 2). With it Bulgaria ranks among the developed countries with advanced instrumentation for studying the great cosmos! The Rozhen observatory, in its current state, is still the largest astronomical complex on the Balkans and in Southeast Europe.

The investment of over 12 million BGL in the 70s, about half of that sum for the 2m telescope seems modest compared to the resources needed to purchase a single fighter jet at that time, yet, this amount is the largest investment to date in Bulgaria's scientific infrastructure! When compared to the 8-10-meter class telescopes, our investment seems insignificant, but it has a very important mission: today our country is able to observe, understand and participate equally in the global efforts to study processes in the Universe!

Fig. 2. The tour of 2 meter reflector telescope in NAO Rozhen

National and operational activities beneficial to the state

On the territory of NAO Rozhen are placed a Weather station of National Institute of Meteorology and Hydrology, BAS; a seismic station of National Institute of Geophysics, Geodesy and Geography; a complex ecological background monitoring station of Ministry of Environment and Water of Bulgaria. NAO supports the activities of these scientific stations by providing some of observatory's instrumentation and the necessary communications. In 2012 started cooperation with the state-owned enterprise Bulgarian Air Traffic Services Authority for the construction and operation of a tower with a radio beacon within NAO Rozhen. The aim of the agreement is to improve flight

safety by exploiting the favorable geographic position of the observatory.

Benefits to the society

Astronomy is among the most popular sciences, of great importance for shaping public opinion towards science. Teaching and training students and pupils supplements their education and clearly show the benefits of scientific research in enriching our understanding of the Universe. At the Rozhen observatory annually are held summer schools in astronomy for children of astronomy workshops and university students training, which increasingly strengthen the relations between NAO and the universities. There is continuous curiosity of people visiting NAO Rozhen, as well as organized groups of school students. Scientific equipment and research topics are presented to the visitors in short discussion of the history and achievements of Bulgarian astronomy. Visitors have the opportunity to ask questions to a professional astronomer of their research interests and talk about recent discoveries. Thus NAO Rozhen becomes the largest forum for the promotion of Bulgarian science, particularly research conducted in BAS.

In 2015 the NAO Rozhen have carried out a total of 15 summer schools, students trainings and amateur-astronomers' expeditions, which have an important implication for science education. The number of interviews on current astronomical topics in TV and radio transmits, in newspapers and electronic media of employees of the Institute exceeds one hundred and twenty in the year alone.

Over the past three years, the National Observatory is hosting workshops for students of Sociology at the

University of Plovdiv “Paisii Hilendarski”, Department of Applied and institutional sociology. These practical sessions in which the objects of study are the astronomers themselves, have a new and unusual to the astronomers research task, but studies have their own valuable information about the relationship between the astronomers and the observational technologies. Also, such studies provide a realistic evaluation of the importance of the astronomy and of how recognizable it is in the social relationships in our society.

As for the global processes of development of astronomy, we are witnessing the rapid progress of technologies and communication, including astronomy. Orbiting the Earth we have launched satellite systems serving astronomy, with precision parameters unimaginable until recently. Successfully completed missions to space bodies in the Solar System, which in turn were considered to be pure science fiction. Most likely, in the next 10-15 years we will witness absolutely new achievements of our civilization, related to our quest for advancement and improvement, inevitably connected with aerospace. In the next few years many new ground-based super telescopes will start functioning - an 18 meter Magellan telescope, 30 meter NASA telescope, and the Extremely Large telescope of 39 meters diameter of European Space Observatory. The estimated cost of each of those telescopes is more than $ 1 billion, equipped with the most sophisticated technologies for operating, receiver computer equipment. The knowledge and conquering of space is an integral part of our future. But yet, the vast Universe does not reveal its secrets of its formation and evolution. What is the place of humanity in the vast cosmos, what is the role of the human, what is the human thought? That are just a few of the questions we crave to find answers.

CHAPTER ONE

THE MISUNDERSTOOD ASTRONOMY. WHO, HOW AND WHY MISUNDERSTANDS IT (The social knowledge of "doing" astronomy at The National Astronomical Observatory "Rozhen")[6]

Darena Hristozova, Zornitsa Yulianova

Abstract: This analysis aims to present the different perspectives to astronomy and to track how the understanding of this science is changing. Interweaving it with the Latour's theory of actor-networks, we'll prove that 'doing' science is far from the conventional idea and we'll outline the expert/professional knowledge of astronomy. It is a complex network of relations which, even slowly, is constantly progressing. Confronting the

[6] We are grateful to our mentors and senior researchers - Prof. Ivan Tchalakov and Dr. Tihomir Mitev and the whole team of NAO "Rozhen". Without their help and support this research work would not be a reality.

bias with our impressions from The National Astronomical Observatory ‘Rozhen’ and looking through the theory of actor-networks of Latour and the three ideal types of social knowledge of Schutz, we present three points of view, their overflowing from one to another and the way in which they misleadingly explain astronomy.

Keywords: misunderstanding, astronomy, science, ‘doing’ science, knowledge, network, activist, relations, translation, connection, ‘man on the street’, expert, ‘well-informed citizen’, point of view.

The Observatory

National Astronomical Observatory "Rozhen" is the largest astronomical observatory in the Balkans and Southeast Europe. Officially it opened in 1981, but regular observations were already held in 1980. It is the largest single investment in scientific infrastructure in Bulgaria - over 12 million levs, The Observatory is equipped with: 4 telescopes - two-meter PKK-telescope, Cassegrain telescope "Zeiss-600", 50/70 cm. Schmidt telescope and 15 cm. solar telescope - coronagraph; CCD-cameras; and other equipment - Coude-spectrograph of the two meter telescope and channel focal reducer FoReRo 2. For the purposes of this study we were introduced to the way the equipment works and to the ways of conducting a research. For several days we observed one of the PhD students - M. B., who has experience with all the telescopes - young and ambitious astronomer who allowed us to examine his work and presented his views on the process of doing science.

The attitudes

Usually science is perceived as something that is far away from us, as another universe different from our everyday lives, based on specific laws. This is not far from the truth, but there is another side of this matter. In the process of doing science we can find much of the actions related to our daily life and "living" as a whole. Of course, in order to see science that way, one has to connect with it, to look beyond the walls that surround it and make it so mysterious, and for some, even boring. We have to "feel" it with pure consciousness.

In our society, we have the habit of putting labels on everything that surrounds us and mostly on the things we know nothing about, we don't know how the people who bring them to life actually work or what they are searching for. The true essence of science is far from the ordinary people's perceptions. We tend to say that, because at the beginning of our study we ourselves were part of them.

Expectations, impressions, issues

As students of sociology at Plovdiv University "Paisii Hilendarski", we got familiar with what to expect and what is expected from us in the third consecutive summer practice of our training, entitled "Science, Technology, Innovation", held in The National Astronomical Observatory "Rozhen", held for the first time with foreign students. The main aim of the practice was to put us in a real environment, in the role of researchers studying an unfamiliar area. We were not prepared, however, for much

of what actually happened at the Observatory. A completely unknown world revealed itself in front of us, which surely enriched and changed us - changed our notions of astronomy.

We left for Rozhen with mixed feelings - some of us curious, others prejudiced, and some with an open heart, ready to explore the unknown. After facing astronomy, we can say that we are now on the other side of the barricade - we joined the people who know a lot about scientific work, who changed their ideas about astronomy and fell in love with the stars.

The summer school at NAO "Rozhen" was extremely useful for us all. Arriving at the Observatory, we were impressed by the beautiful scenery and the hospitality of the entire crew of astronomers. The good organization of the researchers and their perfect collegial relations were apparent. All lectures and conversations with them about their scientific work and the research process, and also the very observation of "doing" science, were not only interesting, but also opened an area for analysis of many various issues. The whole team, consisting of young and purposeful people working with passion and love for space, made us believe that this science has future in Bulgaria.

We were impressed by the patience with which astronomers work. For them, the small, seemingly insignificant steps are the surest path to a great discovery, in which they will be pleased to have some input. Their resourcefulness, which is expressed in their perfect coordination and knowledge of the nature and possibilities of each piece of equipment, is the next element, without which they would not be able to evolve as scientists. The accumulation of experience is crucial for them, whether they win or fail. Last but not least, noteworthy fact is that love of space is not self-sufficient for the successful process

of "doing" science. In order to be good at something, you should be specialist in several different areas. The development of a particular science, sooner or later, leads to the need of knowledge of a different field. Our observations have shown that astronomy is no exception. It was very important for us to follow the relationship between the researcher (astronomer) and the equipment which he operates. It turns out that things are far more complicated than we imagined and this connection is not always direct.

All this showed us, that there is a huge difference between how the average person understands science and what in fact it is. We consider this a problem and think it's important for people to know how complicated this area is and how little we know about it and about the efforts expended by the entire team of the National Astronomical Observatory "Rozhen".

Our goal, as researchers, is to look at astronomy from several different angles to better understand the three types of social knowledge about it and how it changes (especially in us - the researchers) in the course of the analysis. On the one hand, we describe what this science is in the minds of a considerable part of the Bulgarian society. On the other, by analyzing our data, in-depth interviews and observations made at the Observatory, we will present what it really is - viewed and described by the astronomer himself. On the third hand, we will trace how our own impressions have changed our initial expectations - a moment to look at ourselves as an object of study. Based on this comparison we seek to reveal how the collision with the actual process of "doing" science changes the social knowledge about it and proves the misunderstanding of it. We will try to look at astronomy as really complicated synthesis of a large set of interrelated physical and non-physical elements, intertwined actions of humans and non-

humans, about which the ordinary person is hardly aware. We hope to show a new face of science in general, because the analysis that will be applied to astronomy, can be related to any other science or sphere of our lives. This new image of science will convince us that we are still misunderstanding its essence.

The research

In pursuance of the above-mentioned tasks, in the multiple conversations we mentioned many of the issues on the equipment with which the team of researchers works. We monitored the work process and had the opportunity to ask questions of different nature, and we were given detailed answers. The in-depth interviews conducted at the end of our stay, gave us very useful information summarizing all important issues relevant to the main topic of the practice. These conversations with our astronomer led to many additional topics closely related to our research. We also had the opportunity to see the astronomers in crisis situations in which the level of teamwork in such "closed" community can be actually seen.

As basis of this article we apply two theoretical constructs - Schutz' three ideal types of social knowledge and Latour's actor-network theory. Through them we aim to justify our main thesis, showing:

- different views about the science of astronomy and their intertwining;
- astronomy in a whole new light - as a network of actors that will clearly outline one type of social knowledge - that of experts, which will be useful for the overall analysis.

According to Alfred Schutz, there are three types of social knowledge: the knowledge of the man on the street,

which is the operational knowledge from many fields that are not necessarily related to one another; Expert knowledge, limited to a particular field; knowledge of the well-informed citizen who aspires to be well-informed and stands between the ideal type of the expert and that of the man on the street. In our everyday life each of us, is simultaneously a man on the street, expert and well-informed citizen. But in terms of different fields of knowledge we possess only one of these three types of social knowledge. Correlating them with the available empirical data, we will try to understand how the knowledge (attitude) of people change and we will seek to find the roots of the wrong-understanding of astronomy.

Latour interferes with another aspect of our activity that complements the above and thus makes it possible. According to his concept the world is built on countless networks of actants, or actors, which can be both humans and non-humans. All actors in a network are interconnected and between them there are relations and connections (translations). Every actor is trying to get others to act in a way conducive to its own implementation, and this is the result of a translation. Translations change the reality of the actants - when an actor is "translated" by another, he becomes his ally. An actant draws its strength from alliances with other actors. The bigger a network becomes, i.e. the more alliances between actors occur, the more real and strong it is. This is what moves and develops the world. An actor can be anything - individual or group, something figurative or non-figurative, animate or inanimate, human or non-human. Heterogeneous communities are "born" from these relationships between human and non-human actors. The very relation between actors is called "trial of strength", which leads to constant change in the world. By "looking" at astronomy in this way and using the information received

from the astronomer, we can easily delineate one of the types of social knowledge - that of an expert.

"Man on the street"

Hardly anyone would deny that astronomy is one of the most compelling among the sciences. We doubt, however, that ordinary people are familiar with the way this science is "made". What they think they "know" is very far from reality. From the conversations with our astronomer we can judge for one of the possible public perceptions of astronomy. In his words, astronomy is often perceived as a fairy tale - as activity consisting only of the monitoring of space objects and nothing more:

> *"In the perception of people, the notion of astronomers is that they are looking at the stars and count them, i.e. lots of people imagine us to be some star-gazers who lay on the meadow at night and watch the sky. While today professional astronomy is very far from this idea ... They imagine gazing at stars, planets, moons and stuff. "*

Changing these views is one of the missions of scientists from NAO "Rozhen":

> *"It's part of our job - when dealing with others, with people outside who have nothing to do with astronomy, to pass them more accurate idea of astronomy: what we do, why we do it. And one of the tasks, that I think is very important, is to show people that here in*

Bulgaria we are also doing a lot of quality work from a world level; to show that there is an Observatory, which operates on advanced level; that does useful work and this is also appreciated by all other colleagues who work in other observatories, some even larger. They appreciate that here we do quality work. This, I think, is one of the important things that need to be dealt with. Just to explain to people. i.e. people must know that there is science in Bulgaria and it is developing."

As it is clear, the desire for work and scientific development is present. What is lacking is the support from state institutions. Astronomy in Bulgaria can and wants to develop, the Observatory wins projects that cannot be implemented, because of the paltry funding of science in the country (0.5% of GDP, at the average 2% rate for Europe). From here we can conclude the possible reasons for its low popularity, which is a prerequisite for the misconception of astronomy among people. If these projects were being implemented, if there were appropriate operating conditions, astronomy wouldn't be so foreign to people - they would be interested and would know that our country is "doing" quality science. Each year, the NAO is facing closure due to the above reasons. Investing in science and talking about it are two key steps to alter the attitudes and knowledge of people about astronomy and to retain the research practices in the Observatory.

It is necessary for people to understand the essence of the scientists' work, the overall process, because in fact there is nothing mystical in it. It's hard for the ordinary people to imagine that a research is largely collective, not independent activity. It needs organization, synchronization and coordination. There are many things that need to be

reconciled, and to invest so much more effort in order to carry out a successful research:

> *"Our work can be very intense when observing or working. On the one hand, doing quality work requires a lot of concentration. On the other hand, when we want to get a good result, we must be well aware of what we should do and to do it in the best way possible. This is what most people usually do not imagine - that sometimes you sit bemused and think about the best approach when observing or when processing a picture, or any result. People do not imagine this."*

All these efforts and the enormous amount of labor expended in research at NAO, need some kind of supportive environment, which again is related to the position assigned to science and its overall state. The passion in these young researchers needs to be stimulated by the institutions. So their scientific work will be able to develop in the right environment and there will be a chance for the results to reach the public. Funding brings motivation, and hence results.

From what has been said here, we can classify the majority of Bulgarian society to the type of the man on the street, much more led by feelings, rather than information: "He takes his passions as means for orientation. Under their influence, he builds a network of vague beliefs and views, which he simply trusts, until they begin to impede him. "(Schutz,1999:39). He could go to the group of the well-informed citizen, but there is a lack of the need for this transition. A need, that could be triggered by the "talking" about astronomy and its development in the country.

“The expert”

In the main part of our work we will present the other perspective - the very "doing" of science through the eyes of the interviewed astronomer. We emphasize on the elements which he considers an integral part of the research. Considering these elements and relationships between them, we try to look at astronomy as a network, giving it a different from the above-mentioned sense.

For a central figure of the analysis we take one of the astronomers of the NAO "Rozhen" - M. B., PhD student at the Institute of Astronomy, where he currently works. His areas of scientific interest are star clusters, representing huddle of many stars. His research is aimed at obtaining information on the origin and evolution of star clusters, and what are the similarities and differences between them. The project he introduced to us, made it clear that he explores not only the star clusters in our galaxy, but also those from other galaxies, thus you can see not only the differences between galaxies, but also the place of our galaxy among the rest. According to him, this is the first step if we want to study distant worlds.

The studied person is the main figure (actor) in our network of actors and relations between them. The primary focus is on the conditions that promote the implementation of scientific activity in the Observatory. There are three separate fields of relations: between the interviewed astronomer and:

- his educational and scientific qualifications;
- his current work and contacts Observatory;
- the environment.

Our goal is to track how our central actor interacts with these fields that incorporate many actants. In other words,

to show the relations between the astronomer and every individual, non-human or group of actants, that plays a role in the creation of scientific knowledge.

First, the received by the astronomer education is of fundamental importance. This includes not only knowledge and degrees, but the influence of eminent and proven professionals in astronomy, both at home and abroad. On the one hand, the connection between the actor and his teachers who have inspired and taught him to be not only successful scientist, but resourceful person, able to react and behave in the best way in different life or professional situations. Through this alliance, this group of actants (teachers) transmits a part of themselves, their knowledge and experience, in order to prepare the central actant for his future realization:

> *"A good teacher doesn't just transmit their knowledge. He rather gives life advice and guidance on the approaches for successful career and not just a career, but for being successful scientist and person."*

On the other hand, the additional experience he acquires at trips and conferences related to his field of research:

> *"When I was a doctoral student at Sofia University, I had the opportunity to go on conferences abroad and to participate in different workshops and I can say that I have been in many places, mainly in Europe ... And recently I went to the largest observatory which is in the Canary Islands (Spanish). So I had contact with old and new, modern telescopes and each works differently and is doing some useful work, and so are the astronomers who*

work there. This is very valuable because one can see some good practices and can use them in his work, and share them with his colleagues, or some new approaches, which to introduce here in our work in Bulgaria."

Based on all this, the actor evolves as a scientist, draws strength and security in his knowledge through the coalitions that have a positive influence on his career and his subsequent research – he has the courage to apply good foreign practices in his work in Bulgaria. Thus there is the possibility for him to involve his colleagues into already proven approaches and to contribute to the development of astronomy in the country. For the purposes of his research, he maintains contacts with many foreign scientists, sharing experience and ideas. Thereby, the mutual help further enriches the object of our research in the face of the astronomer:

"In my work, the work on my doctoral thesis, I cooperate with a team from the University of Athens, Greece, where there are many good specialists working on the same subject as me... I also work with a colleague from Poland - Toma Tomov - a very good spectra specialist. And we are now working on the testing and improving of the echelle spectrograph."

By implementing all of these translations of experience, skills and knowledge from the above actants to our astronomer, our network of actors gets more complicated. Implemented alliances are favorable prerequisites for successful research in the Observatory.

Secondly, let's turn our attention to the Observatory and the relations present there. Crucial for a regular and

quality research is the relationship between the team of scientists and the management of the Observatory and the Institute. Astronomical work must be coordinated with the opportunities that the Institute offers. And for the future development of science both sides need to compromise. This is what he says on the subject:

> *"We can, at least according to my impressions, safely and freely talk with the management and express opinion and even criticism when it is necessary and it is generally accepted in the right way as a creative, constructive criticism. There is a part from the management that has the desire to improve the working process at the Institute, i.e. they care very much for the good of their employees, working in the Institute. And also, when we have any requests, we comply with the capabilities of the management, as the people who run the Institute are not almighty and omniscient."*

From here we can conclude that the relationship between the central actor and the group of actants in the face of the management is present and again aims to upgrade the experience, knowledge and skills - efforts to create favorable working conditions are made through mutual compromise. These connections are part of the network, but there is another relation. The actor can influence the relationship between the team of astronomers and the management of the Institute, but not the relationship among the above-standing institutions responsible for the Observatory (Institute of Astronomy BAS). The interview made it clear that he is not well aware of the relations between the Astronomy Institute and Bulgarian Academy of

Sciences, which directly affect the research work in NAO "Rozhen":

> "*I cannot say what the situation is and whether there is good communication between them. I only have some vague impressions, but I cannot say how good the communication is, or whether they listen to each other, hear and understand each other."*

All this shows that the relationship between these key for the Observatory institutions is not so obvious. It seems that they are separated from what is happening in the observatory, and this division is likely to jeopardize its development, because decisions are made on a higher level without any apparent consultation with the main actors in this network - the astronomers. I.e. the network exists and acts, but the lack of good communication between the higher institutions and the team of researchers at NAO prevents it from being sufficiently productive.

The team is an integral part of the implementation of almost any activity. In the case of the Observatory, good relations between astronomers are mandatory – not only they work with each other, but also they spend much of their free time together, which reflects on their daily research. According to the astronomer:

> *"I would say that we operate in a positive environment. As for the work, we strive to be and usually are good professionals. When we are in an informal setting, we also live in a very friendly and pleasant environment. But always, when it comes to work and interaction at a professional level, we try to be as accurate as possible, and I can say that I get along with all*

my colleagues. They are just very good specialists. We have a distinguished professional in each area and if I need to I can go and ask for advice on how to approach a problem. So, when working, I think we have a very good team and the communication is also very important, as we talked about."

As it becomes clear, good communication and good relations are essential for scientific research. The presence of specialists in various fields in combination with the friendly relations and confidence within the team is leading us to the next thread from the above network. Our actor does much better work when he knows that he can rely on a team of professionals with which mutually exchanges experience. This alliance between the actor and this homogenous community of actants helps his own development as a scientist, that of the Observatory, and of science in general.

Undoubtedly, the telescope is the main non-human in this network called astronomy. It is main link between space and astronomer, but not the only one. It translates information about the celestial objects and in this sense becomes an ally of the scientist (actor). But much of the work of the astronomer is not behind the telescope. I.e. the use of the telescope is indirect part of the scientific work - most of the data received by the telescope is processed by computer and other devices programmed for such purposes. Thus the heterogeneous community is formed, including the actor himself, the telescope and any other set of non-humans, necessary for the conduction of the scientific process. The ability to handle such tools requires not only good computer skills but also the ability to create your own applications for processing specific data (programming, scripting)

"Very often we have to write some scripts or programs ourselves, this is just part of our job. When we want to get something new, we create it."

This proves once again that the work of the astronomer does not consist solely in observing space objects. To fulfill its assigned tasks, the actor must have the necessary skills and experience in order to operate the equipment, without which it is impossible to read the translated data from the telescope. A trial of strength is performed with a number of technologies that make the actor stronger, as long as he has the experience and skills to work with them. This demonstrates the usefulness of contacts with various experts in the field and exchange of experience.

On the other hand, proper and full use of the equipment is in direct relation to the collective relations – depends on the coordination and communication between astronomers in their work:

"Communication between people, especially people who are connected through telescopes or any tool, communication between them is very important because when you do something with the telescope you must notify everyone who might be affected. If everyone starts doing something without telling others what he did and why he did it, then we can get to the point, where every day we will re-invent the wheel and each time a different person will detect a different "wheel", which would be wrong. It is important to have good communication, so that when a problem arises, when it is removed, the others have to know what the problem was, how it was removed,

what the reasons behind its occurrence were, if they are known. And then, if someone encounters this thing again he will know how what to do."

Namely the accumulation of experience is relevant to the actor; with its help he and his colleagues are ready to handle crisis situations quickly. One of our actor's goals and tasks that he has set in his work in the Observatory is not to look at the equipment as a closed "black box" but to understand its actual character, how it works, what problems may appear, how they can be fixed. All this we can support with a quote that illustrates that the connection of the astronomer with the equipment is in fact deeper - his relationship with the team determines his relationship with the tool:

"One of the tasks I gave to myself is to make something like a list or to collect data in any form about the problems that have occurred with the telescopes and consequently how they were removed ... And when you have experience, when you have seen different situations, different things related to the telescopes that are non-trivial and there is no way ... or is very unlikely to appear again, then he is prepared. And if you see something, you will know where the problem might be and therefore it's much easier to focus the search for, the identification and then the fixing of the problem."

The fact that there is trust between the team at the Observatory contributes to the optimal use of technology and the improvement of the actor as a scientist. I.e. the network of relations is complemented - the role of the non-humans appears and it is no longer associated only with the

astronomer (actor) and space, but with all astronomers working as a team; it helps both their individual development as scientists and actors in this network and the development of science. In turn, for this process to be effective, proper planning of research is needed - what, when and how will be monitored and evaluated - which is related to funding. It directly affects the network of relationships - all actions of the astronomers, their participations in different projects depend on funding; every observation should be accordant with the financial capacity of the Observatory.

Thirdly, it is important to pay attention to the environment around the Observatory, which is also relevant to the actor and to the maintenance of the overall network of actants. Under environment we understand villages and resorts around Rozhen. The way they affect the work at the Observatory is connected mostly to light pollution, which hinders the implementation of night observations. We can give an example - the night ski slopes of Pamporovo resort as a whole, whose size increases through the years. On the other hand, the influx of tourists seems to have a positive effect on the Observatory – possible rising of interest in it as a tourist destination and hence in astronomy as science. All of this could stimulate scientific activities. We can summarize by saying that the environment is part of the network with both positive and negative influences.

The proper functioning of the network is directly dependent on the maintenance of good relations between the Observatory and the local authorities in the Smolyan region - both sides are trying to support and help each other:

> *"Since we are in the Smolyan region, we have, I think, a very good relationship with ... the local authorities and with other similar institutions, whether a community center or something of*

this kind. I.e. we see ourselves as part of this region and try to help each other."

To some extent, this creates the necessary security in the entire team of astronomers who can carry out their research "in peace" - they can count on the support from the local institutions. So the actor-network is maintained and developed. Example of the good realtions with local institutions is the Smolyan Planetarium, which maintains relations with the Observatory through summer schools. It thus shares experience with young people fascinated by science and that probably attracts future allies.

