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Neutrino Physics Sociology

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This brief paper, following my presentation, focuses on two aspects of Neutrino sociology: the multilateralism approach to neutrinos and the neutrino induced skepticism.

1 The multilateralism approach to neutrinos

According to Wikipedia, multilateralism is an alliance of multiple groups pursuing a common goal. This applies very well to neutrino physics.

a. Neutrino properties are studied through different approaches: interactions (cross sections), propagation (oscillations), masses, the number of species, Dirac or Majorana character, CP violation, magnetic moment...

b. Neutrino sources are many and complementary: Natural or artificial sources, reactors, accelerators, atmospheric, terrestrial, solar, supernovae, cosmic, cosmologic... The spectrum in energy of neutrinos in our environment extend from 10^{-4} eV to 10^{20} eV as illustrated in figure 1 [a].

c. The variety of neutrino detectors is also quite impressive: beta decay spectrometers, radiochemical experiments, large underground detectors, large undersea detectors, large under ice detectors, balloon and space detectors, short and long baseline accelerator neutrino detectors, missing energy hermetic detectors.

d. Neutrino collaborations can range from few people to more than one thousand, with various duration and cost. Most experiments are international, even small ones (neutrinos contribute to peace and to a better understanding of people over the world). In general neutrino community is steadily growing.

[a] The first energy spectrum showing the richness of the (anti)neutrino sources is due to Pierre-Olivier Lagage in 1985, two years before SN1987A [2] (see figure 2).

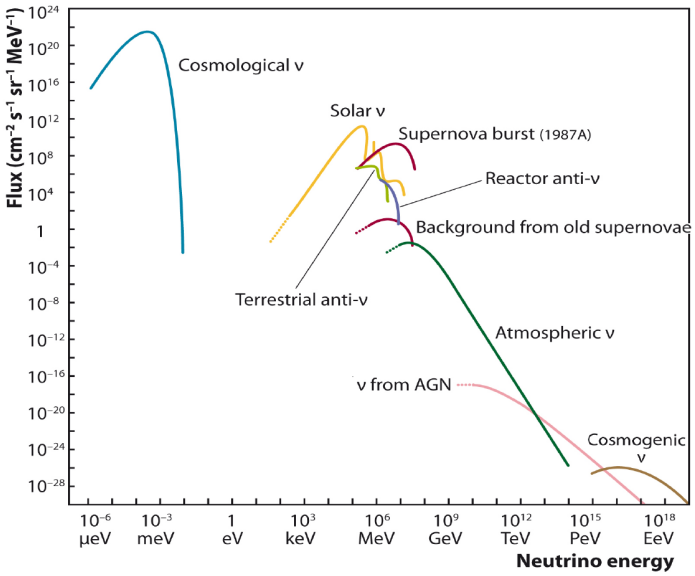

Figure 1 – The natural steady (anti)neutrino energy spectrum in our environment [1].

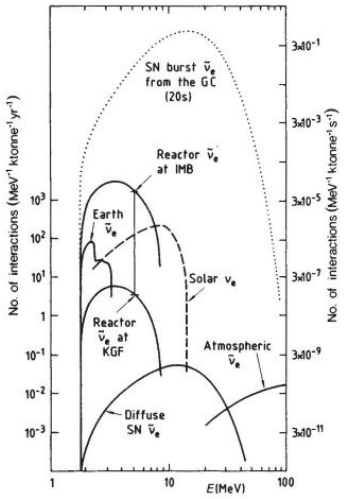

Figure 2 – Number of events expected for different antineutrino and neutrino sources (reactors, supernovae, Sun, atmospheric) between 1 and 100 MeV [2].

e. The applications are also many: particle physics, neutrino astronomy, neutrino cosmology, neutrino earth tomography, geosciences, nuclear reactor monitoring, non proliferation of nuclear weapons...

f. Despite the fragmentation of the community inherent to this multilateral approach (neutrino properties or applications × type of sources × type of detectors × collaborations), the community succeeded to develop a shared and coherent strategy (it took some time), thanks to various institutions/committees: ApPEC, P5 US, ACFA, IUPAP neutrino conferences, IUPAP neutrino panel...

This lively multilateralism was all along its history, a source of controversies: neutrino working hypothesis at the beginning, neutrino discovery, neutral currents, solar neutrino deficit, atmospheric neutrino deficit, masses, fancy properties, sterile neutrinos... It was marked by many working hypothesizes, by many mistakes, by serendipity and by many great discoveries.

2 Neutrinos nourish skepticism

a. Normal Skepticism. First evidences of neutrino oscillations were sometimes taken with great skepticism. Are neutrinos traveling faster than the speed of light? Are neutrino properties an evidence for physics beyond the standard model? Evidences for sterile neutrinos are still the object of great skepticism. I call this normal skepticism connected to controversies in science. At the end some evidence were confirmed, some were not and some are still pending.

b. A priori/systematic skepticism: it can be felt that the normal skepticism (science controversies) turned into "a priori/systematic skepticism" in neutrino history for some cases: solar neutrino deficit at the time of the Ray Davis Chlorine experiment [b], more generally neutrino oscillations were the object of normal and then systematic skepticism until it became impossible to deny. Competing communities sometimes looked at neutrino physics with disdain and systematic skepticism: "it will never work", "what do we learn from that? Is it new physics?"

c. Finally, in this world of fake news we better be prepared to be exposed to reactions like:

"Neutrinos are an invention of scientists, relayed by the media for their own benefit".

"Neutrinos have been proven to be a canard repeatedly over and over again".

"Why wasting so much money on neutrino activities? We will never learn!"

"Neutrinos are based on faulty science and manipulated data".

"The concept of neutrino oscillations has been created by and for the Japonese to make US non competitive".

Any reminiscence of tweets is not fortuitous.

3 Conclusions

The neutrino community is full of diversity, imagination and boldness. It has a rich history (see this conference). It is now well recognized (9 Nobel laureates). It is a field which many others envious of its richness. Let's hope that the next decades will be as enjoyable as the previous ones and let's warmly thank the organizers.

References

1. Christian Spiering, "Towards High Energy Neutrino Astronomy – A Historical Review", arXiv:1207.4952, European Physics Journal H 37 (2012) 515; see also M. Cribier, M. Spiro and D. Vignaud, "La lumière des neutrinos", Seuil, 1995.
2. P.O. Lagage, "Nuclear power stations as a background source for antineutrino astronomy", Nature 316 (1985) 420.
3. Trevor Pinch, "Theory Testing in Science – The case of Solar Neutrinos", Phil. Soc. Sci. 15 (1985) 167; Trevor Pinch, "Confronting Nature, The sociology of Solar-Neutrino Detection", Kluwer/Reidel, 1986.

[b] See the fascinating sociological study of solar neutrinos by T. Pinch [3].