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## The absence of women in neutrino physics

THE DISCIPLINE OF HIGH ENERGY PHYSICS (HEP) has become one of the most expensive in the history of *Physics* and *Science*. One of its peculiarities is that it is divided in theory experiment and phenomenology, and I think we could add the instruments construction as part of the discipline.<sup>1</sup> Neutrinos have become a very important aspect of HEP and have developed the neutrino physics discipline.<sup>2</sup> I will make a brief resume on the history of this discipline.

The neutrino history is very interesting because it is a particle that was introduced theoretically and it was „seen” in an experiment 26 years later. The community believed in the existence of the neutrino and the theory of decay was constructed with the use of this particle. After World War II the discipline of High Energy Physics (HEP) was developed and a lot of money from the militar and the industry was given to the experiments on this topic. On of these experiments that was financed by the Atomic Energy Commission was designed for detecting the neutrino. (One of the first proposals for this purpose was to explode an atomic bomb in order to find the neutrinos that were produced in the nuclear reaction. Very soon this possibility was discarded.) So in 1956 Frederick Reines, Clyde Cowan and their collaborators announced the „indirect observation” of the free neutrino. Although the neutrino was „observed” the discipline of neutrino physics begun with the solar neutrino problem between 1964 (John Bahcall) and 1968 (Ray Davis). Since the 1970’s and specially since the 1980’s many physicists have moved to this discipline enhancing it. (In 1970 near 50 articles on this topic were published in 2005 the number of articles increased to 1300). The neutrino problem has not been settled down.

I will focus on the topic of this work: “the absence of women in neutrino physics”. Very few work has been done on the relation of *Physics* and *Gender* in the second half of the 20<sup>th</sup> century. One of the most important works on the community of high energy physics and gender has been developed by Sharon Traweek in her book *Beamtimes and Lifetimes*.<sup>3</sup> In this work an ethnographic approach is used to understand the values, relations and the share grounds inside the communities of the American Stanford Linear Accelerator (SLAC) and the Japanese laboratory *Ko-Enerugie butsurigaku Kenkyusho* (KEK). At the end I will talk about the conclusions to which Sharon Traweek arrives.

While I was working on the history of the discipline of neutrino physics I was shocked by the absence of women in all the brief histories related to the discipline. The first question arose:

Are there any women in the field ? Why? My first approach to the problem is a quantitative one, I have been searching on the Spires HEP preprint index archive where you can find almost all the articles published and not published on physics and astronomy. The first thing I have found is that in most of the cases the articles are signed with the family name and the persons name has been reduced to an initial.

Maybe this general way of signing can be seen as a democratic one but what it really does is that it disappears the persons identity unless you have become a very important researcher. The first task is

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<sup>1</sup> Galison, P. (1997): *Image and Logic* (Chicago: The University of Chicago Press); Schweber, S.S. (1994a): “Some reflections on big science and high energy physics in the United States”, *Rivista di Storia della Scienza*, 2 (serie II), p. 127–89.

<sup>2</sup> Mateos and Navarro (2006): “The uses of neutrinos: A historical perspective”, *European Journal of Physics*, 27, p. 257–64.

<sup>3</sup> Traweek, S. (1988): *Beamtimes and Lifetimes: The World of High Energy Physicists* (Cambridge, Mass: Harvard University Press).

to find out the name of the articles authors. Not all the authors are searchable in Spires so I used the google searcher in internet to find the persons name. I did not found all the names. In the moment they wrote the article most of these unknown authors where students and then they changed to another discipline or definitely they left the academic world. In this approach all these persons disappear. For finding out which of the authors are women we found that some of them when they get married they use the name of their husband in the next way, for example Susan Kovesi becomes S. Kovesi-Domokos. But others remain with their families name. The Russian women have an 'a' at the end of the family name so you can detect them. All the other women are invisible.

I have made the search of articles related to neutrinos for the period 1964–1972 and the relation I have found is the next: total of authors (T), Women (W), Men (M), Unknown (U),

1964	T=39	W=1	M=29	U=9
1965	T=16	W=0	M=13	U=3
1966	T=10	W=0	M=6	U=4
1967	T=6	W=2	M=2,	U=2
1968	T=52	W=1	M=48	U=3
1969	T=94	W=2	M=70	U=22
1970	T=134	W=1	M=101	U=32
1971	T=142	W=4	M=111	U=27
1972	T=141	W=1	M=114	U=26

I have a methodological problem and is related to two very important aspects of the discipline, we can talk about a global problem as the neutrino physics discipline and we have the local problem that implies different communities of theorists, instrument designers, experimentalists in different laboratories and Universities. I do not know which is the best approach, a case study must be done at Fermilab and CERN where most of the experimentalists and instrument designers are located. With the theorists communities is most difficult to work because they are not located in the same space, so a special strategy must be designed. But what is clear is that one of the things that all these subcultures share is the absence of women so there is a general gender problem.

I still do not have any conclusions the search must be done for the years 1973–2006, and we could expect some changes in the proportion between men and women. I would like to use Traweek's work on the gender problem in HEP. She says:

In the fifteen years [she was making here study from 1973-1988] I have been visiting physics labs, the status of women within them has remained unchanged — in spite of major transformations, in North America and Europe, in opportunities for women and attitudes about their roles. In this book women remain marginal, as they are in the laboratory. The lab is a man's world...the practice of physics is engendered, laboratory work is masculinized.<sup>4</sup>

This is for the laboratory work, but what happens with the practices of theory and instrument makers? How it is engendered? It is a problem of language, metaphors and practices.

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<sup>4</sup> *Ibid.*, p.16.