Last but not least, the compelling nature of Rozhen deserves some credit. According to our astronomer, it is the most valuable:

"There is a lot of life in and around the Observatory. There are all kinds of creatures that live in the forests around us. And my view is that we are their guests, not the other way around. I.e. it's their forest, the observatory is here, because it is appropriate ... Although we have modern, very modern equipment, this is also a nice place where life thrives uniquely."

The different atmosphere that nature creates around the Observatory brings the necessary positive influences favorable for scientific activities. The merging of nature with modern equipment and hence, the merging of nature and the actor is the last alliance we found in our network. Nature brings life in the Observatory - different from the one in the big city, but somehow wanted and sought by the researchers.

Our actor is "the expert" who has specialized knowledge of the science he deals with and develops: *"His*

judgments are not just guesswork or free assumptions." (Schutz 1999: 39) He showed this to us and thus he triggered our metamorphosis, changing our views as observers and researchers of the scientific process in NAO "Rozhen" - as a third party that sees things from a completely different angle. Angle, different from this of the man on the street and closer to the notion of the well-informed citizen.

"The well-informed citizen"

Heading to Rozhen, on the one hand, as part of the society, we were skeptical about what awaits us there, but on the other, as researchers, we brought our curiosity to the new object of study. As we get acquainted with the astronomer and the way he carried out his research at the Observatory, our ideas about this science also changed radically and enriched.

We can say that, even when we accepted our role of researchers, we managed to keep ourselves “naive”, but this naivety helped us to better understand the great changes that our immersing in this science caused. From people on the street we went to well-informed citizens. And this would not happen without our frank simplicity and enormous curiosity with which we plunged into this venture. We managed to trace how and why the misunderstanding of this science is possible, and how it can be overcome.

At this point we stand between the ideal type of the expert and that of the man on the street: "We do not possess the expert knowledge of astronomy, but we also don’t accept the irrationality of our unclear passions and feelings. We aim to form reasonable understanding of this scientific

area that is at least mediated." (Schutz, 1999:39). The transferred knowledge from the expert who informed us about this science was the turning point that changed our notions and ideas about astronomy.

Conclusion

Based on our analysis so far, we can really say that astronomy is a network, in the center of which stands the interviewed astronomer. We, ourselves, took him as a main figure - he was our starting point in building the network. We traced his connection with multiple homogeneous and heterogeneous communities, incorporating various actors. We tried to show how, allying with them, the actor enriches himself, develops as a scientist, and thus gives his contribution to the development of science. Functioning this way, the network of actors helps the astronomer with his most important initiative for the moment – his PhD thesis. In the long run he wants to achieve a decent life, as being a good researcher:

> *"In science, the thing that I can do and my goal is to be a good researcher, a man who does quality work and that's why I spend part of my time training, in order to learn to work in a better way ... someday when I retire, to have a number of articles with which to be proud and to know that they are something that will remain, something that people will read and will be able to rely on. Thus I'll be remembered professionally. "*

The effective functioning of the above-described network is what would help the achievement of these objectives. It directly depends on the support of the higher institutions and the state as a whole. Investing in the 'doing' of science, the state will trigger the development of astronomy and thus it will become more visible to the public. People will see the results and will not look at astronomy as a "black box" - they will become, to some extent, well-informed citizens. From this we can infer the reason why society misunderstands astronomy and accepts the marks of the man on the street.

This is the network that our astronomer drew himself by answering our questions. And the following conclusions we made were dictated by the current situation of science in our country and by the above-described view of the man on the street. Hardly astronomers realize and see the science in this way - as a network. In this sense, we can say that, to some extent, astronomers misunderstand astronomy too. What our actor strives to achieve:

> "*... someday when I retire, to have a number of articles with which to be proud and to know that they are something that will remain, something that people will read and will be able to rely on. Thus I'll be remembered professionally.* "

For them, success in astronomy is born from the small steps. But is this really astronomy?

Finally, we appear - the researchers who initially were part of the mass of people who misunderstand this science, but after facing the expert knowledge of astronomers, we became well-informed citizens who do not blindly believe in stereotypes.

Considering the consistent three points of view - the public image, the expert knowledge and our personal

impressions and metamorphoses, we made assumptions and conclusions about how and why the three described groups (what is the social knowledge they have about astronomy) misunderstand the here studied science. We followed how these three types of knowledge can flow through one another - as the most accurate example is our own experience.

As already mentioned, astronomy exists and functions as a network, but the lack of knowledge among ordinary people of how exactly it works, what it incorporates and what results it gives. The conclusion we have come up with, based on the interviews, observations and the following analysis is that the role of the state in the creation of science in Bulgaria, in its proper understanding among the people and in its development as a whole is very large. The lack of stable financial support affects the promotion of astronomy and the activities of scientists and creates wrong idea about the work carried out in the Observatory. And thus follows the misunderstanding of the research work as a whole, caused by the lack of information on the work and achievements of Bulgarian astronomers.

State institutions are an integral part of the network. They are the ones who can make it more effective and then bring astronomy closer to the people. Only the "talking" about science will help people stop thinking of it as a "black box", as something strange, too distant from them and from their hectic, full of problems everyday life.

To date, NAO "Rozhen", for a following year, is facing closure and the research work there is in danger of suspension. This was announced in an open letter on the site of the Observatory, which made it clear that the reason behind it is the lack of sufficient financial resources for the maintenance of the activities. This proves our words that what is being done for science in Bulgaria is not enough. It

is unfortunate that such scientists with great opportunities and enthusiasm must rely on donations and empathy.
We presented the essence of their work and good team relations. In fact, the Observatory is one of the best places for night observations due to low light pollution:

> *"However, we are still one of the best places in Europe, considering the darkness of the sky. Although there are lights nearby, they are not that much."*

The equipment is good and everything that's possible is done to maintain it:

> *"Since the beginning of the 21st century, I think since 2005, we have solar coronagraph, with which we can observe the Sun's corona. And this is one of the few appliances of this kind in Europe, here in our Observatory. Across Europe, I think there are only five such devices ... Very useful, very valuable instrument with which we can see how the Sun is changing every day ... We also have several new devices that have been developed for us. One is the focal reducer Forerro-2, which is a universal device ... Also a very good device and optimized for our telescope, making it very valuable. This device is just good and gives the best possible performance for our telescope. And our newest device still in development – the echelle spectrograph ... And that is also a very good instrument with which we can examine quite different set of objects and methods, and we can examine more stars, and any physical characteristics that are of interested to us about the objects we see.*

When optimized it will be very powerful device.
We are still testing it."

However, there is a lack of belief in the man on the street, untouched by true astronomy, that in our country astronomy has scope for development. If the average person understands what astronomy is actually "doing", this science will receive the necessary support and will prosper. And this will put an end to its wrong-understanding.

References

Schutz, A. 1999. The Stranger. LIK Publishing house, Sofia, 1999 (in Bulgarian)

Tchalakov, I., Mitev, T. 2014. Anthology in Social Studies of Science and Technology. Volume 1: Actor-Network Theory. StudioPlast Publishing house, Plovdiv, 2014.

http://nao-rozhen.org/index_bg.htm

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THE IMAGE OF AN ASTRONOMER: DELUSIONS VERSUS REALITY[7]

Anna Tikhonova, Elena Chernyakova

Abstract: An astronomer is a man of science. Contrary to the existing classic images of the astronomer, where he is represented as someone, who always sits in front of the telescope, watching stars, and who also wears a special suit - this is not so at all. In the article the "real" picture of the astronomer's life is discussed, it's based on the observations obtained by visiting Rozhen Observatory. The article is divided into several subtitles: the astronomer's appearance, the technical aspects of his work with the subject of the study, working day and the emotional appearance. We made an attempt to compare the image of an astronomer at students and citizens of Tomsk (mainly focusing on young people's opinion) with the facts that have been collected in Rozhen Observatory.

Key words: astronomer, observation, technical aspects, Rozhen, observatory.

Astronomy, as widely known, is the science of the Universe, which particularly examines location, emergence, structure and movement of the Sun and other stars; also it

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studies solar system planets, asteroids, comets, satellites, meteors and other celestial bodies. Thus, it becomes clear, that the field of the scientist-astronomer's activity is extremely extensive. And having visited acting Rozhen Observatory (Bulgaria), we drew our attention to the fact that an astronomer, as well as any other scientist, has his own specialization, ie he has a specific object of study, in research of which the astronomer can be engaged for most of his life. For example, someone specialize in study of the Sun, while other scientist can choose as his main object the comets' tails or the brightness and sizes of the stars and constellations. All of astronomers-researchers and engineers are combined by the most important thing - it is a big passion for the study of our Universe mysteries.

Our task was not only to understand how astronomers are engaged in the research, but also to determine the interaction of heterogeneous actors in the observatory, considering the observatory as a system, in which all its elements - astronomers, computers, telescopes and other equipment - interact with each other [1]. Having observed for not such a big period of time the work of astronomers in functioning observatory, the process of producing the scientific knowledge about the Universe on the "domestic" level, we could not stop to wonder how ordinary it looks in reality! All our concepts about the work at the observatory were literally destroyed. Upon arrival in Tomsk, we have decided to summarize the "real information", which we have possessed about astronomer-scientists on that moment to compare it in the future with the existing image that youth of Tomsk have about a person, who is involved in such sphere of science as astronomy.

We were lucky enough to look into the amazing world of studying the celestial bodies, and having saw from the inside the process of astronomers' work, we drew up a

number of questions, most of which, in our opinion, should be able to answer every man. Where and how does an astronomer observe the heavenly bodies? How does an observatory look like? What size should a telescope have and how does an astronomer work with it? What equipment is also used except the telescope? What people can say about the everyday life of this researcher? And who all these people, becoming astronomers-scientists?

If to be frank, before our trip to Bulgaria we also had only an abstract, and perhaps, a fantasy image of an astronomer from the medieval mystic movies and some other TV programs. Moreover, people often confuse astrology and astronomy. To avoid this, you should sort out these notions. After all, the ignorance of this difference has turned an astronomer into some magician-forecaster in the eyes of everyman. The basis of astrology is the idea, that it is possible to identify trends of further development of some certain phenomena or events through the study of planetary motion, the location of the stars in the sky and etc. In the journal "Nauka i Zhizn" the academician Vitaly Ginzburg calls astrology a pseudoscience, and it is absolutely justified, because the data, which is provided as knowledge by it, "contradicts to reliable scientific facts of the day" [2].

There is a very interesting tradition of learning something based on the condition that science is a special form of life, as it is some kind of review of scientific knowledge from its "social side". So it is called - public understanding of science, an example of this trend can be considered an issue of the journal "Public understanding of science". This is a relatively new approach studying the set of relations and links in science, technology and Innovations among the public. The point is that science is something unknown for many people: we see only the

results of scientific activity and absolutely do not understand where that comes from. This article is intended to check the knowledge of students in the area of astronomy, who are studying at the university now or have already been educated in the humanitarian and natural science fields.

The main problem in forming the people's image of the astronomer - that's who he really is. People often simply project their memories of the astrologer-stargazer, from what they have once seen in unscientific TV programs or have read in fairy tales in their childhood.

Having composed a short list of questions, we interviewed the students and the indigenous residents of the city Tomsk to confirm or refute the validity of our hypothesis. Because we had the experience of observing astronomers in their "natural environment" - the observatory, we were able to compare our knowledge received an experimental way with the information that we were said by people in the interviews. It is interesting enough that sometimes people spoke so inspiring and convincingly, but unfortunately, absolutely wrong. Our survey led us to interesting results - we had been partially right, and, perhaps, fortunately, that only partially. It means that scientific and technological progress "wins" the ignorance of the masses. This opinion can be confirmed by the words of a young man of 22 years old: "The astronomers - they are scientists, right? So, like all scientific men, they have to be absorbed by what they are doing. Well, then it is clearб that they need to be purposeful and serious relative to their work. And I'm not sure, what they dress – it may be white robes or some suits, but also it may be just some sort of comfortable casual clothes "(M., 22, Tomsk).

For this research we used the method of semi-structured interviews, ie we had a list of specific questions that we should have addressed in interviews with the respondents. 20 young people were interviewed between the ages of 18 to 28 years old: 10 of them had humanitarian direction of their specialization, and 10 - natural science; in both tens there were 5 boys and 5 girls. Also, for better understanding the whole picture we interviewed several seniors at the age 50-60 years old.

The astronomer's appearance

If you see a man, who has found his calling in astronomy, probably, you even don't realize it. In the Observatory all astronomers to the limit comfortably dressed not to freeze. It is particularly important, as the majority of observatories, and "Rozhen" is not an exception, are located in maximally open-air places for easy observation. And it is often that observatories are founded in mountains.

20-year-old girl was telling us very emotionally with laugh during the interview about the astronomer's appearance: "Maybe he wears a blue cap with stars and a black cloak? It is even more interesting, giving to his occupation some charm" (W., 20, Tomsk).

Some people doubted to give answer to this question at once, as if they were ashamed of their ignorance or their point of view. Thus, another girl-student initially asked for a few minutes to collect her thoughts together and only after that began to answer: "…like a stargazer, kind of an old man with big white beard, wearing round glasses…" (W., 19, Tomsk). Saying that she was smiling and laughing sometimes – it can be described as disbelief at her own

words. But still, the things, which she has said, are quite recognizable for an everyman. And it is true, that with reality, as we have already seen, it has quite little in common.

One more feature, which let us understand, that the interviewed girl was familiar with a fantasy "astrologer", but she did not share that image, and she referred to it as a kind of joke: "Clothes, well, he wears normal clothes, like a normal person. Of course, it would be funny, if he was in the hood and cloak with stars" (W., 20, Tomsk). Also, her image of an astronomer is more close to the real person. She clearly says that scientists, studying the stars, wear ordinary casual clothes. And certainly, it would be fun if they wore cloaks with stars, but they weren't.

Another girl gave a similar response: "... A grizzled old man with a beard..." (W., 19, Tomsk).

Real suppositions were said by two women around the age of 60 years. They said: "What do you mean how it is look? It is a strange question. So, I think a simple man. I think he wears as we are taking into account the place where he lives. That is all. What about the answers of other people?" (W., 60 years old, Tomsk).

The one thing that the majority of respondents agreed in – is the gender of astronomer-scientist. At the meaning of majority, more men engaged in astronomy, than women did. But they think that in any science more men, than women.

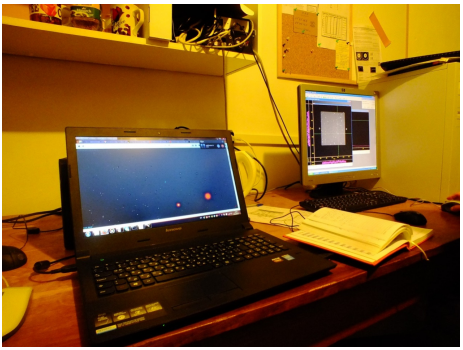
In Rozhen Observatory there was only one woman in the small collective of people. Thus, we can agree with the last statement. Our respondents allowed the possibility of existence of women astronomers in general, but did not hear about this.

Technical aspects of work

"How do you imagine working place of the astronomer?" – This kind of question we asked our interviewees. Girl-student 20 years old describes this way: "…I do not think that is a tower. So, I think that it is necessary to have a big window, glass ceiling or big hole in the roof; also it can be a terrace. There is nothing above your head. The astronomer can see sky without any problems. He can look at it. Here must be a simple telescope, but it is not important to have super-telescope…" (W. 20 years old, Tomsk).

Pic. 1 Two meters telescope.

The observatory "Rozhen" – is high building of circle-like shape with opening roof. On the high floor is located huge telescope – near 10 meter in high. On the same floor, there is a small room with computers, which monitor and record changes in the sky.



Pic. 2 Computer technologies through which astronomers explore sky.

Majority answered rationally on the question about equipment, reasoning in accordance with the general technical development of the present.

Previously were provided examples of women in general. We also were interviewing. So, guys-students said that the telescope is not the only instrument in the work of astronomers, which can have different size, also they use a computer, and spend most of the working time using this one. It is important to emphasize that the statement “A telescope's size depends on the object being studied” is very controversial. In the current observatory, communicating with engineers and astronomers, we were able to see the computers that were used 20-30 years ago (they are saved as a tribute to the memory of the past, we were very pleased to see), and innovative technology, which greatly facilitates the work of researchers in present.

According to the students meanings’ difficulties, which are faced by astronomers during their work, are “Optical phenomena in the sky: lightning or thunderstorms”. And this assumption is true; we can only continue the list of obstacles: humidity, cloudiness,

fogginess. Observation of celestial bodies is carried out in groups, where every person is responsible for his own object of research, in the further obtained information is processed and systematized; scientists think that the number of people in group must not be more than 10 people. We observed the work of group of people consisted of 6 person. Also they connect with their colleagues from other places and even countries, using Internet connection, which is very useful for this.

We can admit influence person's level of education on his answers. For students on the humanities more susceptible to the opinion that astronomer is a stargazer, while those who have a college education, think more realistically. But it is important to note personal warehouse of human mind. Sometimes humanitarians tell very interesting and truthful details.

It is very often that humanitarians does not think about technical 'little things'. One man at the age of 29, having liberal arts education, on the question –"What size must be the telescope?", without any doubt answered: "The more you want to see, the more it should be" (M., 29 years old, Tomsk). The only difficult with which person can face during his work, it is only his own "uncontrollable alcoholic state." We think, that this kind of answer is insulating to the people, who work in this difficult sphere. It is difficult to find the right time, when it is possible to watch this or that phenomenon. A lot of obstacles can intervene to this, moreover such incompetence sometimes may even frighten.

Working day

According to our observations in the observatory "Rozhen" astronomer's working day cannot be accurately normalized. Working hours with "the sky" direct connected with

weather, cloud cover, precipitation, humidity, wind. Of course, scientist's object of research is very important. If astronomer research the sun, then he will study it in the morning and the afternoon.

According to the meaning of the respondents, working day of scientist irregular: "In the daytime the researcher has the task, but at night tends to achieve a result." Also was noted that there are a lot of scientists, who study the celestial bodies in the morning or afternoon. And indeed, in the school we were lucky enough to meet one of them. The director of the observatory "Rozhen" – Nikola Petrov studies his object (the sun) in the daytime, because it is impossible to study it at night, as he says: "It is more convenient to observe the sun at daytime; to the same it is a great opportunity not to disrupt the daily routine" (Nikola Petrov, Rozhen, June, 2015).

For example one of the students of university in the Tomsk on the question: "How do you imagine work of the astronomer?" answered the following: "Probably, he is just staying and looking in the big telescope" (W., 22 years old, Tomsk). It is wrong, because of shortage of knowledges in this sphere – except for the telescope, astronomer interacts with other equipment, spends a lot of different accounts and calculations.

Emotional appearance

One of the respondents said to us the following phrase: "Astronomer must be married to his work" (M., 21 years old, Tomsk). We clarified the statement. We got an answer, that astronomy – is not just a profession, but also a vocation of man, for which he can sacrifice a lot: family, material

wealth and etc. In the observatory “Rozhen” we were watching people, who spend most part of their time at work. Most of them stay at work at nighttime; some of scientists live in the observatory. So, we think that this statement is a true. For example, director of the observatory lamented the luck of funding that is why people work there for idea, not for money. However, this situation is widespread in many professions.

“…It is common perception that science has become something of an arithmetic problem that it is created in laboratories or with the help of statistical card indexes using only cold reason, not all the "soul"…”, - this statement you find in the book of Max Weber “Science as a Vocation”. In this book he wrote the following “The man needs the idea, and, moreover this idea must be true, and only because of this condition, he will be able to do something complete” [3]. Arguing about his thought and adding information from the previous paragraph, we can continue and say that the “idea” comes from “inspiration”, which is born of passion: the passion of the scientist for his work.

As for the knowledge about astronomers of our contemporaries, we can say that there are a lot of influencing factor such as age, education and cultural environment. By and large, the interest in any science depends on sphere of activity in which a person is engaged and certainty that it is too hard to live in the modern world without scientific knowledge.

To sum up results of the work, it is easy to find contrast perception between astronomer and his craft. In the modern world, part of people who is not engaged in given theme professionally, get information in accordance with their personal curiosity or stumbling accidentally on articles in magazines or television programs. Faced with the experience of our research, it is possible, a number of

activists puzzled how nowadays to convey to the public a more realistic image of the astronomer, to clarify aspects of its research activities.

References:

Ginsburg V. L. Astrologiia i Izhenauka. Nauka i zhizn, 2008, no. 1 [Electronic resource] https://www.nkj.ru/archive/articles/1266.

Latur B. Peresobiraya sotsialnoe. Vvedenie v aktorno-setevuiu teoriiu. Ekonomicheskaia sotsiologiia, 2013, vol. 14 no. 2. Shuvalova O.R. "Obraz" nauki : vospriiatie naseleniem rezul'tatov nauchnoi deiatel'nosti. Forsait, 2007, no. 2. pp. 50-59.

Weber M. Nauka kak prizvanie i professiia, translated by Filippov A.F. Moscow: Progress, 1990.

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SOME DIFFICULTIES OF WORKING IN THE "FIELD" IN THE FRAMEWORK OF THE SUMMER SCHOOL OF ANTHROPOLOGY OF SCIENCE AND LARGE TECHNICAL SYSTEMS IN BULGARIA[8]

Seil Dzhanyzakova, Ekaterina Lukyanova

Abstract: In June 2015, there was anthropological school in Bulgaria, which was devoted to the study of anthropology, science and large technical systems and the identity of astronomers and engineers who work in the Bulgarian observatory "Rozhen". The school has already been held, but only the 15th school has taken an international character: It was attended by students from Bulgaria and Russia. Sure, a new level is a new stage in the development of anthropology in this direction, it brings its own difficulties - in the research of the objects of study, as well as in the communication between the members of the school. This article is about some problems that have arisen in the course of the study. Conventionally, we divided them in two aspects - theoretical and communicative. Like N.I. Vakhtin, we will try to describe the problems encountered during the study. The theoretical question is about the misunderstanding of astronomers and engineers; the communicative is about how we try to communicate with others without perfect language and so on.

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Key words: Bulgaria, anthropology of science, difficulties of fieldwork, observatory, telescope.

In June - July, 2015 anthropological summer school took place in Bulgaria which was devoted to studying anthropology of science and big technical systems, and also the identity of astronomers and engineers who work in the Bulgarian observatory "Rozhen" and at a dam in the settlement Dospat. This field has been relatively concerning the West European anthropologists for a long time and has 50-year history. The understanding of anthropology of science gradually evolved and today it is meant as understanding of science and its development from the point of view of the human pole in the informative relation subject — object. For Russian researchers this sphere of anthropological interests recently joined a discourse of modern researches that can't but attract the interest of both leading anthropologists and sociologists as this field is very perspective, but thus demands special applied preparation, introduction of a system approach to studying laboratory life of scientists, the community of researchers of different sciences and other aspects concerning this discourse.

The summer anthropological school of science and big technical systems has 15 summers history. The head and the main organizer of the school is Ivan Tchalakov – professor, head of Applied and Institutional sociology department at The Philosophico-Historical faculty of Plovdiv University “Paisii Hilendarsky”[9]. The research associate of the PAST Center of Tomsk state university also

[9] Site of Plovdiv university Paisius Hiledarsky [official site] / Historical-philosophical faculty. URL: https://uni-plovdiv.bg/pages/index/42

participated in the organization of the school along with the assistant from the Department of Applied and Institutional sociology Tihomir Mitev, who himself was a student at the Plovdiv University.

It should be noted that the Bulgarian summer school in 2015 for the first time got international status as Tomsk students – anthropologists - joined Plovdiv students – sociologists. Also the organizer of the summer field research from Russia was the associate professor of national history from the Department of History, and also the leading researcher of the laboratory of social - anthropological researches at the Department of history of Tomsk State University – Irina Popravko. Undoubtedly, the new, international character of the school means a new stage in development of anthropology in this direction, but, it is worth noticing that it brought also difficulties in the studying of objects of research, collecting specific "field" materials and in the communication between the participants of the school.

So, it is possible to allocate the main objectives of our research:

- supervision over everyday life of astronomers and engineers. The scientists in scientific community working in line with some certain paradigm theory are integrated, not only committed to it as to some truth, but also as set of social, psychological, moral circumstances. The world of scientists is a special world which can be compared to ethnos. People, submit to certain rules of conduct, a ban, special culture and, of course, have their own language. Rozhen's world isn't similar to the world of the ordinary citizen at all. Even day and night for the astronomer can differ, as a rule, astronomers are vigorous at night and at this time they perform the

main part of their work, and in the morning and afternoon they sleep. The world of the observatory, could be viewed as similar to Ariadna's thread in a labyrinth of visible chaos[10].

- studying of professional activity. Astronomers spend most part of their time working; therefore, it isn't surprising that work plays an important role in their life. Professional activity influences the person therefore without understanding of how the astronomer is engaged with it, it is impossible to understand his behavior, its character, and the relation to these or those subjects or things. So this was prime task. It was very important to figure out the actions of astronomers and engineers in order to better understand logic of behavior and lifestyle.
- artifact study. In the observatory there are a lot of various special tools which astronomers use. Starting with the instructions for a microscope, finishing with specially equipped computer. These tools or instructions - the description of the workplace of the astronomer or engineer, what the astronomer faces every day and what he works with. And so we entered our task of describing the tools with which scientists work – our task to try and understand how these subjects can characterize astronomers, and also to analyze them and to reveal special communications between the researcher and the tool.
- Visual analysis. The visual component is also important in such work. Here emphasis was placed on

[10] Latour B., Woolgar S. Laboratory Life: The Social Construction of Scientific Facts, Princeton University Press, 1986. (Chapter 2 from this book “An Anthropologists Visits Laboratory” was translated into Russian by A. Kuznetsov and published in journal Sociologiya vlasti, No. 6-7, 2012) quoted by Russian text, p. - 179

various instructions, announcements, writings on devices, microscopes with which astronomers work.

