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Note on the fieldwork in anthropology of science and technology.

M.A.Popov

This note is inspired by Marianne de Laet 's anthropological comments (*Nature* vol 501: 164-165, 12 Sept 2013) on Harry Collins (2013) new book *Gravity's Ghost and Big Dog : Scientific Discovery and Social Analysis in the 21st Century* (University Chicago Press).

Harry Collins produced brilliant systematic sociological account of his almost 40 years (!) fieldwork among scientists in the area of wave gravitational astronomy. However, some details of his sociological observations cannot be understood without historical context or some related semantic model, indeed.

Gravitational waves were the first predicted by Einstein's General Relativity in 1915 and, later, an existence of gravitational waves was rejected by Einstein (together with N. Rosen) in 1936 as well. Following Daniel Kennefick (1997), in his letter to Max Born, Albert Einstein the first reported that he arrived at the interesting result that gravitational waves do not exist at all, though they had been mathematically in-built in General Relativity before. Pure mathematically, Einstein probably had a sufficient foundation to reject such " natural" consequence of GR, because he faced with an existence of non exact solutions for nonlinear general relativistic equations which described plane gravitational waves. In 1936 Einstein and Rosen had submitted a paper entitled "Do Gravitational Waves Exist ?" to the *Physical Review* (USA) for publication (similar competitive result suggesting more dramatic refutation of Riemann geometry and Einstein's time theory was published by Leningrad's physicist Jakob Bronstein in 1935). However, Einstein's paper was returned to him with a critical referee's report .Einstein withdrew the paper and dismissed out the referee 's comments (Einstein to Tate : July 1936, EA 19-086). In his letter to Editor (Kennefick 1997:2) Einstein in particular wrote :

"We (Mr Rosen and I) had sent you our manuscript for publication and had not authorized you to show it to specialists before it is printed. I see no reasons to address the – any case erroneous – comments of your anonymous expert .I prefer to publish the paper elsewhere "(!)

As is known, in 1937, indeed, one modified version of this paper with Rosen was accepted for publication by the Journal of the Franklin Institute in Philadelphia and another (reduced) version was published in the USSR. In his Soviet publication, N. Rosen showed that plane gravitational waves were an impossibility due the ineradicability of singularities in the metric of General Relativity. Later, new generation of theorists had found that Rosen did not distinguish sufficiently between coordinate mathematical singularities and physical singularities, which , nevertheless, could be detected experimentally (Bondi, Pirani, Robinson, Landau, Lifshits, and Weber) Thus, contemporary ground - based interferometers (for instance, LIGO) as well as ESA-NASA space - based interferometers (LISA) which built to detect gravitational waves are based on Einstein –Rosen unsolved mathematical controversy .

Hence, thus, Collins (2013) sociological observations on the puzzling semantics of knowing of gravitational waves, his sociological finding that experimental evidence in gravitational wave astrophysics has gradually shifted from true observation to a social

consensus and feeling of becoming catastrophe among experimentalists are probably have a sense in the context of our story.

In accordance with anthropologist Marianne de Laet (2013: 165) “Collins defies a best practice of anthropology – to examine one’s motifs and motivations “ of scientists... I suppose, nevertheless, that this feature of Collins’s social analysis of gravitational waves detections cannot be achieved even within current anthropology of science and technology, because, perhaps, both today’s sociologists as well as anthropologists of science do not speak in mathematical language of scientists, they, correspondingly, have limited access to understanding of scientific literature produced by members of subculture.

Being anthropologist I am doing fieldwork in some post-classical anthropological manner among quantum physicists and quantum hackers from 1996. I started my investigations with training in mathematical language (mathematics is language of scientific subcultures)of theoretical physicists and later in order to be confident in my fieldwork, I published own mathematical result in *Bulletin des Sciences Mathematiques* (1999). Hence, it is quite natural that my *language based ethnographic* approach produced and is producing different results. In particular, I have formulated for myself some elementary rules of the fieldwork in anthropology of science and technology which I’d like to share with readers .

RULE 1. Mathematical language of scientists is essential.