For the work within the research of anthropology of science and big technical systems: we were introduced to astronomers and engineers and in the first day we were divided into groups consisting of 4-5 people, in each group there were both Bulgarian and Russian students. Then each group chose field from a list which was offered by the organizers of the school. For example, it was possible to choose to work with the astronomer who is engaged in the studying of star clusters, or to work with the engineer who watches safety and serviceability of all microscopes and other equipment at the observatory.

The following step of research activity was the very access to the field. The participants of the summer school had no problems with that because the school assumes practical research work and so the contact with "objects" started quickly. First, because all participants of the school lived directly in the territory of the observatory where some astronomers lived as well, but the majority of them come from Sofia for some days in a week to observe the stars, their congestions, the Sun and other planets of the Solar system relevant to the subject of astronomical research and their interests. They were engaged in systematization of knowledge, writing articles in Sofia at the University.

During the immersion and work in the field we, anthropologists, had some difficulties. Therefore, the purpose of this work is to show what difficulties the young anthropologist can meet plunging into such field. We conditionally divided problem bases into 2 categories - internal difficulties which proceeded from researchers and investigation; those are problems in the "field"; and external difficulties which have impact on the field, for example, weather conditions, which are one of the important aspects

of the astronomer's work. If it's cloudy, direct supervision over the object will be impossible. Therefore, in the territory of Rozhen Observatory meteorological station is settled allowing the prediction of the weather conditions for a certain time. With internal difficulties we refer to: the theoretical insufficient preparation and absence of necessary knowledge during the work in a technical field and also the communication - difficulties of interaction both with astronomers and engineers, and with Bulgarian colleagues, which is understandable.

In order to introduce the research objective, it is necessary to give some characteristics to the Summer anthropological school. As it was already told earlier, the school took place in Bulgaria. Bulgaria is in the southeast part of Europe, occupies the northeast part of the Balkan Peninsula. Both in territory and in population — this country is one of the smallest countries in Europe. The value of Bulgaria is unquestioned, first of all, because of its geographical arrangement as it is at the intersection of roads of the Western and Central Europe and the Close and Middle East. Due to its geographical position Bulgaria has exclusively rich history which is reflected in a cultural originality, traditions, diverse kitchen, linguistic features, religious accessory of the state, and also in ethnic structure of the country. Bulgaria is very ancient. In this small country located on a threshold of Europe and Asia practically all great cultures of antiquity left their trace. Thracians, Greeks, Romans, Byzantines, Ottoman Empire. It is possible to notice the influence of the Union of the Soviet Socialist Republics in particular ideological aspects. All of them managed to visit the Bulgarian lands, all of them left uncountable monuments here: tombs, fortresses, temples, mosques and objects of art, and the most important

they left a trace and changed the life of the people living in this territory of Europe.

The capital of Bulgaria is the city of Sofia with population more than 1,4 million people. It's hard to say, which of the cities is the most ancient because almost all cities have interesting and long history. At the moment the largest cities of the country are: Sofia, Plovdiv, Varna, Bourgas, Russe and also Stara Zagora.

Plovdiv is one of the largest cities in Bulgaria, there is the Plovdiv university "Paisius Hilendarsky" [11] where for 15 years this summer school has been held and it already represents a certain sort of tradition, and the organizers are teachers of this higher educational institution. The university pays much attention to anthropological and sociological spheres studying science, innovations and technologies.

The Bulgarian National astronomical observatory - "Rozhen" which is located in The Rhodope Mountains, 25 kilometers from the small city of Smolyan - is located at the height of 1750 meters above sea level, the road to it lies through beautiful serpentine, with amazing nature, with periodically found barrows, a large number of springs. This place was not chosen incidentally – it has more than 200 sunny days in a year, and most importantly for the observatory - 300 cloudless nights in a year.

Except the beautiful panoramic view which opens before tourists in the territory of the observatory, they can also observe celestial bodies and stars through the telescopes. At the complex there is the two-meter telescope – 2m Ritchey-Chretien-Coude (RCC), 50/70 cm Schmidt

[11] Plovdiv university of Paisius Hilendarsky [an electronic resource] / Euro Compass. The higher education in Bulgaria. URL: http://eurocompass.ru/puph-plovdiv.php

and 60 cm Cassegrain telescope[12].

At night, time tours for tourists are conducted, where everyone can see the stellar sky with the telescope. It is impossible to describe this beauty, it is necessary to see it and feel it. The observatory opened in 1981. It is the largest astronomical site on the Balkans and in general in this region of Southeast Europe. Regular scientific activity began earlier, in 1979.

The observatory is equipped with several telescopes which are integrated in well considered equipment complex, providing conditions for development of several directions in the field of astronomy. They observe the Solar system – observation over comets, asteroids, planets, their satellites, and also over stars of our galaxy, over star clusters. Observations over other galaxies are also held, up to the most remote objects of the Universe, available to observation, quasars. The astronomers work on international projects, being part of the international scientific network. The center of coordination of this international network is established at the University of Yen in Germany. Such networks in astronomy are formed quite often. They ensure the round-the-clock observation over astronomical objects. Thanks to the specific geographic location, the observatory is responsible for a certain part of the days, in which the observation of some object is possible only from this location. This gives the opportunity for carrying out continuous observations over astronomical phenomena that wouldn't be possible from any other observatory.

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[12] Cassegrain's system [electronic resource] of URL: http://www.astronomy.ru/wiki/%0%A1%D0%B8%D1%81%D1%82%D0%B5%D0%BC%D0%B0_D0%9%D0%B0%D1%81%D1%81%D0%B5%D0%B3%D1%80%D0%B5%D0%BD%D0%B0%

The observatory is the only place in Bulgaria in which both professional astronomical activity, and educational work in the sphere of astronomy is carried out. Each night with a clear sky, telescopes provide observational material which is both used by employees of The Institute of Astronomy, and teachers at the universities and students. The national astronomical observatory is well equipped for scientific meetings, trainings and schools. And one such school of anthropological science was carried out this summer.

Anthropology is an interdisciplinary science, and an expert has to possess a wide range of knowledge in various spheres, whether that will be psychology, history or physics and chemistry - everything depends on what the "object" of research is. In order to work within the science of anthropology, it is necessary to have knowledge in such area which will help with the understanding and analysis of the field materials collected by the anthropologist.

Thus, the specifics of a field create difficulties in the process of studying that involves certain problems. It is possible to assume that the anthropologist has to be ready to enter such fields, and will need both the general and specific knowledge, which would answer the questions of this field.

This particular field – The Rozhen Observatory - demands additional knowledge in astronomy, physics, mechanics, even instrument making. It is possible to call it language of technical science and to compare it with the language of other people - the researcher has to know the language of those he studies as a huge layer of culture, traditions and customs is hidden in this language. Knowledge of language - a guarantee for the best understanding of culture of people, acts of people, etc. Therefore, going unprepared to a technical field dooms the

researcher to obtain incomplete information on his object. And also the probability of misunderstanding the major communications grows in the process of working of the astronomer. It should be noted that before the field work, we took a small course from Ivan Tchalakov (the head of the Department of Applied and Institutional Sociology at Plovdiv University) for he has been working in this field for 15 years and knows its "language". But when we appeared in the field, it became obvious that a small theoretical course isn't enough in order to plunge into the circle of astronomers without problems or to start understanding them with ease and to analyze. For the students from Plovdiv University more thorough training was carried out, which reflected in the quality of their researches: the Bulgarian students met less problems and could find quickly a common language with the equipment and the scientists. To solve this problem all participants were divided into groups which consisted of students both from Plovdiv University and Tomsk. So, it was possible to solve the problem of limitation of knowledge.

But here we also met difficulties. We had a language barrier. Shocked students of different courses took part and all had a different language preparation. In the group with which we worked, we had language symbiosis - English, Bulgarian and Russian. We tried to understand each other because it was important, first, for carrying out the general research. A group of 4 people worked with one astronomer or engineer and the task included working with him, supervision of his activity, and also description. Therefore, we had to establish the "rules of the game": how we will communicate when we meet our astronomer. The language barrier didn't allow us to carry out such strategy, also because the astronomer with whom we worked knew English and Bulgarian. Therefore, we decided to conduct 2

interviews: in Bulgarian and English. Also there were astronomers who talked only in the Bulgarian language and it was difficult to conduct interviews, to ask questions, to watch their work. In such conditions the researcher gains a minimum knowledge. Also it should be noted that the Bulgarian students had no communication problems with astronomers and engineers as there was no language barrier. Also it was possible to see that they have found a common language with researchers quicker. The Russian students experienced difficulties, but it should be noted that some astronomers knew Russian which allowed good communication.

It is possible to point out one more problem – the weather conditions. The observatory was constructed taking into account that astronomers will live there, so it was equipped with good hostels, rooms. But a current trend is that many leave and continue to go back to the city, and come to the observatory once a month for a week or two. Therefore, weather is an important factor for the work of the astronomer, because rain and clouds prevent supervision due to the lack of visibility of stars or planets. Often astronomers who are coming for a week to the observatory can't observe the sky. This factor became decisive for us anthropologists too. The astronomer, with whom we worked, comes to Rozhen for couple of days to make supervision and to return to the city as he works at the university. At this time, while he was at the observatory, the weather conditions didn't allow him to make observation and we, in turn, didn't see how the astronomer works with the telescope, what kind of data he collects. There is a "special connection" between the astronomer and the object of research which is very difficult to understand, but is also interesting to watch while establishing. According to Nikola - the director of the observatory who works with the sun -

the sun is a friend with whom he can communicate. This communication can only be seen while directly watching the astronomer in operation.

We allocated a problem of temporary limitation. Because of the complexity of the object, work in such field has to be long. We worked at the observatory for about a week. This period was not enough for us to deal with the subject of our research, to draw deep conclusions, to carry out the analysis. Therefore, conducting this school for 15 years is not a coincidence. This problem is closely bound with a theoretical problem. If the researcher feels a lack of base, theoretical material, it is better to conduct longer research to get acquainted with the field and to collect good materials.

We need to pay attention to an ethics problem. The ethical aspect in researches of the anthropologist plays huge role. And every time when you are in the field - it is necessary to remember not only the subject of the research, but also the rules of society, the ethical standards. At first sight, in this field this aspect isn't accented. But the good informant is always the person who trusts the researcher, he is ready to tell everything about the "favorite" work, all difficulties or arising conflicts. To gain the trust of any person, first of all you need time. People have to know each other. Therefore, it was important to communicate with and meet the informant much more often. And also the researcher has to be the first to make confidential contact. Having achieved it, there is other side of the problem - what to do with the received information? After all the informant can tell much that he wouldn't like to be given publicity. The anthropologist stands before very important choice: what to do with the received information? For operating time in observatory we met only the first aspect - it didn't turn out to establish the confidential relations with the

astronomer. Therefore, the information which managed to be collected has more official character, it is the kind of information told to any person. We didn't manage to learn something personal, interesting.

It is important to pay attention to how the anthropologist appears in the field. How deep this field has been studied earlier? This school has been carried out for 15 years and all astronomers who work there know that there is such practice, which takes place approximately at the same time of the year. They also know that it is necessary for them to work with students. This became a norm for astronomers and engineers; therefore, it is accepted as a reality. Why it is difficult for anthropologist? There are two sides of a medal. On the one hand, there is a certain trust between the observatory and the university, the arrangement which continues for several years, undoubtedly, means a strong link with the director of the observatory and a scientific cooperation. Astronomers don't perceive it as something exotic therefore can behave, also, as usual. That positively influences the research. Thanks to it, it is possible to watch the real work of astronomers and engineers. On the other hand, the 15th school for the first time has an international status that means a certain novelty. Therefore, astronomers may have changed their behavior and behaved formally. The interview with the astronomer B. can serve as an example, it was very interesting to him to learn much about Russia and about the purposes of our arrival. The interview took place in the form of a conversation, and the informant asked a question after answering to an approximately similar question from the interviewer.

Thus, we noted only the main problems considering the work in such field which, in our opinion, complicated the research. These factors, namely problems of theoretical character, communication, ethical standards, and also

external influence, are undoubtedly important and during preparation for research the anthropologist has to pay attention to them and to be ready to solve them. Actually they can easily be solved with the correct and system approach to a field and arrangement of priorities.

It is also worth telling that despite all difficulties of work, this experience has also positive aspects. First, as it was told earlier, for the anthropology students of Tomsk state university the work in such field was first time experience, and in our opinion, it was carried out quite successfully, moreover, we succeeded in getting valuable experience in anthropological research from a new view point. We managed to plunge into a field, to understand what difficulties the anthropologist or the sociologist can meet on the way. The international experience always carries new opportunities and prospects. Thanks to the collaboration with the sociologists of Plovdiv University we could exchange knowledge, experience, discuss the most exciting questions, tell about domestic systems of teaching and scientific approaches. This school allowed us to rise to a new step in our anthropological education.

Also we understood that it is important to remember that the anthropologist needs to have good general preparation as anthropology is an interdisciplinary science therefore huge background is required to enter any field. Without speaking about more difficulties, it is important to know foreign languages as language is an integral part of the research, it is a way of communication, of establishment of communication with the field - you have to know not only your language, but also the language of the object of research. And it is even more important to have special preparation - for a concrete field - to learn to speak the language of informants, and to understand them. Immersion

in the field doesn't require fast or single research; on the contrary it demands continuous interaction.

Thus, for the anthropologist to become a really outstanding researcher, it is important to remember all nuances and difficulties of work in the field which can arise in operating time and prevent them.

References:

Agazzi E. Reconsideration of philosophy of science today // Voprosy philosophii. 2009 .No. 1. Page 40-52.

Gilbert D., Malkey M. Otkryvaya yashik Pandory: Sociologocheskiy analys vyskazivaniy uchenyh. – Moscow: Progress, 1987.

Latur B. Dayte to me laboratoriyu I ya pereverny mir // Logos. 2002. No. 5-6.

Latour B., Woolgar S. Laboratory Life: The Social Construction of Scientific Facts, Princeton University Press, 1986.

Stolyarova O. E. Social constructivism: ontologic turn (an epilog to B. Latour's article)// Bulletin of MSU. Series 7. Philosophy. 2003. No. 3. Page 39-51. Uyti, chtoby ostatsya: sociology v pole / sbornic statey, ed. By V. Voronkov and E. Chikadze. – Sankt-Peterburg: Alteya, 2009.

Traweek Shanon. Beamtimes and lifetimes: The world of high energy physicists. Harward university press, 1987. – 195 p.
Woolgar S. The Turn to Technology in Social Studies of Science//Science, Technology, & Human Values, vol. 16, No. 1 (Winter, 1991). P. 20–50.
Woolgar S. What's at Stake in the Sociology of Technology? A Reply to Pinch and to Winner //Science, Technology, & Human Values. Vol. 18. No. 4 (Autumn, 1993). P. 523–529.

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ON THE LINE BETWEEN TWO ENDLESS WORLDS: THE SUN AND SOCIOLOGY[13]

Krasimira Maneva, Anelia Gudjova, Sibel Kehayova

Abstract: The purpose of our research is to describe the data received as a result of collected empiric information after the executed field work on the territory of NAO "Rozhen". Our team had the opportunity to be a direct witness of the accruing events, accompanied by the spontaneous reactions and actions of the astronomers in the observatory. Our job, more specifically, consisted of close "following" of the activities of Nikola Petrov, the director of the astronomic observatory and in the same time in charge of the Sun observations. More specifically, we will aim to lay the conception that we "discover" the sociology in their

[13] We send our most sincere gratitude to the whole team of professionals at NAO - Rozhen who had an open-hearted, understanding, and professional approach to all our questions. Certainly, we are also thankful to our respondent without whom our work concerning empirical data would have been impossible, as well as the followed writing of this present article. We are also thankful to our lecturers – Assoc. Prof. Ivan Tchalakov and Assistant Prof. Tihomir Mitev, who were the organizers of the summer practice and later on reviewers of the pieces of coursework prepared by us.

enormouse searching for answers of well-known questions for the world, as well as questions still unasked. Sociology is "discovered" in the purpose of science as such. We also "discover" sociology in the rule of unlimited right of discussion and critics, as this affects not only the results, but also the basic reasons and methods. The idea of progress, including the technique as well as the science, is deeply buried in their reality. To put it shortly we can say that both worlds – "the Sun" through the eyes of our respondent Nikola and "the Sociology" have a lot in common. And exactly where these endless worlds meet is the purpose of this research work.

Key words: worlds of science, scientific knowledge, science as vocation.

Our team "Sun observers" had the interesting, and as it turned out afterwards, quite inquisitive task to monitor closely the activities of P. N. To do this, two in-depth interviews were conducted, which included a number of observations, as the main one was based on the maximal extraction of information in the form of text (processed audio recording and notes during the interviews) and supporting photographic materials.

So, imagine our trip in the following way: our starting point was "Well, what are we going to practise on Rozhen, we are sociologists?", from thin starting point we reached the final one: Our practice was good! We "saw", in real life, some of the studied theories and they lived there and it was as if they became alive before our eyes. Because in order to be able to see it "you needed only your eyes". Not everyone can see such "connections" and such type of "relations" ...completely different, appearing "everyday" and "made everyday", but in their essence rather meaningful. What do we mean with all said up to here?

Perhaps that our development will be based on the Galileo's thought: "It is not important to be able to "see", you should also "paint" well" – in a way, the painting which we are now "painting" is our development and the more successfully we have recreated "the reality", the better eyesight we acquire. As a result, we simultaneously receive a fact and a proof.

Of course, we shall begin with some background information and a story about the creation of the National Astronomical Observatory – Rozhen; we shall present a short description of it, which will "involve the main characters".

The National Astronomical Observatory – Rozhen was officially opened on 13 March 1981 but the regular observation activity for scientific programmes started in September 1980. It is the largest one-time investment of Bulgaria in scientific infrastructure (more than 12 million levs) and it is still the biggest astronomical observatory on the Balkans and generally in this region of Southeast Europe. The object of activity of the Institute of the Astronomy with the National Astronomical Observatory is the scientific research in the field of astronomy and astrophysics and in the training of experts and PhD students in this field.
The institute has two modern observatories available for the performance of astronomical observations and studies - the National Astronomical Observatory – Rozhen and the Astronomical Observatory in the town of Belogradchik.

The studies in the field of solar physics, which have been conducted in Bulgaria in the last decades, to a great extent are connected to the development of strictly theoretical models, mostly on observation material, received from different observatories abroad. This is exactly what motivates the team from the "Sun" sector, the so called "sun

observers" to find a way to create their own observation base and observation programme to obtain their own material on the Sun. As a result of purposeful efforts, in 2005 a 15 cm coronagraph was developed and built in the Institute of Astronomy, which is now installed in the solar tower of NAO - Rozhen. A new programme for monitoring of the solar corona starts with this coronagraph.

On the one hand, the adjustments of the telescope are connected to the good understanding of the scheme of the telescope but on the other hand this means good practical understanding of the telescope itself. And it, as a carrier of functionality, is an "actor", intermediary and a piece of technology at the same time. That is why we gave a brief presentation dedicated to "its honour". If we had not done it we would not have been able to persuade you that it is a part of the living "local network", that it is active, that it is an actor, that it has "integrated" qualities and that through its functions, and namely through the work of the "scientist-researcher" they clear up and become "visible" to us. "Why is it so important?"- you would ask. What relations? (You are crazy!) It is relevant from the perspective of the mentioned "local network", the one which NAO Rozhen have built, not only as a social and technical environment and surroundings, but also the schemes, coordinates, specialized software, devices, telescopic tubes, team and objects for research and observation taken with them. Everyone "knows" their place there is a specified place for everyone, so if one "does not function" this hinders the entire network, threatens its functionality and it even, as we witnessed, may lead to a "crisis" (reference: "the object is not here" – who should I trust, the coordinates, my eyes or the problem is somewhere else). But the crisis and the explanations about it, as well as the deepening in the analysis of our participants can easily change our emphasis

and may "trick" us to "tell" you more about them since there is much to say. That is why we will keep our focus on our objective, so that we would not have to undergo crises or it would turn out that we have "lost the object". Our analysis of empirical data is preceded by a description which is the product of our "view", i.e. it is a personal position, personal attitude if you will - what we have "found", what we have witnessed and have become accessories to. We would not allow ourselves to channel the "scientific knowledge", i.e. the studied paradigms and theoretical models should not turn into a casing in which we can place that data – no, we are rather striving for "feedback". And this means that we do not aim to "introduce" or "put through" a theory at any price but we feel "lucky", that what we studied has helped us see again...because it is just there. We managed to see that line between theory and empirism which not everyone has had the chance to glance at – the relevant background is necessary when you are at field work.

Stepping in further in our work we reach one of the main aspects, namely, „The Sun" as a vocation and/or „The Sun" as a profession? Interviewing the respondent, his words about the question we had formulated made a strong impression on us:

> *"I cannot call it neither a profession nor a craft, if a person turns their job into a profession or a craft, this means that there is something which has superimposed itself well enough to lose sight of progress and interest in it, this is a thing which is connected to science. In my opinion science cannot be called a profession or a craft. Yes, a lot of people feel like that, it is true that this is my workplace and that is why I am paid salary*

but I, personally, would not call it in this way. It is pleasure. And it is pleasure connected to knowledge."

Referring to what Weber describes in "Science as a Vocation" we can say that when a person deals with science they inevitably need to have that charisma, according to which an individual has certain specific qualities, abilities and even power, without them having any significant personal contributions about it. Generally, the thing is that a person should not deal with something "which is not meant for them" as our respondent says several times. The love for science in its purest form is very clear in the quotation above because our respondent replied to our provocation to him very accurately and categorically, stating that even though that was his place of work, it was neither a profession, nor a craft. His position is clearly expressed here; the enthusiasm and the defensive reaction, i.e. he keeps "fiercely" protecting the scientific field and everything related to it, and his words are the evidence about it. According to him, only the routine and the "accumulated", as he points out, are reasons for an activity to be "placed" in categories like a "profession" or a "craft". Why did we call it a provocation? Because there is "nothing wrong" with practicing a craft, it is another point of view and and behind both of them lies "great skill", i.e. science is also a "fine thing" or at least we recognize it as such and it requires precision and "great skill" to handle scientific knowledge. But as our respondent shared, desire and dedication are the main things needed for science. That is why here we found a similarity regarding the "Weber's science" or the "The science as a vocation". So let that be accepted as an argument in favour of the goal which we

have set ourselves, namely, to prove where and how we saw "sociology" at the NAO - Rozhen.

To reach the true knowledge, according to Weber, it is necessary to follow a certain order of rules, an algorithm which should guide us, and every disregard of these rules is „going astray" so it has its respective consequences, which have a reflection on achieving the final result.

P. N. shares that the goal of scientific knowledge is the scientific knowledge itself. Science is knowledge which rests on precise principles, it has an object which existence can be proven by trials, achieved with clearly formulated methods, based on experience which may be shared, and with results, which may be expressed through concepts and formulas which can be checked. Science has pretentions for universal validity of its methods and results. Up to this day the specifics of science are stated through the formula of Galileo Galilei (1564-1642): „Measure what is measurable, and make measurable what is not so." The words of our respondent „Sun observer" justify that endless field which science has:

> "…*personally, in what I do there is a sufficient amount of unknowns, and more precisely a lot of things which need to be learned. I am far from what the entire science has achieved so far, I am even aware that I cannot learn absolutely everything, even what is well-known, but there are a lot of unknown things so the interest for me is related to the unknown."*

Here we made another provocation connected to the questions about the motivation and the specifications involving the "place of work" and the place itself as a local place. For our respondent this is the "right" place, "his"

place. Because here he is simultaneously distanced from the globalization but is also "*far from what the entire science has achieved until now*", i.e. an endless field is available, the horizon is both full and empty, there are unanswered questions which are evidence for a sufficiently strong interest which can be transformed in motivation for observation processes. In brief, the motivation is hidden in the unknown and in the arising issues connected with phenomena, which, as the respondent explains, if could be observed and explored, may give us answers about the world in order to understand it better. Thus, as he categorically states again: *'nothing is eternal..., life is not either'*; however, if we learned 'the rules according to which the world goes round', even if they were metaphorically said, we would be able to give an answer to the questions of how these phenomena happen, and not to 'how long it will go round' (so, not to those related to not-eternity). It is in their happening that we find a tangent with Sociology again.

According to Weber, the meaning of science is in the vocation. Moreover, in order to have a vocation for science, a scientist must have particular qualities like a close specialization, i.e., he/she must be a person from the world of science, he/she must do that with passion, and he/she must be inspired and determined. He/She must have the qualities of both a scientist and a teacher, he/she must be a leader, a head, but also far away from politics. It is in these features that the scientist's vocation is hidden. Both from the interview and our observations on the territory of NAO Rozhen, we 'find' these features in our respondent. Here are their reflections in the words of P.N.: *"… probably exactly this childhood in the countryside which is inside me has evoked some desire to know more about the things we cannot explain… And, in one way or another, those*

childhood accounts with the real things around me may have evoked the desire in me to learn the laws of how things happen… "– here we find where the inspiration for scientific knowledge comes from; *"… I studied the desired speciality – physics, specifically with astronomy, and I have been at the observatory since 1997 – I am employed with a permanent contract of employment…"* – here is the close specialization; "… *I cannot help but boast that the sun is the prettiest thing, as there is nothing more important in astronomy than the sun…"* – the sun is our scientist's passion; *"… Going to other places has always been valuable as at any time someone may say a sentence, a word, or a thought that is different from the one that is spinning in your head. The more you attend conferences, international meetings, the more you start understanding, and new issues start to arise, so that the relations with colleagues from around the world is a very serious momentum for knowledge…"* – the idea about progress is based on hard work, but not only. It is here that motivation and 'thirst' to reach knowledge 'interfere' again; it is you who 'find knowledge', because, as he explained to us, the exchange of experience often happens in common projects – whether on the improvement of a physical law or the realization of an idea of any of the respective physicists (astronomers) with a significant scientific statute. If some of them have an observation centre, and the idea has come from the other ones, the two things are enough for collaboration. Here he was certain: *"there is no 'separate work in astronomy, it is always a team work",* he said. In addition, it is never located in one country only – according to him this is impossible. This, in turn, talks about real collaboration which supports results from the relevant observation programmes.

"... Anyway, it has already been my 19th year at the observatory; for these 19 years I have been a manager, a head of the Observations Department, i.e., I am responsible for all the telescopes, I must know how all the telescopes work; I am able to fix most of the problems; yet, there is an engineering team, and when I am not able, the engineers join me so we solve the problem together again; and, at times when hundreds of problems occur, all of them different, one gains experience and suddenly the problems start repeating and are quickly solved ..." – we cannot ignore the skills of a leader and manager of the 'vocated' to science.

The borders of the scientist as a 'vocated' one are clearly outlined and our respondent showed several times that he is within these outlines. We talked about 'science as a vocation', so it would be appropriate to also talk about 'science as a profession'.

P. N. thinks that "*... if one turns what he/she does into his/her craft or job, this means that there is something that has had enough power to lose the vision for development and interest, and this is what is connected with science. For me science cannot be called a profession or a craft...*" 'A profession' is a kind of a work activity (employment or occupation) which demands continuous and intensive training and special knowledge and skills; as, in practicing a specific job, a relevant remuneration is expected (the so called salary).

We were impressed by the enthusiasm and euphoria which our respondent showed while telling us what he does in his job. The enthralling way, in which he introduced us to 'his works' made us feel a part of the whole picture.

Despite the various difficulties he and his colleagues have come across during the years, and not only once, they have never thought of giving up their job. On the contrary,

each difficulty has been a stimulus to go ahead once they have overcome it. No matter whether the problems have been financial due to lack of funds for servicing the needs of the observatory, or technical, connected directly with their job, P.N. is convinced that when you are making science there is nothing that can make you give up; while dealing with it you are totally committed to it – if not, you are not a true scientist. It is only when you give everything from yourself and concentrate on your occupation that the results will be positive, and it is of great importance in this job, because, as it is well-known, the job of the astronomer has its own specifications and, of course, it is dependent on the meteorological conditions which means that the true professional must, at each moment, be ready to react adequately to the situation in order to achieve the expected results. Fortunately, our colleagues and we had the unique chance to be witnesses of such 'a situation' and the reactions of the astronomers at that time revealed that spirit and charisma of the man 'vocated to the job' – the one who does not have any obstacles in doing his/her daily activities, the one who is ready to give up a lot of things an 'ordinary person' cannot do without in their everyday life.

It is here that we have to say that the connecting unit between 'the Sun' as a 'vocation' and 'the Sun' as 'a profession, is exactly our 'Sun observer' respondent who unites his duties at his working place (if it is possible to talk about any duties in this case) with his love of the job, thus showing us that he practises his job because of science itself.

In order to not be ungrounded, we will show the particular example from the interview with him, which was also another provocation. The case is the following one – we asked him: "*How would you convince someone who does not know anything about astronomy that you do*

important things?", and we had a proper and interesting response:

> *"… how would astronomy help Granny Pena to pay her electricity bill and live in the countryside, so, would astronomy itself and the galaxies spinning around, roughly said, help her status – no, it would definitely not help her. Thus, if you ask Granny Pena the same question - what opera and cinema are about? Why does Granny Pena actually need those cars with up to 1000 horsepower and such big expenses for fuel which pollute the environment? She does not need them. Granny Pena is already 80, 90 or 100 years old, she does not need school anymore, neither does she need a university. If we follow the logic for Granny Pena, who lives in this village without electricity - why does she not have electricity, why cannot the road reach her? Probably if she had an access to normal roads, electricity, media, television, and technologies, and the modern world had been with her earlier, maybe she would have needed knowledge, including knowledge in astronomy…"*

It is here that we again come to the conclusion that science makes the world go round, or at least it is the one that helps us explain the world's movement, i.e. innovations, technologies, modernization are important and relevant when they have a scientific statute, because in this way they become 'common-and-valid' 'good', i.e., knowledge is taken under control and can be turned into 'an instrument of production', so that one can handle their own world calling upon the experience and practices that can be checked in

time and space. Astronomy is a part of the contemporary pleasures, as it is stated by our interviewee. So here we leave you some fresh air to think if up to now we have not been able to convince you in the tangents with Sociology and in the relevance of Astronomy in general.

Even at first sight we 'were interested enough' in this 'micro society' we found at NAO – Rozhen, to examine it. Still another argument of ours is the thesis that physicists-astronomers are also explorers, they apply analytical and critical mechanisms, too; they have their own encoded language to which we are strangers, and we cannot understand the signs and the information behind them… because we are 'aborigines'. Then the coin turns, metaphorically said, because we clearly realize that we are not the faces of one and the same thing – Physics is Physics, Astronomy is a separate thing, and Sociology is 'something really different'; however, here we have made a rather dangerous experiment – by 'stepping on the edge' to explain to you our idea of 'the seen' – seen thanks to the studied and through the studied theories. Thus we tried both to enter 'somebody else's space', the 'foreign world' we had in mind, and to stay in our own one without 'touching' 'the other person's object', but, in the meantime, we tried to watch and practise our exploring abilities. It is here where the 'thin line' we have been talking about since the very beginning is hidden; that we are literally on the edge of two worlds, as vast fields of question marks spread before them; yet, it was very important to clarify that we would like to present one of the two worlds through the other one, but without dislocating the main aspect and the subject of our research. We made it our task to be able to give an answer to the question why our practice was held there. We found some answers, may be not all of them, but they are ours. As we have already mentioned above, we wanted to achieve

the goal not ‘as an obligation’ through theory (of Latour, Colon), but, when we ‘knew’ them we felt ‘lucky’ that we see and we have that vision.

We chose this topic because we tried to explain the two different ‘worlds’, i.e., our objects of observation were and are independent on their own; still, when we see them as ‘scientists – engineers’, i.e., if we have ‘these eyes’ to see the similarities between them, we can draw the ‘searched line’ as well. Actually, it is ‘a well-known’ fact in our scientific field that *Sociology as a science is ‘bordered’,* and as such it has ‘the privilege’ to ‘delve’ and find the social phenomena throughout unsocial topics, and the sociologist is Zimel’s *stranger, who ‘on one hand works on the edge of several paradigms’, and, on the other has that ‘freedom’ at the assessment and the objectivation of his object.* That is why we have implied here that we have a border to a field which is actually borderless itself, i.e., while we ‘are exploring the Sun’ we can make ‘Sociology’ – by meeting one single condition: to have a pair of engineer’s eyes which focus on the tangents between these separate and independent worlds, the tangents that do not just reflect data, but are actually its weight. The data from the two worlds is in different languages (moreover, coded ones), so ‘a real engineer’s decoding’ is needed to not only show the place where the data moves, but to also explain it adequately and fully. ‘Note: there is no way to avoid the moment of interference of technologies, tools, actors, social and technical environment, etc.; it is how our picture will be full and complete with respect to its analytical character. In the end we expect, in case of ‘good vision’, to be mature and to have captured the moment of legitimation of the scientific fact as an artefact. Thus we, in particular, like social actors, will be able to understand the astronomical artefacts just like the ‘Berlin key’ which does not only have

a mediation function, but also reveals 'the world of meaning', not 'the world of contents' – and all this through the movement of information in literal and figurative aspect. Why is it important to find the 'Berlin key' in our particular work? – Because in this way we would be sure that we have some social relations present; therefore – some social phenomena which can then be explored, observed and described. (see Latour 1991).

In brief, we can say that we tried to rationalize and summarize the empirical data collected on the territory of NAO - Rozhen, we pointed out the basic tangents of both borderless worlds like those of Astronomy and Sociology. We entered 'the unknown' like 'strangers' to get to know the 'indigineous practices', the reactions, movements, spontaneous emotions, the used language ('the two-meter-long', 'industrial accidents', 'colourful picture') and 'other similar', which impressed us greatly and left traces in us as 'scientists-sociologists'. We tried to give our picture comprehensiveness, but without deteriorating, interfering or damaging the foreign world. And while P. N. was convincing us that 'the Sunshine' is the most important thing, as, if it was maximally explored, the things which are learned about it, could be applied to the other stars as a theoretical frame, metaphorically said, in our case it was P. N. – the deputy director of the National Astronomical Observatory - Rozhen – who was our sun; and while the Earth was spinning around the Sun, P. N., like a 'Sun observer' was spinning around it, and we were spinning around him (P.N.) – both literally and figuratively. In conclusion, we are grateful to 'the Sun' that warmed us with his rays and brightened our consciousness.

References:

Weber M. Science as a vocation. In: Essays in Sociology, pp. 129-156, New York: Oxford University Press, 1946.

Callon, M. 1987. Society in the Making: The Study of Technology as a Tool for Sociological Analysis. In: The Social Construction of Technical Systems: New Directions in the Sociology and History of Technology, edited by W. E. et al Bijker. London: MIT Press., Pp. 83-103.

Latour, B. 1991. The Berlin key or how to do words with things. In: P.M. Graves-Brown Matter, Materiality and Modern Culture, Routledge, London pp.10-21.

http://nao-rozhen.org/index_bg.htm

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CHAPTER TWO

NAO ROZHEN LIKE A HETEROGENEOUS COMMUNITY: ASTRONOMERS, EQUIPMENT AND ENVIROMENT[14]

Alexey Tarasov, Ksenia Popova

Abstract: The article is dedicated to analytical description of National Astronomical Observatory Rozhen through the frame of the concept of heterogeneous communities. It is conceptualized as a heterogeneous community inhabited by different types of agencies (actors) – human (astronomers, technical stuff, and managers), non-human (domestic and wild natural beings) such as the object of research – Sun, stars etc., artifacts, and other technical facilities (telescopes, computers, weather station),

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which are included in various forms of association and cohabitation.

Key words: heterogeneous community, actor-network theory, astronomers, NAO Rozhen

Are the actor-network theory to the continuum of astronomers? Or maybe all arguments of B. Latour crumble in contact with the field research practice? These and other questions we asked, and came to our study in NAO Rozhen (national astronomic observatory Rozhen, Bulgaria). Based on these reflections, we have begun work.

Getting into a new field, the anthropologist faces a number of challenges, and we were no exception. Our main problem was the lack of knowledge in the field of physics and astronomy, and the lack of field experience prior to the interaction with the actors. Therefore, in the course of our investigation, we were like children, that adult thrown in the open sea, to learn to swim than professional anthropologists. An important guide for us then was the actor-network theory.

Following the work of supporters of actor-network theory,1 we have compiled a few of its main statements:

1. Heterogeneous communities is impossible without a symbiosis of "human" and "non-human" i.e. agents.
2. "Human" and "non-human" interacting with each other for a long time to form a new form of life.
3. "Human" and "non-human" interacting with each other to form a new type of relationship.

Based on this theory, we began our work in the field.

During the fieldwork, we are faced with the following situation: our informant Nikola Petrov (Director of NAO Rozhen) exists in a community made up of astronomers equipment (telescopes, computers, weather

station, research papers, etc.) and the environment. This continuum is a harmonious whole, and this statement head of station is confirms in their own words:

> *"…This association of scientists, and not only scientists, all with technology that we have [in observatory]."*

According to our observations, this harmony exists largely due to the "special" location of the observatory. This location provides favorable conditions for observation of celestial bodies. The observatory is located in the Rhodope Mountains in the distance from major population centers and popular tourist destinations. This isolated location plays a role of a filter, screening out people who are not able to full devote himself to science, or in the words of our informant:

> *"We had such a place... In this observatory, few people want to come here ... for example there is no discos, cinemas, restaurants ... If a person would like to quickly learn, this is the place - perfect. Nobody interferes with work."*

Due to the lack of external contacts communication between scientists, between scientists and the equipment becomes closer. Every astronomer at the station knows in all details the device with which it works. The level of knowledge in the area of professional equipment is so high that it is able at any time to repair or modify it:

"This is coronagraph ... Such telescopes in Europe, five and one of them is my doctorate ... Now that the telescope does not work very well: it is necessary to replace the filter, and the camera through which we see the sun because they are old."

Despite the closure of the space in which astronomers live and work, they have close contacts with scientists all over the world via the Internet (to communicate at professional forums, read articles with each other, and agree to participate in the conference). For exchange the data, they use special astronomical sites. Our informant demonstrated them:

"On the Russian sites have a lot of literature. Many books in the public domain."

What is interesting, providing free access to fresh research results the scientific community still remains closed. In the observatory, there is such practice as allowing amateur astronomers to observe the cosmos with the help of their equipment. However, such an interest, a sufficient amount of specialized knowledge and skills in working with complex professional technique there is not many. Thus, our astronomical community still remains closed in a narrow space professional. Not only scientist working closely with a technique creating a new form of life, but also the equipment has specific relationship with the environment. The environment may or may not provide the necessary conditions for the proper operation of machinery:

"Now 74% humidity, and between 6 and 24 hours was more than 90%. It will tell us

that it is impossible to observe: with humidity over 92%, it starts to spoil the mirror (optics) ..."

It is also a very important role plays location station. In Bulgaria, there is no better place for the observatory, than the Rhodope Mountains, but are more geared hubs for astronomical observations:

"Now we cannot see the sun because of the weather, but in other observatories can see it. Because of this, we have data. Here is the latest photograph of the sun from Austria."

Astronomical studies are highly dependent on the vagaries of weather. In this fact, we have seen from experience when we are with the staff of the station tried to see the stars with the help of the largest telescope in the observatory. The weather was cloudy, the sky obscures the thundercloud, are clouds. Due to this fact, astronomers were not able to collect the data, and we see through a telescope starry sky.

To keep track of the necessary conditions that allow conducting astronomical research observatories employees have special equipment, including its own weather station.

The situation in which scientists are at the station changes its worldview and character. People there are not as fussy as in the city, they value their environment and look at life more philosophically, even fatal. What it gives to science? Perhaps these mental attitudes are helping scientists to understand yourself and immerse yourself in a job that brings people to the visible benefit.

Let's look at it from the outside community. Before starting the interview, we as amateurs, had a small excursion on Scientific Complex. We pay attention to the

fact that during a visit to the location equipment of observatory, the scientists had to explain to us nonprofessional, many of the points that do not require a separate decrypting for them.

This professional "mythology" was described and analyzed B. Latour:

> *"It occurred to our observer that such location "in a field" facilitated the correspondence between a particular group, network, or laboratory and a complex mixture of beliefs, habits, systematised knowledge, exemplary achievements, experimental practices, oral traditions, and craft skills. Although referred to as the "culture" in anthropology, this latter set of attributes is commonly subsumed under the term paradigm when applied to people calling themselves scientists … The beliefs that are central to the mythology are noncontroversial and taken for granted, and only enjoy discussion during the brief guided tours of the laboratory provided for visiting laymen. In the setting, it is difficult to determine whether the mythology is never alluded to simply because it is a remote and unimportant remnant of the past or because it is now a well-known and generally accepted item of folklore."*

Later, when we interviewed, we are also faced with this phenomenon. Our backgrounds are not enough for a full understanding of the complex technical terms and abstract constructs:

«…Now, 27, 3 hours, a large cloud of solar wind to the Earth it is pressed.

Anthropologist – you can not tell more what the solar wind?

Informant – Yesterday, when we talked about it, that the star, such as our sun, it burns the core, there is a synthesis of hydrogen nuclei. This turns the energy. This energy eventually produces gas ball. All radiation, which we call radiation, that is all - the particles can be, free electrons, photons, ultraviolet or gamma rays, all of this - it is the solar wind. Still, at a distance from the center of the Sun, the solar radius - we call it the solar corona. Then, continued, called the solar wind. However, it is the same. "

What do we have? We came to a kind of «aborigines», whose rituals and beliefs, whose language we do not understand? Here we are confronted with a strange phenomenon - people of the same civilization, the same cultural level, living only at opposite poles of the scientific world, perceive each other as strangers, as two completely autonomous «subculture». Do not need to anthropology of science, to plunge into oblivion, these boundaries between disciplines and to make any scientific knowledge understandable and accessible to every educated person, regardless of the profile of its formation?

We asked this question at the end of our interview. The answer to this question is not so clear. On the one hand, the researchers engaged anthropology of science, serving as a «bridge» between the scientists of technical specialties and those who are far from the «big» science. On the other hand, there exists strong need in this? It is quite heterogeneous community do without the amateurs,

remaining closed community. But in any case, they should not remain unknown.

However, is the complete closure of these communities, a positive trend? Since then, the science took shape as an independent field of activity, it has become closely with politics, or rather, the policy from the outset, took science in turnover. In addition, one of the main problems of science - to constantly prove if not the world, the politicians their necessity and urgency. Unfortunately, those in power can not always see the existence of the need for the individual and for the world community as a whole. Thus, in the countries of the former Warsaw Pact, many promising scientific projects suspended due to lack of funds and a large number of scientists are forced to continue their work abroad 3. Do not forget that the science in these countries can not extract profit from their intellectual «product». So maybe we, anthropologists, is to do "advertising" and the popularization of scientific activity that scientists themselves are not wasting their time and effort.

According to our informant, his science (astronomy) has great importance for the life of all mankind:

> *“In the US, 5-6 years ago, we made a report commissioned by the state, "What will happen if such a strong magnetic storm will happen in the US? If you turn off all the electrical network in the US, they will recover within 6-7 months, subject to electricity running in other continents ... Let's think about the big cities. The water goes through the blocks with pumps. They need electricity. First - there is no water. However, what about the health of people? All gas stations run on electricity. Well, they have generators.*

1-2 days. No more filling stations. What will happen to our products, which are kept at home? Still, our civilization will end. We will return to the Stone Age."

As you can see from this quotation, science in Western countries such as the United States, actively sponsored by the state and its fruit is actively using. In the countries of the former Warsaw Pact, there are many problems with the financing and the receipt of grants:

"Now we have in Bulgaria are no grants for these things [i.e., to buy telescopes]. I'm still in charge of a computer network. In addition, a month ago, I burned a single computer and router. I bought a new one, did set up the router, but no computer. The chiefs said: «there is no money». However, we can not work without the Internet. I had to take the cheapest router."

Problems with funding are so serious that in the 90s the station was turned off heating, without which the working and living on the station were simply impossible.

However, Bulgarian astronomers found refuge in private funding. So, our informant says:

"Next week I will be in Sofia, where my friends have prepared a new computer for me. For him, I paid my friends. On the solar telescope of my friends gave money. When I do an expedition on the solar eclipse, the money was given only sponsors. I have very good communication with those with whom I studied physics together. Only one of them is now engaged in science, woman. All the

rest - they businessmen. Therefore, they give the money. Every year we are meeting 20 people at the observatory."

Therefore, for the most part, the Bulgarian observatory exists at the expense of patrons. Is it correct? What more rational - get scientists to survive on their own, learn to earn, like their Western counterparts? Alternatively, entrust complete responsibility to the state structures, to oblige them to allocate a certain amount of money from the budget is for grants and technical support to research centers in the country? This issue is actual for Bulgarian and for Russian science, with all directions, and the humanities, and engineering.

Summing up, we can conclude that there exists heterogeneous community, it is in constant interaction with each other and form a qualitatively new relationship, a single form of life: space observatory. This community is closed and difficult to accept amateurs, but despite this, it is not autonomous, and depends on the policy of the state and private funding. The next stage of research within the subject should be to identify opportunities to build heterogeneous scientific community into a modern dynamic society. So we think.

References

Tchalakov I. The Amateur's Action in Science // G. Kapriev, M. Roussel and I. Tchala-kov (eds.) Le sujet de l'acteur. An anthropological outlook on Actor-Network Theory. – Wilhelm Fink, Paderborn, 2014. Pp. 25 – 64.

Knorr-Cetina, Karin. "Objectual Practice." In: Knowledge as Social order: rethinking the sociology of Barry Barnes / edited by Massimo Mazzotti p184–197. TJ International Ltd, Padstow, Cornwall, 2008.

Latour B. Science in action, How to follow scientists and engineers through society. Harvard University Press, Cambridge Mass, 1987. (Quoted by Russian translation - Latour B. Nauka v deystvii: sleduya za uchenymi I inzhenerami vnutri obshestva: Izdatelstvo European University, SPb, 2013)

Latour B., Woolgar S. Laboratory Life: The Social Construction of Scientific Facts, Princeton University Press, 1986. (Chapter 2 from this book "An Anthropologists Visits Laboratory" was translated into Russian by A. Kuznetsov and published in journal Sociologiya vlasti, No. 6-7, 2012)

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TELESCOPE AND SPECTROGRAPH AS NON-HUMAN ACTANTS IN THE ASTRONOMER'S WORK[15]

Ivan Tyukhtenev and Artem Teterin

Abstract: The purpose of our research is to present the work of National astronomical observatory in Actor-network theory (B. Latour, M. Callon). We collected vast and diverse amount of empiric materials. We were witnesses of different aspects of astronomers' and engineers' work and dwelling in Rozhen observatory. Fortunately, we interviewed G. N. during his work with the spectrograph. It gave us quite enough information

The main aim of our work is to track networks between astronomer and the technical equipment which he uses in his researches (telescope, spectrograph, etc.), and the influence of technic on character of obtained information.

According to actor-network theory we considered technique as mediator actant between scientist and the information which he gets in result. We will try to explain the speciality of information which scientists receive.

Keywords: Actor-network theory, telescope, astronomer, spectrograph

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Introduction

This summer (22 of June. – 1 of July 2015) we (Ivan Tyukhtenev and Artem Teterin) participated in 15th Plovdiv STS Summer School “Anthropology of Science and Large Technical Systems: Identities of Scientists and Engineers” in Rozhen Astronomical Observatory in Bulgaria. Our supervisors were Ivan Tchalakov and Irina Popravko.

The field of our research was an anthropology (or sociology) of science also known as Anthropology of Science, Sociology of Scientific Knowledge (SSK) or Science and Technology Studies (STS). Moreover, our study partly concerns anthropology / sociology of everyday life.

The immediate theme of our study is “Telescope and Spectrograph as non-human actants in astronomers’ work”. Through the prism of the actor-network theory we will try to describe the connection between astronomer and technical equipment which he uses in his research, as well as to show some specific features of scientific knowledge obtained by astronomer as a result. In addition, we will consider the relationship of astronomers with the equipment, their attachment to it.

The main source of our research is the empirical material we collected. We observed the work and everyday life of scientists and engineers at "Rozhen" observatory, using the method of participant observation; we interviewed

scientists, did a lot of field notes, and collected photos, audio and video material.[16]

The basic theory used in our work is the actor-network theory - representatives are Bruno Latour, Michel Callon and John Law; also we used some of the works on the anthropology of everyday life and scientific knowledge.

The geographical location and the observatory arrangement

Talking about the observatory, it should be noted that it is in Bulgaria's Rhodope Mountains at an altitude of 1730 m, 25 km from the town of Smolyan. It is the largest observatory in Eastern Europe. A rather steep serpentine leads to the site, and the observatory itself is surrounded by pine forest.

Territory of the complex includes a number of buildings which can be divided into several groups:

1. Hall of residence
2. Big telescope (2 meters)
3. Group of three smaller telescopes
4. Meteorological station

The hall of residence is wide multistoried building, which also can be divided into several parts. There are a lot of blocks of small bedroom, restroom, shower and kitchen. These rooms were intended for us and our Bulgarian colleagues-sociologists. Additionally, the campus has a

[16] Majority of audio materials, used in this work graciously shared us by Darena Hristozova and Zorniza Yulianova

conference room, a dining room, a snack bar and the working rooms of astronomers.

We can make some conclusions based on this information. First of all, the hall of residence is designed for permanent (continuous), long (year-round), relatively autonomous residence of astronomers on the territory of the observatory. If there was constant supply of food the astronomers would be able not to leave it whole year. Second, scientific assemblies could be held here.

As for the (main) big telescope, it is part of a multi-floored building with a basement (underground floors). There is special technical equipment on each floor. This equipment ensures the functioning of the telescope, the data processing, etc. Unfortunately, we were not able to explore the arrangement of the main telescope thoroughly because we did not have enough knowledge to understand its system. We were able to examine only the first floor (vestibule, foyer), the room where the big (RRK) telescope is directly located, as well as a small room, where the big telescope controlling was carried out.

There are four large telescopes in the observatory. Three others located separately on a hill not far from the big telescope. We managed to explore one of them. Their arrangement is much simpler than the big one. The buildings are with one floor, the telescopes have much smaller size and they have manual control.

All three telescopes have a different arrangement, diameter of the lens and different spheres of usage. There are 50 \ 70 cm Schmidt telescope, 15cm telescope - coronagraph, 60 cm Cassegrain telescope, as well as 30 cm "tourist" telescope for visitors.

We surveyed the meteorological station much less than the other sites, but we can sum up that it is a vast field (lawn), where a lot of meteorological instruments are

located. As we later found out from the words of scientists, this meteorological station has great importance in astronomers work, namely the observation of the firmament is directly dependent on the weather.

We also found out that the observatory is periodically visited by tourists, for whom excursions are organized.

In addition, communication and purchase of products (food and household) is difficult in the observatory. There are several kilometers to the nearest supermarket. Also, due to the specifics of the work of astronomers only electric heating is possible in the complex, but the funding of the complex is extremely small and so it is very cold in the hall of residence. In general, these circumstances did not prevent our work.