It is well known principle of the field anthropology. Perhaps, Edmund Leach (after Bronislaw Malinowski) was the first mathematically speaking and mathematically educated (Cambridge University ,1st Honour Degree) anthropologist of science within British social anthropological tradition. Some his works on experimental “ethnographic algebra”(1945), binominal arithmetic of Jakobson–Levi-Strauss’s structuralism and symbolic logic of communication in social anthropology can, certainly, help to realize that understanding of the scientific subject and communications with scientists are almost impossible without mathematical language, indeed. Another story about Bruno Latour can demonstrate an importance of mathematical language as well. In 1988 anthropologist Latour published results of his semiotic analysis of theory of Relativity where he expressed some doubts on logical justification of Lorentz transformations in Einstein theory and attempted to describe some sort of absurdity he had found in Relativity . In accordance with Latour, both Special and General Relativity “are accepted, more frames of reference with less privilege can be accepted, reduced, accumulated and combined, observers can delegated to a few more places in the infinitely large (the cosmos) and the infinitely small (electrons), and the readings they send will be understandable “(Latour, 1988) As is known, number theorist Alan Sokal (2008 : 155), rejected B. Latour’s finding as ‘an example of nonsense ‘and had defined 40 pages of Latour’s article as typical ‘comical misunderstanding’ of real physics. He suggested that Latour ‘doesn’t understand what the term “ frame of reference” means in physics – he confuses it with “actor” in semiotics – he claims that relativity cannot deals with transformations laws between two frames of reference, but needs at least *three* [frames of references] “ . Thus, old ethnographic rule about language training is also essential in contemporary anthropology.

RULE 2. Participant – observation of scientific subcultures can include such sort of integration as observer’s scientific publications.

This means that in comparison with sociologist, anthropologist can be completely integrated in scientific community, however, here, there is the risk of losing some levels of objectivity of observation. In my own fieldwork, I used this rule and have published physical article on quantum physics (2003) and have presented, recently, cryptographic paper at the first conference on Quantum Cryptography (QCRYPT 2011) in Zurich ETH (2011) in order to change a focus of acceptance and understanding of rapidly evolving subculture.

RULE 3. Anthropological Analysis of physical and mathematical assumptions can discover something new indeed.

It may seem difficult to explain what kind of anthropological analysis we can use without practical example and beyond concrete context. So let us show how language based anthropological analysis can work in the field of H. Collins’s sociology of gravitational waves detection.

Despite Aristotle’s reputation of the great philosopher, all organic and non organic bodies having different chemistry, composition, form and size are all dropped from the same height to our “sin” Earth with the same acceleration (i.e. 9.8 m/sec^2) under the influence of gravity. It was first discovered by Galileo in High Renaissance and now this fundamental physical observation is called “the principle of equivalence of inertia and gravitation “ (PE). Today this equality of the gravitational accelerations of completely different things is one of the most accurately tested (with accuracy of a few parts in a thousand billion !) laws of physics. Because PE, the principle of equivalence, tell us very little about organic and non-organic bodies themselves, it was naturally to assume that gravity influence is pure geometric effect (curvature of 4-dimensional space-time) but not effect of different taylor-made hidden magnets inside falling bodies. This consequence of the law of equality of accelerations of different things represents a cornerstone of Einstein’s General Relativity. PE is beautiful Master-physics of Nature itself, because everything falls always in exactly the same way and there are no exceptions at all . It applies universally to anything falling in a field which Albert Einstein defined as “gravitational field “. Newton had not this idea, because physical fields were the first observed by M. Faraday in 19th century. According with famous story Newton was inspired by experiment with falling apple which is due to the gravitational field. But Einstein’s gravitational fields are not Faraday’s electromagnetic fields. Einstein’s fields are manifested in the curvature of spacetime (mathematically, this means that “the Riemann tensor differs from zero “). However, speaking exactly, in the case of Newton test with a falling apple, gravitational field (Riemann tensor) plays insignificant role, while the acceleration 9.8 m/sec^2 of an apple is explainable in GR by the curvature (density) of spacetime.

Gravitational wave is a wave of spacetime observables of acceleration characteristics of Riemann tensor , moving with the speed of light. In the language of poets, gravitational waves are the ripples on static spacetime. Thus, hence, it is impossible to measure gravitational wave in any concrete point at all. But, in order to measure

gravitational wave we are needed two masses, distance L and apparatus. Thus, mathematically, by measurement of changing distance $\Delta L = \frac{1}{2} hL$ (h is amplitude of changeable density of space-time) we can provide argument for an existence of gravitational waves. But, physicists had found also that uncertainty of Riemann tensor can produce non-physical “Ghost states”. Ghost states appear also at the astronomical distances in gravitational radiation. In order to eliminate “Ghosts” physicists need new ways to solve nonlinear equations in General Relativity. In 1935-1936 Albert Einstein is faced namely with these problems and he had found that there is sufficient foundation to reject an existence of gravitational waves. In 1968 physicist - experimentalist Weber made announcement on discovery of the way to detect gravitational radiation. He used two antennas with $h = 10^{-16}$. It was beginning of modern gravitational wave astronomy, and, new hope that pure experiment can help to find solution for Einstein-Rosen controversy. Thus, today, “general relativistic waves -1915” are some sort of social scientific construction of physicists because despite of enormous efforts gravitational waves are still dream of Relativists. Another example of anthropological analysis in modern physics could be found at FOXi website : <http://www.fqxi.org/data/essay-contest-files/Popov>

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