The vast territory of the observatory sharply contrasts with the almost complete absence of people, apart from us, and Bulgarian students. The laboratory staff consists of several dozens of people, though we found only a half a dozen people, and at certain times there were only 2 - 3 individuals in the observatory. The staff of the observatory is not homogeneous, it includes astronomers - scientists, having higher education and research astronomers and engineers with vocational education who service the observatory - telescopes and other equipment and ensure their proper functioning. Moreover, as our interviewer said, astronomer-scientists can be divided into observers and theoreticians. It is impossible, however, to say that the scientists are engaged only in writing papers, and the engineers are engaged only in equipment commissioning, as we had seen, astronomers also know how to adjust the equipment, but may be not that sufficiently. It should also be said that the head of the observatory is Nikola Petrov. He is an astronomer too, but

apart from that he is engaged in the management, organization and financing of the observatory. So we can say that the staff of the observatory is a heterogeneous community starting even from different age and education and so on. In general, it can be said that the observatory has a fairly complex structure.

"Seasons" in the observatory

Time in the Rozen observatory has some interesting specific features. Since the observatory is located at a sufficient distance from the city and all settlements, that influences astronomers' work. It allows astronomers to concentrate on their work and not to be distracted. They work almost without leaving the lab, of course, excluding the purchase of food and holidays and vocations. In addition, the very specificity of astronomers' work sets a certain rhythm of life at the observatory.

Time and season affect the type of work. For example, the observation of celestial bodies is possible at night or early in the morning, if the targets are stars, or from sunrise to sunset for the observation of the Sun. Hence the timetable of astronomer depends on his field of researches.

For example, G. (our respondent) wakes up pretty late, because he is exploring star clusters and needs to work all night. Opposite, Nikola (director of the observatory) gets up very early in the morning, because he explores the Sun.

The schedule of astronomer is not normalized by definition, as G. said: «We work, until our work is done», and more «During the day we work with papers, and when it's night we observe»

Last quote shows that we can't say that astronomers sleep during the day and work during the nigth, but rather

that astronomers work day and night, just the type of work is changing.[17]

Also weather conditions are very important too (cloudy for exemple). The visibility of certain celestial bodies depends on the time of year, so for example, the star Sirius can be seen only in the winter. So astronomers plan their observation in advance: «We plan our observations for year or half a year ahead» - G. said.

The tourist season has special impact on their time and work as astronomers in Rozhen, when part of the astronomers transform into tour guides.

We can say that astronomers are rather peculiar tribe living away from towns and has its own original rules.

One astronomer and one telescope

Description of the observatory is very important because it helps us to put it physically, that is, as a space filled with a variety of objects (buildings, equipment, etc.), to determine its location and purpose. Also there is the staff of the observatory, which also has a structure and features. Starting from this, we can interpret the action taking place at the observatory. But our main aim is to study the scientific knowledge. Actor-network theory will help us in this part.

The basic statements of actor - network theory we have learned from Bruno Latour's and Steve Woolgar's work "Laboratory Life: The Construction of Scientific

[17] These words cannot be understood literally. Astronomer is not staffed around the clock every day.

Facts"[18] and Michel Kallon's work "Some elements of a sociology of translation: domestication of the scallops and the fishermen of St. Brieuc Bay"[19]

This theory, in spite of some shortcomings, is perfectly suited for our research. Actor-network theory considers any object (either animate either inanimate), which interacts with people as "actor", or something, that acts, influences people. Through the prism of this theory, we can easily imagine all the staff, all the equipment of the observatory, and also ourselves as "actors". In turn, among all the actors; there are many connections or networks, through which the impact turns. Thus, we have a model in which all the surroundings has significance, the place where specific activities are underway and specific relations originate.[20]

Let's go now to the office of managing the RRK telescope, where we went to interview the astronomer G.N. G. is 32 years old, he is a scientist, he graduated with a degree in "Mathematics and Astrophysics" at Sofia University. We conducted group interview with two Bulgarian students-sociologists Darena Hristozova and Zorniza Yulianova.

Unfortunately, there was language barrier between us, the astronomers and Bulgarian students. We absolutely didn't know Bulgarian language, and they almost didn't understand Russian, so the language of communication was English. Our knowledge of English also was rather

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[18] We had read this work in Russian, that's why we reference to Russian edition of one chapter in journal "Sociology of Authority" («Sociologiya vlasti» № 6 ,2012)

[19] The same reason ("Sociologiya vlasti" Vol. 27 № 1 ,2015.

[20] Tchalakov The object and the Other in Holographic Research: Approaching Passivity and Responsibility of Human Actors//Science, Technology, & Human Values, Vol. 29, №. 1 (Winter, 2004) p. 68.

mediocre, which reflected on the interview, it was fragmentary, and its transcription was problematic.

Nevertheless, in spite of the language barrier the respondent with whom we communicated were open to dialogue, gladly answered our questions, joked, shared his thoughts about his and our work. We were able to gather a lot of information.

We followed G. into a large observatory. When he reached his workplace, he recorded in the accounting journal. After that we entered the main hall of the observatory where we saw the big telescope with the scheme of his devices. There were many pictures of star clusters, planets and galaxies on the walls in the room, among which only a few had been made in the Rozhen observatory. After seeing a large room, we went to G. in the office of management of the big telescope. The cabinet was a small office space with desks, chairs, shelves, various appliances, boards for notes.

Especially important objects, of course, were the computers which receive and process information from the telescope and spectrographs, as well as the small remote telescope control.

The control panel allows astronomers to control the movements of the telescope, turning on or off the telescope in critical cases (mechanical damage, overheating or system malfunctions and other emergency situations).

We were lucky that the interview was conducted during G.'s work. He had been diagnosing the telescope by means of computers, checking camera noises for a few hours (he lowered the temperature of the telescope and checked the data).

During the interview, we asked variety of questions related to his biography, science activity, education, household and the equipment of the observatory.

We asked a lot of improvised questions too. As a result, we found that the work of the astronomers depends on the time of the day, weather conditions and season. So, observing the celestial bodies is possible only at night or early in the morning. Also weather conditions are very important. The visibility of certain celestial bodies depends on the time of the year, so for example, the star Sirius can be seen only in the winter. G. explained to us the principles of the spectrograph device.

The spectroscope is used to break up the radiation emitted by a celestial body into pieces, selecting just one narrow slice of spectrum, such as green or red. It helps astronomers to get some information about the composition, temperature, size of the celestial body, etc. There are different types of spectroscopy (infrared or gamma radiation), but we have considered only optical.

We can consider that the spectroscope is one of the most important mediators between the astronomers and the stars.

We found that during operation G. not only speaks and writes his scientific work in English, but also thinks in English. This is due to the fact that the current work on astronomy is being published mostly in English.

- In our work we need to know English because all books we use are published in English and some international journals too.

- And what about Bulgarian journals?

- There are some Bulgarian journals, but if we write in Bulgarian, only colleagues, who know Bulgarian will be able to read and to understand what we have done here. So that's why we need to work in English, to write in English – in order for everyone to understand what we are doing here.

- Can you work with international colleagues?
- I've been in Greece for four years, working with greek colleagues there and everything we did there, we did in English.

It also affects the work obtained as a result of scientific research. The international scientific community here is the actor, "forcing" the astronomers to publish in English.

We, however, decided to narrow down the topic of our research to the relationship between astronomer (G.) and technologies with which he carries out his research (spectrograph and telescope).

It should be known that technology is an essential element (the mediator) between astronomer and obtained scientific knowledge. According to G's speech, as well as our observations, the peculiarity is that astronomers don't work with celestial bodies themselves, but with their images (graphics and photos), made with the help of special equipment:

- The camera downstairs is supposed to be cooled down to – 80 degrees. It's cooling needs to be slow, so that the camera is not damaged; slowly we cool down the camera, then we take pictures.
- We have image of the sky taken by the camera, which have some pixels.
- We collect the light from the sky, and then project it on the camera. We can measure these pictures: where the object is in the sky, we can also measure how bright it is. We can compare the photo with our background and understand that the object is with that exact brightness.

- We cool down the camera because if the camera works in room temperature (20 degrees) it makes noise, because of the high temperature. When we cool down the camera the noise reduces enough. With the other telescopes we work at temperatures like -30 degrees. …we need to reduce the noise in order to receive signal, if we have many noises we can't see the signal.

It means that equipment transforms the obtained information, turning stars and planets into photos and graphics of stars and planets. G. said that they get new information about the celestial bodies, and compare the new images to previous ones. But simply, they construct new information by comparing new images with great amount of background images. Here we can consider that the astronomer is extremely dependent from his own equipment. That was the purpose of G.'s work, checking the noises in the telescope and the spectrograph; he tried to improve the quality of the images, the quality of the obtained information. He noted that this is one of the most important activities of astronomers.

- What are you doing when it's cloudy, and you can't?

- Most our job is working on a computer, reducing the noises, taking up the signal, taking up what we need from the images, it takes time, it takes efforts. And that's what we do when it's cloudy. We usually have some data… we use this data to create the results. Also our job (the big part of our job) is to read papers, to write papers; we plan new observations over the

year (half of the year). We read what we need to observe, why we need to observe it. So most of our time we do these things, not an observation. It means that badly debugged spectrograph, untrained telescope can change the results of many research works and on a large scale it can change some of our conceptions of the world's structure.

Moreover, the essence is not in the telescope being badly adjusted, its participation in the study that forms the information which the astronomer receives.

As a result of such work astronomer may receive only images on paper, but the paper and the star are firmly united. Now the graphic is the star for the astronomer, and the really existing star is not of interest to him. Thus any astronomer who sees graphs of stellar radiation will tell you that it is a star, and determine what star it is. And only this data - passed through a telescope, spectroscope, and computer programs will be the basis for writing scientific papers.

If we suppose, for example, that those astronomers didn't have telescope or spectrograph - such situation the astronomer will receive other information about the stars and based on this results he would build other reality. So before the invention of the telescope by Galileo Galiley, people's representations about the nature of the sky, stars, sun and moon were rather different.

Likewise, the theories of astronomers can change if their telescopes were more accurate. In any case this will be the construction of the facts.

We should however realize that the Actor - network theory allows us to select only the relationship between scientists and technical equipment, among scientists

themselves, to follow the process of formation of "scientific knowledge", but does not allow to consider other aspects of the scientists' life in the laboratory.

Attachment of scientist

Another part of our work as we noted in the introduction is astronomers' attachment to their equipment and specific procedures which they are performing during work. During our researches and interviews we faced a lot of things that can be considered as attachment, the "strong link" is not in the 'direct relationships' between researchers and their research objects (the nonhuman agents they are taming), but between researchers and the technical artifacts, equipment and procedures they are using in this process.[21]

Fortunately, we were able to witness the way astronomers observe the sky through the telescope. An example of this can be the observation of some stars by G. and his colleagues with the "small" 50\70 Schmidt telescope. Astronomers coordinated the telescope very carefully, so we concluded that using the telescope is hard time-consuming process. We were very amazed with their work.

There is this quite interesting fact that G. and his colleagues used the telescope without automatical configuration, in which you can enter the coordinates and get a result. They worked manually, thus complicating their

[21] Tchalakov, I. (2014) Amateur's Action in Science, in: Le sujet de l'acteur: an Anthropological Outlook on Actor-Network Theory, Special Volume of Morphomata Centre for Advances Studies (Internationales Kolleg "Morphomata"), University of Cologne, Germany.

work. Perhaps this is due to G.'s desire "to bring himself closer" to the star, he has observed, because as we have already noted, the big telescope is automated and controlled by computer and maybe this makes observations more boring.

It was actually G.'s birthday, but in spite of that, he celebrated it looking up at the stars through a telescope with his friends – colleagues (but he could do any other thing). Of course this showed us the fact that G. loves to observe the sky as he said many times.

However, we may have noticed that G. likes not only to observe the sky, but also the process of working with a telescope. G. and all his colleagues were in a very cheerful mood. They smiled and laughed, "fascinated" by the telescopes and the sky.

Despite the fact that from the one hand, working in observatory is mostly analyzing of papers, from the other it is 'strong link' between astronomer and the celestial body which he observes.

Conclusion

Thus, we studied the work of the National Astronomical Observatory Rozhen, as well as the astronomers' work with the technique through actor-network theory and simple ethnographic description on the basis of which we could make a lot of conclusions.

First, the site of the observatory has a complex structure as every "large technical system" - the buildings of the telescopes, campus, etc. are objects that perform specific functions.

Second, information obtained by astronomers is not simple and straightforward. There are many actors -

mediators between the astronomer and the celestial body, which he studies, (a star, a telescope, spectroscope, computer, photo, graphics, data, etc.). Each of them affects the information obtained as a result. Through their scientific knowledge astronomers occur as instructor of this information.

Third, astronomers are in pretty close relations with the observatory. It was our first field work as anthropologists, and it wasn't easy. During the work, we realized the importance of preparation before entering a field - learning the language of the 'indigenous' (including professional language), making notes every day and the ability to communicate with people.

Unfortunately, the field work was so short, one week is too insufficient for making rather objective conclusions. We met only small part of the observatory staff, observed only a small part of their work and everyday life, visited only several buildings. That's why we can conclude that much of our materials are out of the contexts. Nevertheless, our materials were quiet enough to wright this article.

References

Latour B., Woolgar S. Laboratory Life: The Social Construction of Scientific Facts, Princeton University Press, 1986. (Chapter 2 from this book "An Anthropologists Visits Laboratory" was translated into Russian by A. Kuznetsov

and published in journal Sociologiya vlasti, No. 6-7, 2012)

Callon M. Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay – Russian translation of this article in Sociologiya vlasti, vol. 27, No. 1, pp. 196-231.

Vakhshtayn V. Bruno Latur's Sociology of Science [video]: http://postnauka.ru/video/23361

Tchalakov, I. 2004. The object and the Other in Holographic Research: Approaching Passivity and Responsibility of Human Actors//Science, Technology, & Human Values, Vol. 29, №. 1(Winter, 2004) pp. 64-87.

Tchalakov, I. 2014. Amateur's Action in Science, in: Le sujet de l'acteur: an Anthropological Outlook on Actor-Network Theory, Special Volume of Morphomata, Centre for Advances Studies (Internationales Kolleg "Morphomata"), University of Cologne, Germany.

Hennion, A. 2012. Attachments: A Pragmatist View Of What Holds Us\\ The First European Pragmatism Conference Roma, Sept 19-21, 2012.

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TRIALS OF STRENGTH BETWEEN ASTRONOMER AND TELESCOPE OPERATOR AND THE EXCHANGE OF THE ACTORS' ROLES IN SITUATION OF CRISIS

Ivan Ivanov and Veli Saidov

Abstract: In this research we aim to find out the way a relationship between different subjects from one community of different parts is maintained, also to trace systematically their interaction and the artifacts used for communicating between them, and how the subject changes in times of crisis. For us was of great importance to go through these relationships from the aspect of the actor-network theory, to highlight subjects as actors, to view their relationships zoomed. Here, the heterogeneous community was, the subjects of research were: an astronomer, studying the stars and an operator, who works with telescope. We found the tiny relationship between them, the method of calculating the energy and reasons for these calculations. This was important, because, this way we found out about the relationships within a community, their mutual dependence, and understood why they should work together. How the strive of the astronomer to study, makes him find allies, seek their support and fulfill his goals. Technologies that we are using daily - from mobiles, computers to medical equipment, has found its place in our daily routine, that it even defines our progress, so we could not stay neutral.

Key words: Actor, Translation, Crisis.

Introduction

The technologies, which we use, from mobile phones, computers to medical equipment, have become an inseparable part of our lives and also play role in the human progress. They are deeply implemented in human relations, this is the reason why we should pay attention to the whole matter of how technologies and human beings, both , build a community. The pure humam essence has combined itself with technologies, creating a hybrid that maintains the relationships. From the aspect of actor-network theory, the research of the complex relations between human and other matter has become reality.

Astronomy is one of the most ancient sciences, which civilizations such as the babilons, the anceint Greeks, the Chinese have taken up. As technologies make progress and the telescope is created, the astronomy makes great breakthrough as a science. Astronomy has two basic parts - one related to observation and other - theoritical. From the first one we receive information about space, or later called cosmic "objects" , by different ways of observation. The second part, the theoretical, studies the processes that happen in space, using different mathemetical models and simulations. These two different parts complete each others.

In this research, we are going to pay more attention to the observation part of astronomy, in particular, optical astronomy and how exactly the registration and analysis of light and other forms of electromagnetic emission happen through the telescope and the astronomers, who, in contrast to others cannot directly manipulate their "object" and use variations of observational instruments.

Field of study was the National Astronomical Observatory in Rozhen. One of the biggest observatories in the Balkans. Located in the Rhodopes, being built on Mount Rozhen St.Duh over 1759 meters of altitude, it is situated at a place which is best suited for observation activities. The object of activity at the NAO Rozhen is research in astronomy and astrophysics, training of specialists and PhD students in this field. The observatory provides monitoring of a wide range of astronomical and astrophysical problems from dynamic and physics of objects from the Solar system, to out-of-galaxy researches , star ranges from different classes and types, star clusters, distant galaxies and quasars.

Methodology and theorethical framework

Through quality methods, in-depth interviews, observation of the facilities and many informal conversations with the scientists, we got the opportunity to be near them during the process of work and observation. This gave us the chance to take various pictures, which show the exact way in which they work, their behaviour while observing.

By keeping trace of the work process and how they behave in their natural and work environment, we were able to understand their activity in depth, to see their ways of working in an isolated community , the actors themselves and their interactions with each others, how they enter in trials of strenght with others around them. This gave us the opportunity to see how the subject, who is in alliance with the machine , has become a hybrid. In case of crisis the subject re-defines himself and searches for a new actor, who would be translated into support for the crisis to be eradicated.

We used the "actor-network theory", that reaveals a new horizon of terminology, to track how actors interact in a complex network of relationships. Actor could be anyone or anything -from individual to group of something figurative or non-figurative. The interaction that the actors have carried is called "trial of strenght", which means that one actor makes another act in a way that will surve his purposes. When one actor overpowers the other we say that he has translated him, thus making him his ally and and so the stronger one automatically becomes the weaker's speaker. In the same way unity of the two could translate a third actor. The in-depth research conducted with a member from the NAO-Rozhen team helpled us find out what is the meaning of the astronomer's activities, what are his purposes, the way he reacts to different equipment and gets used to it.

In order to gain a better understanding of his activity despite our preliminary preparation, and most importantly in order to discover who are the actors that he must interact with and translate to achieve his goals - a star or an object, and in order to know what is going to happen in case of crisisis in the network of relations, we should observe the astronomer and study him. As it is said in the actor-network theory, all of them are actors. In our case actors are: the telescope, the astronomer and the operator, who manages the telescope, even the artifacts , which are used during the activity.

Steps of translation

While working with the two-meter telescope, the actor also works with an operator, who takes care of the safety, directs the telescope by the astonomer's instructions. Here we see

the intervention of a new actor in the face of the operator, who is translated by the astronomer, because in this particular situation the astonomer has been in need of him. This new actor (actant) – the operator – interacts with the astronomer. We could say that the astronomer translates him, which means using his knowledge in order to achieve his goal. The operator has embodied knowledge, which the astronomer trusts. That knowledge is a result of the educational background, experience, interaction with other operators, his studies of technical parameters of the equipment, educational courses and translation of knowledge from books and articles. The astronomer cannot rely only on the operator's knowledge in his work, he also uses other equipment such as maps from astronomic databases. But let's pay attention to the relationships between the astronomer, the operator and the telescope. We will try to track the inevitable link and the astronomer's need of the operator. We would talk about particular astronomer and operator in order to look into the matter that we present in our article through personal representation.

> *"No actor is so weak that he can't recruit, or secure the support of other actor. Then they connect and become one against third actant whom they now can more easily influence.*"

To use the two-meter telescope, the astronomer needs an operator to give him coordinates, who knows the equipment and can handle it. The relationship between operator and astronomer are professional. For every astronomer there is a "need" for an operator who posses the necessary knowledge and skills to support the work of the actor -astronomer. Here we can talk about the astronomer and operator as

speakers of the equipment. The astronomer pursues his goal- capturing the object and the operator - smooth and proper use of the equipment. They both enter a union to pursue their individual goals, through the persecution they head towards a common goal - the study of an object through certain equipment. But here again appears new actant, this time it has not been translated by the astronomer but by the operator, and this is the system which directs the telescope to the desired object for observation. To direct such a facility with the precision that is required, the operator needs guidence from the system that directs the telescope, which is a non-human. When working with the two-meter telescope the astronomer or the operator could not fully "exist" if the other is absent. One is able to work with the stars and the other with the equipment. The translation between them is inevitable and could not be delayed. They both are able to work in various fields who are in need of each other. The relation between astronomer and operator begins far before the two-meter telescope. Even if the astronomer takes dominance as an actor, he himself is nothing without the operator. Their relationship starts before performing an observation – first the astronomer consults with the operator as the observation depends on the weather conditions. The operator complies with the presence of clouds and humidity, which would impede the telescope. This is how a trial of strength between the two actors takes place. The astronomer makes the operator his ally in order to use him for his observation, but if the weather is bad, the operator in his role of an actor can remain passive in the translation, since the environment isn't proper for the implementation of their activities. The astronomer and operator unite and enter "battle" with natural conditions. We can't highlight the translation as successful or not, it is subject of change. The

situation does not always allow the use of equipment, and hence the observation becomes impossible.

The permanent link between them is established thanks to the mutual goal they want to achieve. In the working process we saw asynchronisation between two different sciences, whose leaders were united in a common cause.

> *"An actor can gain strength only through connecting with others."*

Assuming that a trial of strength took place, we should track how the operator needs to enter into an alliance with other workers who would contribute to the work process. The operator gets his power from connecting to the system, which he translates to control the telescope, his need for equipment is clear. An equipment of such dimensions which should be directed with great precision and from a human would be impossible to handle without the help of a "mediator" - someone who can help the operator. We see a union aimed at the star that is being sought. This way a network of actors is formed, closed in a local network, and by local we mean a closed society of scientists in a remote area in the Rhodope Mountains, and they interact with each other.

Once we built basically a network of actors we should look in-depth what makes them so confident in their work. We see many artifacts that also appear as actors in the network of actors, these are the different instruments in human practice, which help them in activities, various work instructions, in their expression a "help notebook" or other auxiliary tools which show rules or regulations and other marked tables. From these ancillary tools both workers who

have a common language or are able to understand them can benefit.

We will be making a short deviation from our local network to find out the extent of astronomy. Let's take a look on the other hand, astronomy is one of the oldest still existing sciences, which is developing fast. Could we talk sbout it as an actor in our network, but not on a local level, unlike the closed society, we aimed to study? Astronomy as actor has entered trials of strength with plenty of actors, it has managed to keep them on its side, and these are the astronomers, scientists involved in producing the equipment which is used. Scientists with administrative positions are the people who determine whether an object is worth studying, along with the operators who work in astronomical observatories.

"A whirlwind is formed and grows becoming in many other actors (…)"

It is a science of cosmic objects, but to study them, astronomy needs alliances with other actors, the right actors and also needs to manage and keep them on its side.

"Every entelecheia *defines: what lies inside and what outside, which actors to believe when deciding what belongs to it and what does not, and what sort of trial of strength should be used to decide whether to believe or not in these arbitrators. "*

It has collected many scientists on its side, it has already become stable, and left translated actors to deal with its future development.

As has happened to our actor (astronomer), and his answer to the question of how he took up astronomy:

> *I.: How did you start up with astronomy?*
> *S.: "... in our home library there was a book from Vorontsov Vilyaminov, great Russian astronomer and the book title was "The unsolved universe."*

Astronomy has left many artifacts that serve as translations the new actors. Astronomy as an actor has built its rules and has managed to impose them to already translated actors who observe them.

These big impact of the astronomy as a science, may have contributed to the realization of these local networks, which we described above in our analysis. These small societies are also actors, but in a broader sense of a widespread science.

Crisis

We had the opportunity to witness one of the observations and to see how exactly the managing of the two-meter telescope goes. We should try:

> *"to follow scientists and engineers in their work."*

While observing a cataclysmic star we witnessed a crisis in the already established and recognized local network. Our astronomer and the operator could not find the object that had to explore, and refused to accept the possibility that the object has changed its directions. And our question was: As a person you do not trust the coordinates which are entered? We received the following answer:

> *"Yes, because it is a technique that can always surprise us!"*

That is, they trust what they see, not the non-human, in this case the computer, where the coordinates were entered, or the telescope -whose timing by the GPS might be wrong. We witnessed the changing role of one of the actors. The network of actors is not always a constant and sometimes there is a change of groups. In our case regrouping was forced because the crew could not find which of the non-humans refused to give its contribution. They had to go back and check what may have been "mistaken", who is the actor that resisted. The operator had to track every single step of the observation and find the problem. This proves that even steady-designed networks could not have full security and the actors, in our case the astronomers, rely on their own knowledge and do not have full confidence in the use of non-human. The operator had to play the role of an engineer and fix the "damage" , he changed his identity, if you look through the prism of the theory of actor-networks. So in the presence of crisis we observed how the operator changed roles and became an engineer.

Conclusion

We were able to highlight the local network, which is constructed in the small community in The Rhodope mountains - how the need of studying objects makes the actors look for allies, then translates them and with their support "make science". We highlighted the strong connection between the astronomer and the operator, their manifestation as leaders may not have become real if one of them was absent. How in case of crisis the suspicions are not focused on their own knowledge but on the non-human (the technique) and actors quickly regroup to solve the problem and to eradicate the crisis by changing their identity.

References

Mitev, T., Tchalakov, I. (eds.) 2014. Anthology in Science and Technology Studies. Volume 1: Actor-Network Theory. StudioPlast Publishing House, Plovdiv, 2014. (In Bulgarian)

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CHAINS OF ASSOCIATION – CONNECTING HUMANS AND NON-HUMANS. ASTRONOMERS, TELESCOPES AND STARS 'LIVING' IN A HETEROGENEOUS COMMUNITY

Plamena Rasheva, Gulben Yumer

Abstract: Tere are two main objectives of this study. First, by basing our analysis on Bruno Latur's theory of actor-networks, we will try to understand the relationships between these networks and the chains of association (connecting humans and non-humans). Second, we aim to see the social influence on technology and vice versa, the effect of one piece of technology on a human being.

According to Bruno Latur`s actor-network theory we could define the National Astronomical Observatory – Rozhen as a network, consisted of different heterogeneous elements. Every element is a part of a chain, which guarantees the proper functioning of the site. The same chain is also seen in the work of the astronomers. In this article we have tracked how the different "instruments" and "mediators" give their contribution to the network ambition of the astronomers.

The actor-network is simultaneously an actor, who connects heterogeneous elements, and network, which is able to redefine and transform the things it is made of. After finishing the research we reached to the conclusion that this commitment is

observed also in the heterogeneous community NAO – Rozhen, where the actions of actants and the consequences of them receive their functions, resources and interests, because of their place in the network and because of the connections, which link them to other actors.

Key words: Actor-Network theory, crisis, telescope.

The principle of networks

Latour insists that we shouldn't philosophize on raw primary principles and must follow objects in action and describe what we see. Empirical studies are more important to him. Later in his career, he talks about ,,experimental metaphysics ".

According to the actor-network theory, the world is made of actors or actants. Atoms and molecules are actors and so are children, raindrops, politicians and numbers. All units lie on the same ontological basis. This principle puts an end to the classical distinction between natural substance and artefactual aggregate, proposed by Leibniz. It also closes the gap between the thinking human individual and the unknowable outside world. According to Latour, an actor is not a privileged inner essence, "covered" with peripheral accidents and relationships. For him, all the traits belong to the actor itself: a force, that is outspread in the world at any given time, completely characterized with its full set of features.

The means connecting one thing to another are *translation*. Deductions are also transformed step by step through different layers of concepts, adapting to local conditions with each step, defining where the power of deduction for each step is and where possible variations may be accepted or rejected. Here, Latour's guiding maxim is giving respect even to the smallest grain of reality. Nothing is an ordinary fragment that can be used or abused by more powerful actors. Nothing is just a simple mediator.

Actants are not stronger or weaker because of some inherent strengths or weaknesses harbored together in their nature. It's actually the opposite - actants gain their strength only through alliances. According to Latour, an object is neither substance nor essence, but an actor who is trying to adapt or impose forces, along the lines of Nietzsche's will to power.

Although Latour is opposed to the reduction of the multiplicity of simple explanatory structures, all his four metaphysical axioms stem from a deeper principle: the absolute concreteness. Each actant is simply what it is. This means that all actants are equal. No actor is just food for others; each one stands out and resists others in specific ways. Since each actant is quite specific, we find its reality in an absolutely certain place, at any time, with it's specific alliances. Everything is immanent in this world; nothing transcends the actuality. According to Latour, the world is a field of objects or actants, merged by a trial of strength. Some become stronger by increasing their associations, and some become weaker and solitary, as being detached from the others.

And while mainstream philosophy worries about whether things exist independently, apart from us, or are being constructed by the mind, Latour says that they are "socially constructed ", not only by human minds, but also

by bodies, atoms, business lunches, etc. There is no privileged force to which others can be reduced or persistent interaction between pure natural forces and pure social forces, each taintless apart from the other. Nothing exists except actants, and each of them is extremely specific.

NAO - Rozhen as heterogeneous community

Our first impression, arriving at NAO - Rozhen, was related to the people, who work there. These are people completely dedicated to their profession, some of them turned their backs on their personal lives, decided to live there, entirely devoting themselves to science. Others, who conduct observations at the Observatory, said that working there is a bliss. By leaving behind the busy, dynamic life and indulging themselves in the peace, tranquility, clean air and beautiful nature, they are able to "connect" with all heavenly bodies. Citing Bruno Latour and the actor-network theory, we can determine NAO - Rozhen as a network, composed of heterogeneous elements. But not only the networks are heterogeneous, but also their relations. Regardless of their nature and importance, they follow a sequence of predictable and sustainable events. Each element is part of a chain that ensures the proper functioning of the site. We see such circuit in the work of astronomers. As Levski said:

> *"I can say that astronomy builds character, because it is not a science that covers one thing, it is a multidisciplinary science, i.e. it requires many skills, especially nowadays. You need to have*

ideas, you have to be able to observe, to know how to test these ideas. This requires skills of a programmer, because you have to calculate a lot of things; skills of a photographer to make "snapshots" of the stars and to process and analyze these images accordingly. Also you need skills of a writer in order to be able to describe what you have found, you must win the audience and not only the scientists, but also those people who have no concept of astronomy."

From Levski's words, we can see that these different skills depend on each other for the proper functioning of the single units and the whole. Every interaction influences not only the elements of the network of actors, but also their relationships, as well as other networks, in which each of the elements is situated. The actor-network is a network of simple entities that are simultaneously a part of other networks. We define the Observatory as heterogeneous community containing humans, non-humans, artifacts and more. As we know, a problem, or a crisis, may occur in every community and during our stay in Rozhen we encountered such. During one of the observations, the astronomers from NAO-Rozhen were in direct contact with astronomers from Serbia. Their aim was to find, shoot and study a cataclysmic star, that changes its brightness over periods of time. As we are aware, in any job there are difficulties and problems, and when we talk about astronomy - every problem is multilinear. The above-mentioned problem was due to an error in the computer system of the Observatory, which led to an incorrect calculation of the coordinates and incorrect time

optimization, which, in turn, led to the wrong steering of the telescope.

Given this situation, can we say that social relations between the astronomers prove to be mediated by technology?

1. Overcoming the crisis – identification of nearby stars.

If we look at technology, as an intermediary, it does nothing, but to carry, shoot, monitor and reflect objects. Technology is nothing, but discourses, completely expressible through other intermediaries. Material world stands before us only to serve as a mirror of social relations. Surely, it can bring and receive sense, but can't produce it. But, if we assume that the computer is not a intermediary, but a mediator, then "sense" is not just carried by some intermediate, but is composed of units, rearranged, reproduced, canceled, translated and submitted. An intermediary is only a tool for reaching certain end, while a mediator is both the means and the end. The computer turns from a simple tool into a worthy mediator, a social actor, an actant. In fact, mediators always create chains of mediations or the so-called networks.

At the beginning of this article we have set ourselves the task to trace the connection between humans and non-humans. So, if we observe carefully, we should see humans. If we observe humans, we will be interested in things. When we turn our attention to the *firm* things, they become gentle, soft, human. When we turn our attention to the humans, they become electric, automatic, programmed. We can't even define what exactly determines them as humans or technics, while we can document with accuracy their transformations and substitutions, interlacements and relationships, representations and presentations.

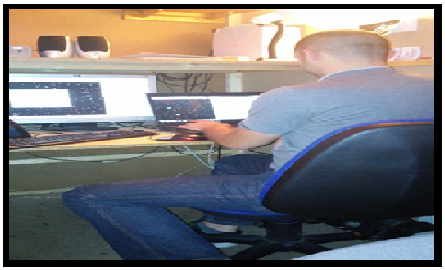
Astronomy as a vocation

After the brief description of the Observatory, it became clear that it employs professionals from different fields in astronomy. Our task was to interview one of the youngest astronomers -Levski- recently completed his PhD in Ireland. At the different stages of his training - from

bachelor to doctor - the astronomer is occupied with the study of different stars - stars with different masses and different characteristics. "*I studied stars that are massive and very hot and are called blue supergiants. One of the problems of these stars is their very existence and it annoyed astronomers, because there was no theory explaining their existence or how these stars die. To take another example, the most massive stars will not reach their end as our sun will. I dont know if you are aware, but before the sun go out, it will expand and devour the Earth and all matter will be spread across space, only it's nucleus will remain. While massive stars - their lives end faster and more dramatically by powerful super explosions with the size of a galaxy. And some of the building blocks of life - oxygen, carbon, nitrogen - are born and spread due to this explosions. If we just pick, let's say, our body - we are mainly made of oxygen - 65% . These elements are distributed mostly through massive stars, they are produced in the bowels of these stars, and if we understand how these stars live and convert and distribute this elements in space, if we understand their "habits" we will get closer to unravelling the secret of life.*" Levski talks about "problems", "life" and "habits" of stars, which shows the attitude of the astronomer towards them - he accepts them not as simple objects, but as actants who live, act, have problems, die etc.

Every astronomer needs a non-human, who can help him, in order to carry out the observation. In this case, the telescopes and the whole equipment appear to be the "non-humans". Our respondent works mostly with two telescopes - the two-meter telescope, for spectral observations, and the recently introduced echelle spectrograph "*that has the ability to shoot a star in all its beauty, a star has millions of colors, but you just have to separate them. This*

spectrograph can divide the many colors of any star in a much larger range than we are able to see. Thus we can understand the most diverse characteristics of the stars - their mass, their speed, etc. With this telescope we take pictures as if they were shot with a camera, but with only one range. " The other telescope, which our respondent operates, is the Schmidt telescope, again used for spectral observations. From what Levski said about their functions and the work with telescopes, we can conclude that the things we call "technology" are the means to achieve order in our world. The assimilation of a technical system actually requires the creation and maintenance of a particular set of social conditions as support for the environment in this system.



Making science" – connection between human and non-human

Technology appears to be a mediator, while the observation is only a "tool" for obtaining information. We can determine Levski's colleagues from the Star Department at NAO - Rozhen, concerned with double stars, as another mediator. Besides working with colleagues from Bulgaria, our respondent is currently in collaboration with colleagues from Ireland and Serbia, which, as he said, "is very nice, because there's an international science that links astronomers." All these "resources" and "mediators", called actors by Latour, contribute to the network ambition of the astronomers.

Like every other job astronomy has its own specifications and subtleties and so the astronomers speak their own "native language". Among the sociological methods, that we used during our field research were numerous participant observations of the workflow. Levski told us that in most of the cases their workday starts at noon - first they need to prepare the site, then ,, the first thing to do before the actual observation is to start the guiding of the telescope in order to compensate the movement of the stars, after that test images are made, their purpose is to show, for example, if there is dust on the camera or on the mirrors, because this will reduce the light from the star that falls there." This happens during the normal workflow, but sometimes there are problems that happen to be an obstacle to its implementation. One of the main problems astronomers face at the Observatory, is that the Schmidt telescope doesn't have some of the filters needed for their researches. The severe winter conditions are another obstacle. Due to them, the guiding of the 60-cm telescope is no longer possible.

Despite the inevitable difficulties and the emotional effort, that our respondent faces, each resolved problem

leads to tremendous satisfaction: *"The more efforts you make, the more stubborn you are, there comes a time when you find a solution, and you know you're the only one who knows it and you go to bed with this thought ... this feeling is amazing and it's worth it ... In that moment, somewhere, you understand why you are doing all this and it is indescribable feeling!".*

During the interview, the astronomer mentioned his work in BAS and the various departments of the institute - *"Department "Galaxies", Department "Sun and Solar System" - here in the Observatory we have solar coronagraph, used for the study of solar corona; there are also colleagues who study comets ... there are diversity of activities in the Institute. "* As professor Rakovsky, said," *In astronomy it's very common that the person's character corresponds to the character of the objects he studies. The most rough division is that of hunters and farmers. Hunters are those who study the objects that appear, explode, and then disappear. A farmer has his favorite objects, and he studies only them. These are two extremes and often you have to be a hunter, when you are farmer at heart, and vice versa. This often breaks out in some unexpected things. It is a very good thing for a theme to be developed by both hunters and farmers."*

From Levski's words, we can see that the Astronomical Institute of the Academy of Sciences is also composed of different "families" - farmers and hunters.

From the answers received during the interview, it becomes clear that the environment appears as having both favorable and negative impact on the actors. The negative impact is the influence of nature on the non-humans: *"Bad weather has great influence on the observational process, also the breeding season of the pines, when they start throwing a lot of pollen, which falls inside the telescope and*

contaminates it. Humidity is also not desirable, so when the weather is wet, even if the sky is clear, we don't proceed, because it is more important to preserve the telescope than to observe once and then to amortize the equipment ." Although the environment affects the non-humans in such way, it is what carries the chains of association between humans and non-humans. *"Generally, nature doesn't influence me in a bad way, on the contrary, it makes me feel good, because I'm away from my computer, from the noisy town, and I come here to connect with the telescope and the stars, to remember what I do and why.* " Here, citing Latour, we see these chains of association, and we claim that only they exist. We come across the interrelation "man-machine-object".

Conclusion

According to Latour, Modernity is the impossible attempt to create a radical separation between objective facts of nature and random human perspective. Moreover, modernists try to purify objects by classifying them into one of the poles of this artificial division, denying the existence of anything situated in the middle.

The history of relations between actors involved in the infrastructure, can be told from the perspective of how possessions or great material structures find their representatives, defenders and promoters, and strengthen their position among other social actors through them. This perspective implies rejection of the understanding of material objects as something passive and closed, which comes to life only through the actions of humans. Social constructivism is a methodological position in the research of technology, which is criticized for its excessive focus on

the socially based explanations of technological change - natural or technical components are completely ignored in the explanatory mechanisms for analyzing. The actor-network theory tries to compensate this exact extreme emphasis on interactionist explanation of the construction of the social world, which tends to ignore those structural constraints in human activities, that occur through "passive" elements without "action" status.

Describing the NAO - Rozhen as a network of actors should not delude us that the actor-networks link elements that are completely stable and unchangeable. On the contrary, the elements - natural or social - can alter their identity and mutual ties, and bring new elements in the network at any time. The network of actors is both an actant that links heterogeneous elements and a network capable of redefining and transforming this elements. This connection is manifested in the heterogeneous community at NAO - Rozhen, where the actant's actions and their implications receive their functions, resources and interests according to their location in the network and the links that connect them with other actors. The chain of association "astronomer-telescope-stars" is evidence, that there is no assimilation, but reformation - in this case, interaction, in which neither the person, nor the physical object is treated as "passive". Latour's idea of networks shows horizontal relations between nature and society, between human and non-human, and their contradictions; there is no domination in this relations, and though speculative, these relationships are equal.

References

Harman, G. 2009. Prince of Networks: Bruno Latour and Metaphysics. Re.press Melbourne 2009. http://www. press.org/book files/OA_Version_780980544060_Prince_of Netw orks.pdf)

Callon, M., Latour, B. 1992. Don't Throw the Baby Out with the Bath School! A Reply to Collins and Yearley. In: Pickering, Andrew (Ed) Science as Practice and Culture. Chicago: University of Chicago Press, pp. 343-68.

Collins, H. M., Yearley, S. 1992. Epistemological Chicken. In: Andrew Pickering (ed.): Science as Practice and Culture. The University Of Chicago Press, Chicago.

Callon, M. 1987. Society in the Making: The Study of Technology as a Tool for Sociological Analysis. In: The Social Construction of Technical Systems: New Directions in the Sociology and History of Technology, edited by W. E. et al Bijker. London: MIT Press., Pp. 83-103.

Winers, L. 1980. Do artifacts have politics? In: Daedalus, Vol. 109, No. 1, Modern Technology: Problem or Opportunity? (Winter, 1980), pp. 121-136

Latour, B. 1991. The Berlin key or how to do words with things. In: P.M. Graves-Brown Matter, Materiality and Modern Culture, Routledge, London pp.10-21.

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HAS THE REPLACEMENT OF THE OLD SYSTEM FOR CONTROLLING THE 2-METERS TELESCOPE WITH A NEW ONE HAD AN INFLUENCE ON THE LIFE IN THIS HETEROGENEOUS COMMUNITY?

Anita Tserovska, Venislava Petrova

Abstract: In our field work we became witnesses of the process of "doing science" – it became clear that an astronomer could not receive knowledge about stars, planets, comets or anything else if he doesn`t associate with as many as possible other actants. They include both humans and non-humans – engineers, mechanics, operators, computers, software, filters, plates, hygrometers, liquid nitrogen, observational diaries, coordinates, folders, integral schemes, etc. That`s why the process of "making" science is not an isolated, intimate activity which is implemented between the researcher and his object – it is a process of "trial of strength" where the astronomer becomes a speaker of the related with him other actors. That was the aim of our field work – to understand how is constructed the world, which is a result from the everyday life of the astronomers with the other doers.

In this article we try to give answers to these questions: What kind of relations are there between humans and non-humans in this heterogeneous network?, What extend is the existing of this network based on the division of the "roles" to?, Has the replacement of the old system for controlling the 2-meters telescope led to formation of a qualitatively new type network?

Key words: old system, "science making", researcher, object, heterogeneous, network, crisis situations, non-human, negotiations, "trial of strength", actor, indigenous language.

Introduction

We examined this "system" using the theoretical apparatus of the interdisciplinary direction Science and technology studies (STS), which gave us a privileged point of view. It helped us to get into an unfamiliar to us world, which we got acquainted with, described and explored without any prejudices about the influence that every doer (a human, a non-human, an artifact, a hybrid) affects to the life in this community. It was an extremely interesting challenge for us to discover if it was possible "our world" to interflow with "the astronomers' world".

The results of our research are received on the basis of a in-depth interview with an operator in the Observatory, conversations with the astronomers, and an included observation to the work process. Our observation continued during the whole period we stayed. It was done with the knowledge and the agreement of the astronomers, who were so kind to invite us in their "heterogeneous community". In order to complete our analysis and acquire an accurate idea about everything related to the old system and the new one, we examined all kind of documents and technical artifacts, which the astronomers gave us. We will present analyzes to the interviews with the astronomers and the operator and also to the audiotapes as *"communicational artifacts, which stand out the interests of doers"* (Ivanov, M. 2013).

Some theoretical prerequisites

We visited the Bulgarian National Astronomical Observatory – Rozhen for the purpose of our research. Our work is based mainly on the Actor Network Theory of Bruno Latour, Michael Callon, John Law, etc., which finds its place in the Bulgarian sociology during the last 20 years. According to this theory the world can`t be divided into "natural" and "social", it should be accepted as something total, which is built throughout the interaction between the actants. Humans and non-humans are in sync, there is a relationship between them, and the interaction between them is called a "trial of strength" (from the researches of Tchalakov, I. (1998, 2008) and Mitev, T. (2007). During our visit in the Observatory we became witnesses of exactly the same "trial of strength" – it was realized between the astronomers and the machines by which they explore the cosmos, on one hand, and the objects in it, on the other hand.

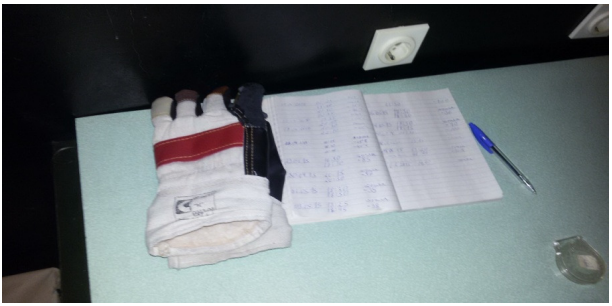
Latour insists that the things are real by themselves, they are actants by themselves – they are not signifiers, phenomena or instruments of a human practice. We shouldn`t accept either the Marxist explanation that the social has an entire domination on the natural, nor the Fascist one that claims exactly the opposite. They just interact to each other, because all actors (humans or non-humans) are placed on absolutely the same ontological basis. Thanks to this principle it is put an end to the classical division between "natural substance" and "artefactual aggregate", which belongs to Leibnitz.

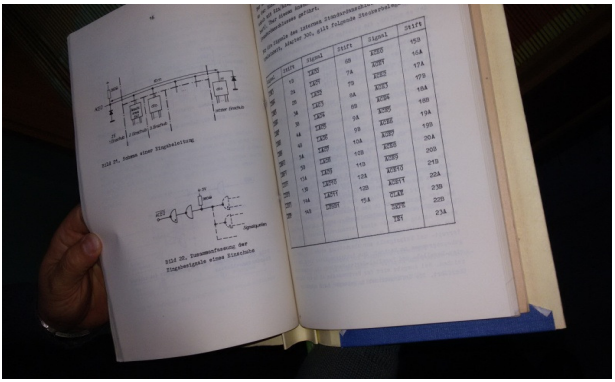
Latour and Callon claim that non-humans are a side in every negotiation, but instead of being indrawn, frozen and alienated things-in-themselves, which role often is underestimated, they are actants – exposed or indrawn,

close or distant, active or passive, wild or tame, it depends on the result of interacting. The networks, which are built as a result from this interact, are simultaneously real like the nature, commented like every discourse and collective like the society.

In analogy with Foucault`s theory of disciplinary authority, the researchers` work, which sets the objects of the cosmos in a field of supervision, also includes them into a network of texts – they become connected with stacks of documents which "catch" them and "fix" their place. Thanks to the whole written apparatus, which attends it, the researchers` work offers two correlative possibilities: on one hand, a transformation of the cosmic objects into describable, analyzed objects, in order to stand out their specific features and their individual development to be always under the supervision of a permanent knowledge. It also suggests construction of a comparing system, which helps to measure the global occurrences, to describe the objects in the cosmos, to distinguish the differences between the objects (temperature, size, remoteness from the Earth, etc.). On the other hand, the field of supervision comprises also the world of non-humans – all coordinates, data and features of the machines and the telescopes are filled in special diaries. Thus "the authority of writing" is realized by filling the observational diaries in the Observatory.

The scientific texts, the technical artifacts and the normative documents are also part of the network of "the authority of writing".





1. *The folders, containing the schemes for controlling the old system*

The astronomer Peter tells us*: "The whole technical system is registered in these folders – all schemes are in German – Carl Zeiss, Jena. Everything is described here – how it works, the whole electronic system is described and mapped. There were "grandiose" drawings for every single thing – and everything was done by hand. On these schemes is built the whole electronics."*

The research

In order to figure out how the work process proceeds, our team conducted an in-depth interview with David, who is an operator in the NAO Rozhen. At the beginning we started the interview with questions about the preparation of the machines for the observation. It turned out that the work with the telescope is not just an adjustment and taking pictures. In order to be done these activities, the operators are those, who have to precede the telescope that the astronomers can do their work.

David tells us that it is very important the camera of the telescope to be much more sensible than the camera of an ordinary smartphone, that`s why it has to be cooled down. It is proceed by infusing liquid nitrogen into the dewar of the camera, which is under pressure. Thanks to it and to the electronics inside the camera, the temperature is kept to -110°C. This procedure is repeated before every observational night and if is necessary it could be proceeded again every 5-6 hours. The infusing of liquid nitrogen could be repeated 2 or 3 times a night during the long winter nights.

From our respondent we also understand that he is not the only operator in the NAO Rozhen, there are 4 more people, who do the same work. The operator`s work lasts

one week a month for him – the other time of the month he spends in Plovdiv city where is his main job. He tells us that the time he spends in the Observatory is for him like *"a rest from the other job"*.

David tells us that he had not been in university, that he have only secondary special technical education. His interest in astronomy led him to come to the Observatory, when he had understood that there was a vacant place for an operator. After a training period, he had to take an exam and a commission had to decide if he was ready to work by himself. This is evidence that the Observatory creates the necessary qualities in the workers by itself – it is not necessarily for an operator to have any specific knowledge and skills. There is continuity – more experienced operators teach the others and thus they give them their specific know-how.

We understand from the interview that the astronomers` work is as important as operators` work. The operator is a mediator between humans and non-humans. With the coordinates which he is given, David finds the objects and the astronomer begins the observation. The 2-meters telescope which our respondent is operating with is manufactured by Carl Zeiss Company and the old system is made by the Czech company – Vilati. It is replaced with the new one in 2009, two years after David started working in the Observatory. During the observation night there are both funny situations and difficulties. One of the most difficult things is the accurate measurement of the humidity because there are two hygrometers on each telescope and each of them shows different values. The accurate measurement, however, is very important because an observation in weather with high values of humidity could damage the telescope.

It was a surprise to us to find out that the astronomers and operators do their job with such a strong striving and desire despite of the low remuneration and the bad conditions of labour (outdated bases, problems with financing, etc.). They say that in cold weather they are held on by *"the enthusiasm of science and the adrenaline"*. As David says he doesn`t work in the Observatory because of the money, he works here because of the lovely nature, the fresh air, the beautiful scene and the rest which Plovdiv city can`t offer to him.

The old system for controlling the 2-meters telescope

The mission of our team was examination of the old and the new system for controlling the 2-meters telescope in the Observatory. It was important to understand if the organizational alterations, related to the replacing of the old system with the new one, have led to any problems, or have contributed for improvement the work process in the NAO Rozhen.

The old system is a heterogeneous network: it is an aggregation of machines with different size and function, technical artifacts and integral schemes, photographers, engineers, operators, astronomers, diffractive lattices, filters, etc.

The machines of the old system for controlling the telescope include: a panel for controlling, a device for processing information, cameras, a generator *("the high-power part"),* computers, and a spectrograph. These elements are *"much bigger and rugged"* and it was necessarily *"much more space for them"*.

These machines are manufactured at the beginning of 70 years of XX century. One of the first machines that astronomer Peter shows us, is a device which had double usage – except converting decimal code into binary and thus setting coordinates to the telescope, it could navigate long-ranged rockets SS-27. That is why *"inspectors from Austria had been coming every year in the Observatory to see what Bulgarian astronomers had been using it for"*. This fact is corroboration that astronomy is an international science, but also it is evidence that science is not a hermetically closed system at all – it is connected with tight links with authority, politics, economics and society.

The computing power of this machine is, in astronomer`s words, *"less than the computing power of a modern, good calculator"*. The coordinates for the telescope are made on a punch card – there are two coordinates with six digits on it. The punch card is put into the computing machine, which transfers the coordinates to the controlling panel of the telescope.

It all is organized by modules in order to be easily replaced if it needs. This was very important because there were a lot of problems with the old system. The astronomer Peter tells us: *"The engineer had a lot of work to do, these things were damaging all the time, and he knew it all by heart – what purpose does every single thing have. The problem was that these machines were very unreliable after using them for a long time, so they had to be replaced"*. Another astronomer – Maria tells us: *"It was a big deal to find your object because the telescope had a lot of deviations",* and continued: *"It was very "funny" with the old system because sometimes the telescope just moved by itself and all operators were on pins and needles during their whole shift – they were listening to every unusual noise. If they heard something, they used to jump*

immediately and go to see "what the telescope was doing" and if it was necessarily they pushed the emergency button in order not to break the mirror of the telescope."

By using the new system these problems disappeared, or as the astronomers and operators say *"the problems are gone for now"*. The software is designed especially for the camera of the telescope – if the camera is shifted so has to be the telescope, too. The new system for controlling the telescope is electronic; it is described as a very reliable and modern by the astronomers and operators. Most components of it are made by the company Siemens. *"When the computer submits a command industrial controllers Siemens transmit the command to the system – thus the computer "communicates" with the engines, with the different parts through these controllers."*

The replace of the system has led to change into the whole heterogeneous network: a part of its elements has disappeared, other elements have changed, third have appeared. For example, the photo plates have disappeared and so have done the photographers because there is no need of them anymore – everything is computerized. As the astronomer Peter tells us: *"Now, there aren`t two operators – one for the machines and one for the cameras – because with the new system one operator with specific software, only with one computer can do it all, while here (in the room with the old system) you can see that is much more complicated – there are much more things demanding intervention by hand, as opposed to now when everything is automated."* Another permutation, which comes with the replacing of the old system with a new one, is the obsolescence of the large and difficult to support machines. Thus, the nature of the negotiations between the doers – the engineer, on one hand, and the machines, on the other hand - is alternated. The elimination of the need of a daily

repairing of defective elements opens the possibility of focusing the efforts on improving the quality of the received data from the observation.

The astronomer Peter tells us that astronomers in the Observatory have an idea to agglomerate the machines of the old system for controlling the telescope in an exhibition in museum of Bulgarian astronomy, which could party solve the problems with financing in the NAO Rozhen.

Despite of the replacing of the old system with the new one, the relations between an operator and an astronomer haven`t changed qualitatively – only the time for observation is optimized, which leads to reduction of the expenses for missed profits for the Observatory. The reliance between them remains an important prerequisite for successful observation and the division of the "roles" is an attempt for preventing crisis situations, or if they appear – it is an "auxiliary tool" for identifying and solving the problem.

2. *Components from the old system for controlling the telescope*

Crisis situations – it is time to negotiate with the other actors

During the time we stayed in the NAO Rozhen, we had the possibility of attending on an observational night; we attended the process of "doing science". As the astronomers told us, their work starts before the Sun goes down – the landing is prepared, the cameras are cooled down, the objects are coordinated in order to optimize the time for observation and avoid the expenses from missed profits.

This observational night, however, was a little bit different from the others, in astronomers` words. For almost two hours the astronomer and the operator of a 2-meters telescope and three astronomers on the Schmidt telescope couldn`t start the observation, because they couldn`t manage to "find" the objects they wanted to observe. The astronomer of the 2-meters telescope told us: *"I haven`t had this "shiver" for years... It was a big deal to find your object with the old system because the telescope had a lot of deviations. With the new one, however, it should be on maximum… on a very small distance."*

Entirely in the spirit of the Actor Network Theory the crisis situations become a new arena for "trial of strength", there are new possibilities for confederations and renegotiations. The actants are not stronger or weaker because of their inherent powers or weaknesses – their strengths are gathered solely by confederations. According to Latour there is one main principle: everything is possible if those, who have been spoken to, are convinced. But we shouldn`t forget that "those, who has been spoken to" and "those, who are convinced" include also inanimate objects – non-humans.

This is exactly what the astronomers and the operator are trying to do in the crisis situation – they are

trying to entice their allies again (the telescope, the machines, the software, etc.). They are doing this by renegotiations of the rules – they are changing the coordinates of the objects, synchronizing the time of their computers, calibrating the telescope, communicating with their colleagues, restarting their computers, changing the object, calculating the mistake and "doing correction". As a result of their efforts the problem is solved – it became clear that "the traitor" is the software. A mistake in the computer programme has led to incorrectly calculating the hour angle of the object. Eventually, after two-hour "trial of strength" the operator and the astronomers manage to "persuade" enough allies to become the winner of this battle – then the observational night continues by schedule.

Defining the situation through the "indigeneous language" of the community

In the process of our researcher`s work it was really important to comprehend and riddle the "indigenous language" of this heterogeneous community in order to avoid misunderstandings. In the analysis we render an account the "defining the situation" performed by our interlocutors. They "typify" the experienced by them social situations; assign a specific sense to them, which the sociologist has to "catch" in order to achieve authentic comprehension of the situation (Molhov, M. 2004, p.134).

We were impressed by the way the astronomers and operators articulate the aspects of their job: the observed cosmic bodies are called "objects", other cosmic bodies (usually stars) are called "standards" because they are used for more accurate orientation and coordination of the observed "object". So, here appears the question: why is

different signification assigned to identical in form and substance *things*? Why are they attached with a different sense? As soon as they are included into the researchers` discourse, once inserted into a mental framework, these identical at first glance *things* acquire different roles, therefore they acquire also different entities.

The dialogue between two astronomers during "the crisis" was indicative for our research:

- *Let`s try with another object?*
- *I want the Hercules, by Jove!*
- *Your Hercules went down.*
- *Went down? I will tell you in a second on what air mass it is… Don`t tell me such a bullshit, it is exactly in culmination now!*

The emotional blast by which the astronomer defends his desire of observing exactly this star is an indicator for the relationship between the researcher and the object. The possessive "***your*** *Hercules went down"* used by the other astronomer shows not private, supreme possession but rather empathy to the object. It is not more external to the astronomer, it is not objective anymore.

"Correction by Alpha", "electricity on darkness", "flat fields", "finding the correction" are also part of the specific phrases, part of "the indigenous language" of this community. "Leading" represents "following the objects seen on the horizon" by adjusting the telescopes with the same velocity as the velocity of the Earth but in reverse direction.

We understood from the astronomers that there are two types of coordinates: hour angle and coordinates of object (Alpha and Delta). An important condition for smooth observation is also setting the correct time in the

system – as one of the astronomers said: *"Wait, I will give you the correct time because even 10 seconds are too much!"*

The panel in the observational room on which were attached some notes and schemes was very interesting to us – it became clear to us that this is a helpful appliance for the astronomers, thanks to which they save time and efforts for calculating coordinates. On one of the boards on the panel we noticed something interesting – along with the notes and schemes there was attached also a plush donkey – a bright and extraordinary evidence for interlacement between the scientific life and the everyday life.

3. *The interplacement between the scientific life and the everyday life*

Conclusion

The Actor Network Theory claims that the world is a concatenation of negotiations between various armada of forces and humans; that it is not built from stable, solid as a rock formations but is only a front line of battles or love stories between the actants. The whole Latour`s world is not made of anything else but individual doers, events which are entirely deployed in every moment without any potency or hidden intentions, lying outside the alliances.

Our research work was consisted of finding out how is constructed the world which is built and constituted in the everyday life of the astronomers with the other doers. In this research we applied specific semiotic and sociological methods for analyzing different data types – technical artifacts, photos, audio files, video recordings.

The empirical research we conducted in NAO Rozhen "disenchanted" our conception about the researcher`s work in this heterogeneous community. There more than clear is "visible" the relationship between humans and techniques, between embodied cognition and skills and the software, between "the natural" and "the social".

As a conclusion we want to emphasize also on another important relationship – this between astronomy and sociology. The professor of astronomy Pavel presented to us his "fairy tale" about "the machine of time" through which the astronomers observe the cosmic objects, convincing us that with its help it is possible to understand what had happened million years ago or what might happen in the future. He presented this "story" so exciting that if

someone has still not understood why the astronomers in the Observatory love their work so much and forget the bad labour conditions… he hadn`t listened to the professor.

The professor said that when astronomers "make science" they have to be ready to present it in such a way that the other people believe them, and so it is also for us – sociologists. They examine the vast cosmos, we examine the vast society. Society such as the sky is changing constantly and we have to be ready to examine and explain these variations. In one "Astronomy Handbook" is written: *"The more you observe, the more you will see. The secret of astronomy is persistence. If it is cloudy one night, then you should try again the other night. Reserve the observation data and build your experience. The night sky changes during the year, so there are always new things to see."*

The piece of advice which the professor of astronomy gave us: *"Pay attention to the small things because they are important!"* sounds very close to Latour`s ideas: *"Here and elsewhere Latour`s guiding maxim is to be given respect even to the smallest piece of reality."* (Harman, G., 2009)

References

Callon, M., Latour, B. 1992. Don`t Throw the Baby Out with the Bath School! A reply to Collins and Yearly. In: Pickering, A. (Ed.) *Science as Practice and Culture.* Chicago, Chicago University Press: 343-368

Harman, G. 2009. Prince of networks: Bruno Latour and metaphysics. http://re-press.org/book-files/OA Version 780980544060 Prince of Networks.p df

Ivanov, M. 2014. Renewable energy industry in Bulgaria: Challenges to its development. *Sociological problems, special issue 2014;* 151-154

Latour, B. 1988. Pasteurization of France, Harvard Univ. Press, Part II – *Irreductions*, pp. 158-172

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OBLIGATORY ROUTES OF TRANSLATION IN THE SCIENTIFIC WORK OF THE ASTRONOMER-ACTOR

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"A physicist is an attempt by an atom
to understand itself."
Michio Kaku

Abstract: This article is the result of the data that our team collected. Our mentor N.P., a doctoral student in astronomy, provided detailed information about his work - relationships with colleagues, tools, methodologies, specifics on their use and much more. That information is used in this current article to describe the routes of translation, which astronomers follow in their research work. The analysis is focused on the discovery of actor-networks and the interactions and translational processes between them.

This work seeks to show the ways in which the production of scientific knowledge is accomplished by the astronomer and his tools, through the continuous "trials of strength" between different actors - humans and non-humans. Or, in other words, the continuous processes of translation that could modify the characteristics of "knowledge" indefinite number of times.

Key words: scientific knowledge, translation, actors.

Introduction

Between June 22nd and June 27th, 2015, Summer School "Science, Technology and Innovation" was held at the National Astronomical Observatory Rozhen, Bulgaria. There, the teams that were formed had the task to explore the scientific environment, the astronomers work, their tools, the internal organization of the community, the regulatory framework, the lifestyle and relations among researchers and their connections with the outside world.

Theoretical framework

Our data will be considered through the prism of the actor-network theory, for the development of which Bruno Latour has the greatest merit. Based on it, we can uncover the interconnections, alliances, relations between astronomers and their instruments, and between the scientific community and the surrounding world.

The Actor-network theory describes the world, as a whole, as made up of actors, or actants. Each actant pursues different goals. In order to understand Latour's ideas, we must introduce his terminology. The actor-network theory does not try to frame the world. Rather, it "tells" a story about the organization of the world, which operates in certain ways, regardless of the explanatory theories that interpret it.

Actors/Actants - teleological creatures that have nature and potential. They seek to manifest themselves through their relations with the wider world, because nothing is a variable or inert, human or inhuman, useful or

useless by itself. Never on its own, but always through others.

This theory describes the interaction between different actors, which represents a "*trial of strength*". Everything that resists the trial of strength is real. The trial of strength is between the actors that seek to influence another actor, so that he/it can contribute to the implementation of their purposes. When that happens a *translation* is performed. Through this translation one actor makes another his ally, because he puts into action its power too. The logical follow-up to this process of *translation* shows us that the power (or "knowledge") of the actor is determined by the strength of his allies. And for the translation to be possible actors should constantly trigger the mechanism of "simplification" of the network (Callon, 1989) in which they operate, and so the network by itself is also an actor. This is actually a simplification of the infinite complex world (world of networks or system of networks and interactions between them). The actor-network is a network of simplified (limited) entities, used by the actors, and they are simultaneously a part of other larger networks.

Methodology

Our Mentor, N.P., is a fourth year PhD student at the Institute of Astronomy. He graduated Astronomy and Astrophysics at Sofia University "St. Kliment Ohridski." He is concerned with comet physics, currently studying a number of comets for the purposes of his thesis. For the last four years he has been an operator of the two-meter telescope. He takes care for its proper exploitation during observations. Each month he gives a weekly duty by participating in the observational program of the Institute.

He works with colleagues from the Institute and with other foreign scientists. Furthermore, he carries out his own observations with the telescope (stating his own time). We conducted participant observations and two in-depth interviews.

Differentiated actors

Some basic actors emerged in the course of our research. This differentiation is not based on rigorous theoretical framework which outlines what our actors should be, but this separation is rather a fact observed in the particular scientific community. In our list of actors there are both humans and non-humans. The interaction between them and the translations that occur are described further in this article, but before that, it is important to show the main actors with some of their characteristics.

• Astronomer - a major actor that becomes speaker of most of the other actors, through constant translations. The astronomer is a scientist studying celestial objects. He has the freedom to explore and observe objects that are of interest to him, adhering to certain methodology, which in turn is woven from translational processes.

• Acquired knowledge (or education) - all the knowledge and skills that the actant had successfully translated and withholds in order to use them in need. This is the overall education, specific knowledge and skills learned and practiced. This knowledge is not only in astronomy, but also in chemistry, physics, informatics and others.

• Mentors, colleagues - These are the people who have influenced the astronomers actions associated with the production of scientific knowledge.

• Object - constantly changing magnitude that at some point in time has to be reached. The astronomer-actor directs all its "powers" and "allies" to capture, use and decipher it.

• Technical equipment - non-human actors "subservient" to their spokesperson. By translating them, he is getting closer to his goal:

- Computers
- Telescopes
- Cameras, filters, collimator, etc…
- Coude-spectrograph and Echelle-spectrograph, focal reducer
- Software for image processing
- Databases with coordinates and additional information about the objects

• Captured images - pictures acquired through the telescope

• Scientific articles and studies that guide the work of the astronomer in the process of doing science

• Special scientific committee, which approves the requested observing time

• Funding - the financial funding for maintaining the functioning of the Observatory and its constituent elements.

• Weather conditions - Cloudiness, illumination of the sky, humidity, etc.

Routes of translation and acquiring scientific knowledge

In the main part of this work our aim will be to describe the steps that an astronomer takes to reach his scientific goals. This description is intended to reveal the intrinsic practices "creating" knowledge, as well as the actants, constantly

defining the environment in which these practices are deployed. For this purpose we put the actor-astronomer as a spokesperson:

> *Interviewer: Can you describe what specifically comprises your work with the telescope?*
> *N.: At first, one should have a **broad knowledge in astronomy** to be able to contribute in the observational cycle. Then, you must have some **technical background**, and be familiar with the particular technique and its specifications. For this purpose I had a special training, I passed the test and then followed the long process of accumulating **experience and knowledge**.*
> *Description of the work in consecutive steps - I come in Rozhen; I know in advance who the colleagues I'm going to **cooperate** with will be; We make description, depending on the season when we will start the observational programme; it includes, as I said, always different things, **different objects** and so the routine is more or less a foreign thing to us; every time we have to learn new things; we prepare in advance the things we need for observations; we prepare the right **filters, devices and cooling of the CCD camera**; then we go to the telescope and with the help of an astronomer I operate the telescope all night, looking for different objects, hepling him with the observation. Overall, this continues all night if **the sky is clear**. In the rest of the time I do my particular tasks.*
> *As an observer I have a long process of work. To get an observational time I must make a request where scientifically to substantiate my specific purpose of research. So, I prepare a list with objects to observe, **the visibility** (efimeris) of these objects with the exact time **when they will be observable**, and the whole sequence of activities: **filters**, exposures and*

*so on, in order to optimize my time and specific goal - what I'm going to get out of these observations and the following analysis . **The special committee decides** whether to approve the requested time and if they do, I'll get the telescope.*

The respondent points out keyword from the actor-network theory, which is "to cooperate", suggesting that the world consists of "acting" in "cooperation" entities. There may be cooperation between human and non-human actors. The spokesman states that he cooperates with other researchers, but he also "prepares the filters, equipment and cooling of the chamber", i.e. he, as an actor himself, translates other non-human actors and makes them his allies, committed to his goal in their capacity of tools. Cooperation with non-human actors transformed into allies is not more important than that with other researchers. They are identical, as being allies to the astronomer, helping him in his "battle" against those actors, standing in the way towards the ultimate goal.

The actor-astronomer makes a successful translation of "the special committee" with his "request", as its spokesperson. By using allies translated back in time (which are now embodied knowledge that the astronomer withholds) he was able to translate a new actor, respectively, a new ally that "professes" his purpose. And this purpose is to examine the object of his choice. Here, the actor-astronomer performs the so called *trial of strength* with another actant, which allows the translation to happen by setting the "rules of the game" (i.e. the requirements of the Committee). The astronomer harnesses the needed simplified entities (a selection of corresponding set of rules that triggers the matching between the objective and the means of achieving it); then he goes into "battle" (playing by the rules that were also mastered) and reaches the "intermediate goal" - "union" with the committee.

As we already mentioned, actants can be also non-human. Due to the acquired knowledge of using it, the actor-astronomer adds the telescope to his allies, a tool that itself is a spokesman of all the particles (also actors) that compose it. The telescope-actor has the characteristics needed for the astronomer to reach his goal. Through a new translation (the actual practicing of the acquired knowledge) the scientist is able to "dominate" over the telescope and reach its scientific target.

> *N: [...] For The Large Telescope… in the cometary physics the direct and precise measuring of the productions of gas and dust requires high spatial resolution. For this purpose we use only the large telescope (2m telescope). [...] The telescope has very modern cameras that make high quality images, and* ***they fit the field of view****. We can see an entire comet and the small details, which is very important to us.*

So, the astronomer does not always need the full capacity of "powers" of an ally, and the very knowledge of this fact, is the result of successfully carried translation.

> *I: And what are the disadvantages of the large telescope?*
>
> *N: The problems are especially related to the observations. The observations depend on number of factors, one of which is the weather, i.e.* ***the meteorological conditions*** *should be appropriate: first - the sky must be clear; second - no strong winds to be present; third - no high humidity. All of these parameters have their own specific values that limit the observations. The fourth is that the telescope and the entire equipment must be in good condition and*

*we should have **an approved request** for these observations.*

So far, we pointed out only successful translations that the astronomer-actor accomplishes in the name of his goal. A strong actor stands before him, whose translation is not successful - the weather. The actor-network theory talks about war, fight, battle. This happens between the astronomer and the meteorological conditions - they militate against one another and none of the translated knowledge, whose spokesman is the astronomer, is able to "defeat" the meteorological conditions. This extremely necessary translation is not successful and the actor is kept from moving forward to his goal, while looking for new allies. Cloudiness, high humidity, brightness of the sky stop the observation - the path to the objective is temporarily closed until the successful translation, which ends with a high- quality image of the observed object. Then a new goal setting follows.

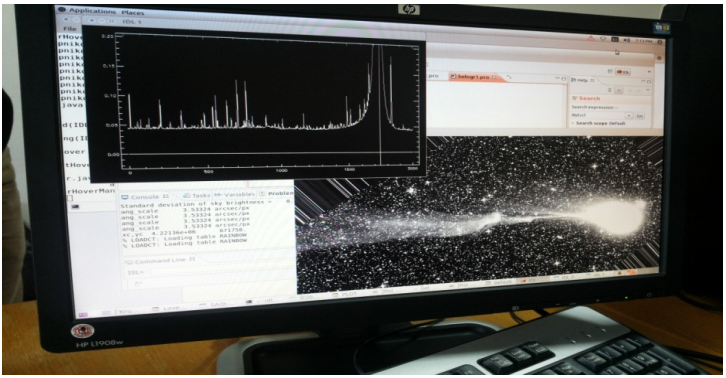
Pic. 1. This picture is hung in one of the recreation rooms at NAO Rozhen and shows how powerless the astronomers are against the whims of the weather.

I: And what about the data processing?

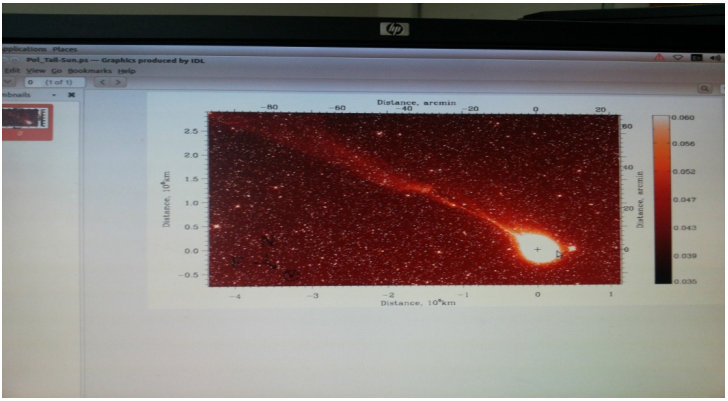
N: We take the images from the telescope, then the processing takes place entirely separately and it takes much longer. There are different ***calibration images*** *that we use to calibrate our usual images. We* ***do not have specific software*** *for cometary research that can be applied to the images in order to get an exact "answers", as it is in stellar astronomy. Cometary physics is special because each comet has specific characteristics and we need quite different approach for every comet. There are common reductions that are made, but to a certain point, after that we get the reduced image that includes only the comet's emissions and then the processing continues* ***according to the objectives and scientific vision of the researchers*** *about what the analysis should be. We decide how to process the data and what we will do with the images. Then we describe everything in an article and if there is some uncertainties or mistakes the referee will find them. But if he accidentally misses something,* ***our colleagues,*** *will help us understand our mistakes, if there are such, of course.*

The Astronomer-actor, through his already translated (in the case supplied and utilized) knowledge in chemistry, physics, mathematics, technology, software, will translate the resulting image and make it his new ally, by setting such parameters which will reveal characteristics of the studied object, that will serve the ultimate desired purpose of the researcher. And so, he adds another ally-actor in his ranks. The astronomer overmasters allies to reach his goals. This subjugation represents his transformation into a spokesman for all the elements he had united, who keeps them in war footing so that he will be able to use them anytime the

network, where all these actors cooperate, requests it. He makes his purpose theirs. "... *the processing continues* ***according to the objectives and scientific vision of the researchers*** "depending on the purpose, he harnesses certain actors that are needed and would produce a specific kind of knowledge. In different situations different actors are harnessed or a certain amount of their "power".



Pic.2. *Original black and white image*



Pic.3. *Image during processing*

Picture 3 is a hybrid between the used translated technology and the personal intentions and judgements of the astronomer, tailored to his ultimate goal. The image is processed with software - another translated tool (programming is done by the astronomers). This treatment will extract new information from the already available black and white photo, and will subordinate/translate it by testing different parameters. This reformulation is based on the already produced and absorbed scientific knowledge which sets the steps for secondary translation (scientific papers explaining certain methods for data processing).

Translation is never a one-time activity. The process of association and the multiplying of power never stops, whether it comes to attracting new allies or to the redefinition and improvement of the present translated ones.

> *I: Can you tell us more about the equipment's history?*
> *N: The focal reducer (FoReRo2) which I use for my research, it's been here since 2001. Long time before me. It has a wide class of optical element we use today. We haven't changed anything in it, until now, because of this new fashion - polarimetry. [...] I was also involved in the development of the new spectrograph, it will replace the old coude-spectrograph. I was involved in this new initiative to improve the quality of the echelle-spectrograph by introducing new equipment and also a new way of research. It was a great experience in terms of how to develop a new instrument, how to enter it into exploitation and how it works.*
> *I: And Did you have problems with the implementation of the eschell-spectrograph?*
> *N: Yes, we did, because we had a **limited** funding. We bought the optical elements according to the funding and some of them were with poor quality.*

*Their assembling was not easy, we had various difficulties and we made different **optical tricks to achieve the parameters** that were needed. The adjustment of all elements inside the spectrograph was made with micron/submicron accuracy. Everything was mounted very accurately, measurements were made by laser, and corrections with micrometer screws, and it took a long time. Especially, because we **are not experts in this**, i.e. we do not make such instruments, we do astronomy, but sometimes such activities are needed.*

The actor takes direct part in the "improvement" of its allies chasing his own goals - developing new spectrograph. So, the translation of an ally is never final. This work reveals the translation of new knowledge by using already put in action previous one. Our actant triggers a new translation to increase his "strength" - in this case the spectrograph - a new tool that has replaced the old one - he converts it into a new ally, although opposed by another actor - the funding, which challenges the "non-expert" actors, along with their translated knowledge. The spectrograph is successfully translated by these unions, when it starts "working" adequately and procures the sought information.

I: Would you tell us about some non-typical situations in which you have been involved?
*N: [...] For example, with one of my colleagues, D.D. - he is a physicist, but he is a very good scientist, just without a PhD, although he has papers fit for a professor. We have a terrible experience in observations with the Slit-module integrated in the Focal reducer. This is a little instrument in the order of 20x20 centimeters, but so complicatedly arranged that almost every possible detail crushed at some point. And because **we don't have the money** to buy*

new slit-module, our fellow astronomers developed such with primitive elements and it is a great odyssey every time we work with it. First, its camera was adapted to work with ***a made up software****, so we were never able to see a clear image of our object. The Slit always requires* ***special moment of adjustment****. Second, the motor which moves the slit-mirror never moves when* ***we want it to****. When there's a need to move it somehow, but the telescope is located in a difficult position, I feel nostalgic for the old equipment that wasn't like that and I was not supposed to climb 10 meters height in the middle of the night. There are so much more horrible examples, like when there's an inappropriate rotation of the filters or instead of filter there's an empty position, we make non-informative images and in the end,* ***the night is just lost out of inattention.***

I: And what are the difficulties or problems you have encountered?

N: There are many problems. We always resolve difficult tasks, usually people think that we solve problems. No we do not solve problems we resolve tasks. [..] Especially bright memory for me is the spectrograph, ***it has been integrated for two years*** *and almost every month people were involved (me especially as a PhD student of the Director) in dealing with it and trying to do some useful work. Most of the time, we have to do something little in order to have some progress; for instance, before* ***moving the collimator with one millimeter****, which may seem really simple to you, I had to read a book to figure* ***out how the collimator works and why we should move it*** *and what can go wrong.*

To be a spokesman of his allies, the actor has to constantly fight with other actants. He leads a battle and translates more and more knowledge (books and articles) to achieve

efficiency of his actions. To perform seemingly simple act, which would lead to this efficiency he constantly teams up with new actors that help him. Because of this "***special moment of adjustment*** ", the astronomer seeks to translate all knowledge that **may** be necessary, so that he will be strategically ready in the event of a "collision". All these battles are a constant process of connecting separate actors in network, stable enough to carry out the procedure of obtaining knowledge. This knowledge is actually the "reflection" of all these translations.

> *N: So, the adjustment of each optical element included very long process of reading. Such tasks require a lot of work, not only physical, but also intellectual.*

The astronomer accumulates allies, which are already translated knowledge themselves, by human and non-human "means". He seeks certain results and every ally brings him closer and closer to achieving them. The actor-astronomer is winner in the arena when he observes the desired object and obtains new data, fit to undergo new translation. So the unification of diverse forces (humans and non-humans) reproduces new knowledge through the absorbing of an old one.

Conclusion

In short form we tried to describe the important characteristics of actor-networks found in the astronomer's work. We selected passages from the interview, that show that not every translation is successful, there are obstacles in the way to the desired destination, and the trial of strength

never stops. We presented the relationship between the actor-astronomer and all other human and non-human actors and their various unions - other researchers, technology, instruments, telescopes, software and more. Translation is an ongoing process. The astronomer is constantly looking for allies to overpower or is being translated himself. All translations, in which the astronomer participates, are his obligatory route to the target - in this case, obtaining scientific knowledge. Accumulation of translations and simplified entities is the right way to its goal.

These obligatory routes to "knowing" can be infinite, depending on the scope of the network in which the actors operate. Simplification of the environment or the network is also a type of translation performed by the actors. It gives guidance to the new translational battles by setting the direction of action.

Knowledge is a final reflection of the ongoing collisions, the constant trial of strength, the absorption, re-use and navigation of already withheld allies. It is final as far as it is set as a final goal by the actor at some point in time. But it is subject to repeated translations and changes that may alter his characteristics indefinite number of times. As Latour says, truth is only momentary "front line", constantly shifting its direction. So, scientific knowledge reproduces itself thanks to the translated actors, that redirect the endless network of information and knowledge that precedes them. Thus, science is trying to understand itself, through itself.

References

Mitev, T., Tchalakov, I. (eds.) 2014. Anthology in Science Technology Studies. Volume 1: Actor-Network Theory. StudioPlast Publishing House, Plovdiv, 2014. (In Bulgarian)

Latour, B. 1993. We Have Never Been Modern. Harvard University Press, Cambridge, Massachusetts.

Callon, M. 1987. Society in the Making: The Study of Technology as a Tool for Sociological Analysis. In: The Social Construction of Technical Systems: New Directions in the Sociology and History of Technology, edited by W. E. et al Bijker. London: MIT Press., Pp. 83 103.

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AFTERWORD

SCIENCE AND TECHNOLOGY STUDIES AS A WAY OF PRACTICE

Ivan Tchalakov, Irina Popravko, Tihomir Mitev

Since the beginning of the XX-the century a small group of researchers developed a massive program for maintaining and spreading STS as an academic discipline and advanced research field in Bulgaria. Nowadays, Plovdiv Univeristy is the only Bulgarian university where STS has significant place in the curriculum of B.A. program of Sociology of law, economics, and innovation, and also it is a core in the curriculum of the M.A. program Management of Research and Innovations. It is the place where students are systematically taught how to know, analyze and govern contemporary science and technology. Students gradually study classical sociology of knowledge with its methods of studying traditional, everyday and other forms of non-scientific knowledge in the tradition established by Carl Manheim and Alfred Schutz and encounter the sociology of science in its classical view of Robert Merton and his followers, which focuses on science as institution and its rules and norms. The core of the program is studying sociology of laboratory life where the key STS approaches are introduced: sociology of scientific knowledge (SSK),

ethnographic (or anthropological) studies of Knorr-Cetina. In the specialized courses on risk societies, innovation and entrepreneurship and economy of technical change are introduced additional STS approaches - social construction of technology (SCOT), Schumpeter's approach to innovation and history of technology. Special attention is paid on the Actor-network theory.

Apart from that, the researchers from the Plovdiv University established the Center for Science, Technology and Innovation at the Department of Applied and Institutional Sociology in 2004. Its research agenda is focused on classical studies of scientific and engineering practices (ethnographic studies of scientific laboratories, engineering communities and large technical systems), sociology of innovation, academy-industry relationships, public involvement in science and technology policy and evaluation, cognitive approach to social movements.

Why it is important to students to go to a field? Here we briefly argue that the importance of our continuous efforts to bring the students to the empirical evidences about research and engineering practice and train them to make sense of it, go beyond the purely educational objectives and helps their proper scientific rationale.

1. STS cannot be understood unless practiced in the field.

STS emerged in the late 1970s as an attempt to rethink the basic assumptions of philosophy and epistemology of science, based on a new understanding of the activities of scientists and the empirical study of these activities. In fact, the roots of what in the tradition of STS was called a

“pragmatic turn” in science studies, one can find in the works of philosophers of science (Khun, T. 1962, Lakatos, I. 1970, Feyerabend, P. 1975), as well as their disciples in sociology (Bloor, D. 1976) who developed the discipline Sociology of Scientific Knowledge (SSK). However, the real breakthrough was made in the end of 1970s, which, according to Karin Knorr-Cetina, radically transformed our understanding of what is going on in the scientific laboratories. Now they have been considered as a special form of life, where new scientific objects are not just technically created, but also constructed symbolically and politically, thereby changing the deep structures of the social world (Knorr-Cetina, 1981, Knorr Cetina 1995). A number of studies have been carried out during the 1980s and 1990s within the framework of the Sociology of Scientific Knowledge (Collins, Mulkay), Anthropology of Science (Traweek), and especially in Actor-Network Theory (Latour, Callon, Law). They have identified a number of hitherto unknown mechanisms of creation, consolidation and reproduction of knowledge - linguistic and rhetorical practices that justify the scientific statements as true or false, strange intertwining of cognitive and social (in the narrow sense of the word) practices, and especially the procedures of "translation" and the establishment of socio-technical networks comprising human, non-human and hybrid agents, the stabilization of these networks through ‘trials of strength’, adding new " allies ", etc.

Over the past 30 years, the results of these now classical case studies have been repeatedly tested, confirmed and developed in different directions. At the same time there was intense process of translation of the classical STS works to almost all European and Asian languages, as well as substantial growth of theoretical and methodological analysis. Its expertise have been elaborated

and applied in the social studies of medicine, of information and communication technologies, in urban studies as well as in research and innovation policy, etc.

However, observing the STS development, we have the impression that after the "boom" of the 1980s and early 1990s, there are fewer new empirical researches of the laboratory practice carried out. Russia is a good example, where the introduction and active translation of the classical STS works has begun about 15 years ago, but till now there is one PhD thesis in the field of laboratory studies (Artyushina 2014) and some applications of STS approach to areas that are fairly distant from science, such as sociology of politics (including science and technology), urban transportation, and others. There are even less such studies in the other countries of Southern and Eastern Europe.

Oddly enough, thirty years after the described pragmatic turn in science and technology studies, one could claim about the STS the same thing that more than 25 years ago was formulated by the Dutch sociologist Gerard de Vries concerning the old philosophy of science:

> "... Until now very few philosophers could have say something meaningful about the technologies, skills and practices. All these issues have dropped out because of the very way of formulation of the problems in terms of the relationship between subject and object, language and the world, etc. To understand these new areas, we need to get rid of the traditional schemes of formulating questions – in their rough form of epistemology of the 18th century or of the more refined forms of modern "rules of skepticisms» »(de Vries 1992).

It seems to us that there is a danger of turning STS into a form of academic scholasticism, where similarly to the analytical philosophy of the 1980s, the students and their teachers limit themselves to the analyses of classical texts, removing from STS their very essence - a symbiosis of theoretical and methodological work with field research. Some years ago John Law put this in the following way:

"(...) it is possible to describe Actor Network Theory in the abstract. I've just done so, and this is often done in textbooks. But this misses the point because it is not abstract but is grounded in empirical case studies. We can only understand the approach if we have a sense of those case studies and how these work in practice» (Law 2009: 143).

Law claims that ANT (and STS in general) falls under the same group with other areas of social sciences as a symbolic interactionism and ethnomethodology, and in this respect they are similar to the practices of natural sciences, there theory always has to be subject to empirical testing.

Criticizing relativism of sociology of scientific knowledge, Bruno Latour points to the "quantum" character of relationships between text and reality (or language and the world) (Latour 1988). When we analyze and comment on the text of the laboratory practices, he says, "reality" is already not the laboratory practices, but the texts on them. In other words, moving away from the direct observation of the practice of scientists and engineers and training students only on the basis of previous texts about these practices, we permanently lose something. It's one thing to describe in an entertaining way the 'chain of translations' a natural entity is undergoing in the laboratory to its final appearance in the

form of tables and graphs, based only on the texts of B. Latour and M. Callon, and quite another to put the student in a fragile and unstable actor-network of scientific research: to participate together with astronomers or microbiologists in their work in sampling and data collection, track the record-keeping, observation protocols, etc. Students do need to immerse themselves in the field and observe the actions of scientists and engineers through the prism of the theory of accumulation, thereby checking, and "falsifying" (Popper) them - that is the real test of strength and the adequacy of our STS concepts.

2. Today researches and engineering are not what they were thirty years ago.

If we return back to John Law, we can say that similarly to his claim that there is no single version of ANT but "…rather it is a diaspora that overlaps with other intellectual traditions" (Law 2009: 142), the same refers to the STS in general. Hence, each area of STS tells its own story about "how" the relations take place, so it is necessary from time to time to empirically come back to the science labs and see how and what is happening there. Labs have their own life. And since most of the classic authors of STS have long ceased to carry out field research, it turns out that now we build our understanding of the science and laboratory based on data collected in the 1980s and the early 90s of the 20th century! Where is the guarantee that the world of laboratory has remained the same? As the one of the few contemporary studies in this area (Rosental 2007) pointed out, during the last twenty years with the process of digitalization going on, the laboratories have been populated with ever increasing number of 'smart'

devices, that took on themselves large part of the efforts for registering and checking reliability of the data, its storage and initial analysis, thus enormously speeding up the research process and leaving to scientists more time for final interpretations. We mean for example the mass GPS use instead of old manual techniques of finding locations, computer simulation and heuristic methods for predicting the expected results based on the limited amount of data, etc. Hence, a possible conclusion could be: the science of the second decade of the 21st century is not the same, as it was 30 years ago, when the major discoveries in the field of laboratory studies were made. This is especially true in research areas with marked degree of digitalization. Astronomy, molecular biology, geo-sciences, mathematical chemistry, etc. are some of the sciences in which the applying of digital technologies transformed their own "essence".

Box 1 - Digitalization in astronomy

At the end of 20th century photographic technology in astronomy gradually shifted from electronic images obtained from the so-called digital (or "charge-coupled devices", CCD) cameras, discovered in 1969 at Bell Laboratories in the US. Digital cameras allow the resulting image to be stored electronically and eliminate entire trademark and uncertain process of recording, processing and storage of the photographic plate. In the 1990s the leading astronomical observatories in the world began to install CCD cameras on their telescopes. This led to profound changes in the

"craft" of astronomers, because images can now be further processed using different computer programs. Furthermore, digital data in the form of files spread more easily and everyone could independently analyze them. Computer programs themselves generate relevant "log files" with the necessary telemetry data "attached" to each recorded image. Along with the automation of the management of telescopes, this increasingly led to ejection of the astronomer from the "living" process of observing celestial bodies. So we got astronomers who have never worked with a telescope and only use digital data received from colleagues and even robots. Among the astronomers working at observatories there are many who increasingly rely on automation and poorly understand the processes occurring inside the telescope during the observation.

Classical STS relies mostly on traditional method of participant observation, in-depth interview and semiotic analyses of texts and images. However, they are not very suitable for the study of profound changing in the lab practices related to the digitalization of research. Most of these changes remain ‘salient and hidden’ from the traditional methods, being tacitly transmitted from the more experienced to the younger researcher during the mutual work in the laboratory and in the field. Hence we need a new visual methodology to focus on “science in the making” and make observable and better understandable the tension and dynamics between handling and observing, and between active and passive bodily

practices of interaction between researchers and their not yet (fully) known epistemic objects.

3. The 'enduring science' as pristine field of study.

There is one more argument in favor of continuous effort to study empirically the practices of scientist and engineers. Traditionally STS focuses on what one of us framed as 'entrepreneurial' science, where

> "…the mastery of a specific method (tool) and its transfer into a new area of research gives the newcomer a competitive advantage over the indigenes of the field, such as that which Pasteur found over the veterinarians in his studies of anthrax. Here the "strong link" is not in the 'direct relationships' between researchers and the studied objects, but with technical artifacts, equipment and procedures they are using in this process… The 'entrepreneurial' scientists come to a field where the research problems are already articulated, the debates are going on and the interested parties identified. Arriving with their new methods and techniques, the scientists in fact transform (or translate) the old problems—'translation' always presupposes a text (or story) that is already available, an existing configuration of actors & interest" (Tchalakov 2014).

As pointed out by authors such as S. Shapin (2008), the 'entrepreneurial' science became dominant in the decade after Second World War, where the huge investments in

scientific equipment in nuclear physics, material sciences, molecular biology, laser research and many fields of science increased the proper role of methods and techniques of study in the process of research. It is strongly related to the intentions of the European and North American elites to understand and control science and science-based technologies. The professionalized science of 20th century became a world of aggressive competition, where the new sophisticated equipment counted at least as much as the audacity, ingenuity, and persistence of individual scientists. STS researchers - B. Latour, M. Callon, J. Law, Sh. Traweek, K. Knorr-Cetina and some others - were the first who discovered these changes during their fieldwork work at scientific laboratories and offered a relevant language for understanding it. Similarly to the natural scientists they studied, practically all of them, later on, successfully applied the newly developed approaches to the other areas of social life – law, religion and ethics (B. Latour), finances (K. Knorr), medicine and public health (J. Law).

Yet there are empirical studies carried out during the last thirty years. There are a few, which gradually revealed another type of science that for a long period of time has been overshadowed by the mainstream STS researches — a science guided by patient, laborious, and uncertain efforts for acquaintance of a new agent or unknown features of an existing agent and where the methods of study are secondary. This science may not be as successful as the 'entrepreneurial' one, but it is indispensable for the development of knowledge and for the evolution of human ways of engaging with the world (Tchalakov 2014, 2015). Somehow these research practices have escaped the attention of STS and Actor-Network Theory in particular— maybe because they have been exploited too much by the old epistemology and history of science, or described by

ethics and psychology related notions such as 'calling', personal devotion, etc. that today seem applicable to science amateurs rather than to the community of professional scientists.

From a sociological perspective, however, the crucial research problem arising here is what provides a point of support for the researchers during these longer or shorter periods when they are left along with their research (Fox Keller 1983, Tchalakov 2004, Bosch 2006). This problem still remains unanswered. A possible solution might be the modification of the well-established STS notion of heterogeneous community (or as-sociation as Bruno Latour put it, 2005) between researchers and studied objects, so that it takes into account the bodily, inter-corporeal interactions of researchers with the equipment and objects of study. Fewer sociological studies have approached this problem (Boltanski 1990, Tchalakov 2004, Thevenot 2000, Hennion 2007 and 2009).

Hennion deserves special attention, because he proved a theoretical frame for the analysis of co-production of human agents (scientist) and objects of their study, mediated by the equipment and various instruments: "the 'object', Hennion points, is not an immobile mass against which our goals are thrown. It is itself a deployment, a response, an infinite reservoir of differences that can be apprehended and brought into being." (Hennion 2007:101). Practically all of these authors point out the difficulties in analyzing the research as a process of becoming, which ends with 'established objects and their effects', our 'knowledge' about them, and sometimes with modified equipment that allows better grasp or 'reading' of these effects. In some key aspects this process of becoming is tacit and 'silent' (Hirschauer 2007) and it is even more difficult to be analyzed when the new smart digital devices

are ‘black-boxing’ what was before a deployed set of human actions and make this process even more difficult to grasp. So it is argued that the application of visual methods of analysis appears to be especially relevant (Mohn and Amann 2002, Schubert 2006, Dobler 2016).

Facing such resistance from empirical reality, or rather considering the defocus between the method and studied object, we believe in the hard work needed for further “calibration" of STS (and ANT!) methodology and the only way to do this is its continuous testing in the field. That is how the original concepts of ‘coupling’ (heterogeneous micro-community) and enduring science came into being (Tchalakov 2004, 2014, 2015), and which are developed in the research program of the Plovdiv School. Hence, the following program for new empirical STS research, which focuses on bodily practices, mediated practices and the inter-corporeal relationships between human and nonhuman actors, might be outlined:

1) “Emptiness” as an initial state towards the object of study: The new scientific discoveries and engineering designs emerge initially as a specific ‘emptiness’ and ‘absences’. These are manifested on the side of researchers as dissatisfaction from and problematization of the existing ‘picture of the world’ in the given field (theories, instruments, studied entities).

2) Knowing and endurance: In the initial period of ‘radical uncertainties’ the researchers are subjects of different types of societal pressure and negation, that put to the test their endurance and ability to resist. Hence, it is the entering into (heterogeneous) community, with the arising new entities and establishment of relationships of inter-corporeality and

'attachment' with them that provides the researchers with point of support and helps them endure the pressure.

3) The instrumental role of passivity: According to Levinas, once a man becomes aware of the existence of the object of study (if yet not fully known), a 'state of passivity' emerge, (Levinas 1982, Mitev 2006, Tchalakov 2014) that induces the 'reflexivity' of the objects (Hennion 2007). Similarly to the claim of ethnomethodology about reflexivity of everyday practices, this notion could be applied to objects in the practices of scientists and engineers.

4) The situation of knowing as an 'event' and the reflexivity of objects: the slight, almost invisible manifestation of the knowledge objects in the course of experiment, observation, or in the field work, is similar to the encounter between the amateurs and the objects of their taste described by A. Hennion. Following Hennion we claim that this is an ability of the researcher that is yet to be learned (Tchalakov 2004, 2010, 2014) through the continuous presence in the laboratory. Being 'timid' and to a larger extend non-explicit, the newly emerging knowledge could be better registered by applying visual methodology.

References

Артюшина А.В. 2014 Сетевые взаимодействия в условиях конкуренции за ресурсы на примере молекулярно-биологических лабораторий в России и США. Кандидатская диссертация на соискание уч. ст. канд. социл. наук, ГУ ВШЭ, Москва, 2014. (Artyushina, A. V. – Network interactions in the conditions of resource

competition. At the example of two molecular biology labs in Russia and USA, PhD thesis, 'High Economic School' State Univeristy, Moscow, 2014)

Bloor, D. 1976. Knowledge and social imagery. Routledge&Kegan Paul. L., Boston, Henley.

Boltanski, L., 2012 [1990], Love and Justice as Competences - Three Essays on the Sociology of Action (translated by Catherine Porter), Cambridge (UK), Polity Press.

Boltanski L., Esquerre A. 2016 "The Economic Life of Things", New Left Review (98) : 31-54. Bosh M, Friesen J., Siebert H, van Dorst C. Curious Careers. An Unexpected History of Women in Science and Technology. Foundation for History of Technology, Eindhoven, 2006

de Vries, G. 1992 "Wittgenstein and The Sociology of Scientific Knowledge : Consequences to a Farewell to Epistemology", mimeo – library CSI, Ecole des Mines, Paris

Dobler J. M. 2016 Collaborative Imaging. The Communicative Practice of Hand Sketching in Experimental Physics. In: Proceedings of Design Research Society 50th Aniversary Conference. Pp. 1-15.

Fox Keller, Evelyn 1993 Secrets of Life, Secrets of Death: Essays on Language, Gender and Science. New York: Routledge, Chapman &. Hall.

Feyerabend, P. 1975. Against Method: Outline of an Anarchist Theory of Knowledge, New left books.

Hennion 2007 – Hennion A. Those Things That Hold Us Together: Taste and Sociology // Cultural Sociology 2007; 1; 97-114.
Hennion, A. 2009 Réflexivités. L'activité de l'amateur, Réseaux Volume 27 – 153/2009, pages 55-78
Hirschauer Stefan 2007 Puttings things into words. Ethnographic description and the silence of the social // Human Studies : A Journal for Philosophy and the Social Sciences (published online in February 2007)
Knorr Cetina K. 1995 Laboratory Studies: The Cultural Approach to the Study of Science, in: Handbook of science and technology studies. Jasanoff S (Ed); Los Angeles.
Kapriev, G., M. Roussel and I. Tchalakov (Eds.) 2014 - Le Sujet de l'Acteur. An Anthropological Outlook on Actor-Network Theory, MORPHOMATA Volume 21, Wilhelm Fink GmbH & Co. Verlags, Paderborn
Khun, T. 1962. The Structure of Scientific Revolutions. University of Chicago press.
Knorr-Cetina, K. D. 1981. Manufacturing of knowledge: An essay on the constructionist and contextual nature of science. Oxford: Pergamon.
Knorr Cetina, K. 1995. Laboratory Studies: The cultural approach to the Study of Science. In: Jasanoff, Markle, Petersen, Pinch (Ed) Handbook of Science and technology Studies. 140-167
Lakatos, I. 1970. Falsification and the methodology of scientific research programmes. In: Imre Lakatos & Alan Musgrave (eds.), Criticism

and the Growth of Knowledge. Cambridge University Press 91-195
Latour, B. Woolgar, S. 1979/1986 Laboratory Life. The Construction of Scientific Facts. Sage/Princeton U.P. London Los Angeles/Princeton.
Latour, B. 1987. Science in action. How to Follow Scientists and Engineers through Society. “Harvard University” Press.
Latour, B. 1988. The Pasteurization of France. Harvard University Press: Cambridge Mass.
Latour, B. 1988 The Politics of Explanation: an Alternative, in: Steve Woolgar (editor) Knowledge and Reflexivity, New Frontiers in the Sociology of Knowledge Sage, London, pp.155-177, 1988
Law, J. (2009) Actor Network Theory and Material Semiotics, in: The New Blackwell Companion to Social Theory Edited by Bryan S. Turner © (2009) Blackwell Publishing Ltd.
Mitev, T. 2006. Semiotics and Phenomenology in The Social Study of science. About Some Limitations of Actor-Network Theory. In: "Sociological Problems". Special Issue No. XXXVIII/2006, 64-75 Pages
Mohn, Elisabeth und Amann, Klaus 1998 In: Anthropolitan: Visuelle Anthropologie. Mitteilungsblatt der GeFKA, 6, 4-20.
Rosental Cl. 2007 Les capitalistes de la science. Enquête sur les démonstrateurs de la Silicon Valley et de la NASA, CNRS Éditions, coll. « Société », 2007.
Shapin, S. 2008.The Scientific Life, University of Chicago Press, Chicago and London

Schubert, Cornelius 2006 Video Analysis of Practice and the Practice of Video Analysis. Selecting field and focus in videography. In Video Analysis : Methodology and Methods. Qualitative Audivisual Data Analysis in Sociology, Peter Lang, 2006. Pp. 115-126.

Thevenot, L.2000 Pragmatic Regimes Governing the Engagement with the World, in: Knorr-Cetina, K., Schatzki, T. Savigny Eike v. (eds.), The Practice Turn in Contemporary Theory, London, Routledg

Traweek, Sh. (1988) Beamtimes and Lifetimes, The World of High Energy Physicists, Cambridge Mass, Harvard University Press.

Tchalakov, I. 2004 Language and Perception in the Coupling Between Human and Non-human Actors. In: Arno Bammé, Günter Getzinger, and Bernhard Wieser (Eds.) 2004 - Yearbook of the Institute for Advanced Studies on Science, Technologies & Society. Graz, Austria, 2004, pp. 193-218.

Tchalakov 2014 – Tchalakov I. The Amateur's Action in Science // G. Kapriev, M. Roussel and I. Tchalakov (eds.) Le sujet de l'acteur. An anthropological outlook on Actor-Network Theory. – Wilhelm Fink, Paderborn, 2014. Pp. 25 – 64.

Tchalakov, I. 2015 The New Space Entrepreneurship and Its Techno-Economic Networks, in: International Journal of Actor-Network Theory and Technological Innovation, 6(4), Volume 7, Issue 1, pp.43-63

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