No Tau? No Astronomy!

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Astrophysical or not?

• There are, several arguments to keep in mind before any claim of neutrino astronomy arising from the 54 HESE events:

• 1) There are no clear Galactic plane signatures. Most gamma Fermi MeV-GeV and even TeV telescope astronomy do show both rare extragalactic but also a clear galactic plane signal.
• 2) There are no GRB-neutrino correlated events. These GRBS events are the most (apparent) gamma brightest flashes and they were expected to be in correlated shining activity with highest neutrino energy.

• 3) There are no at all any AGN-neutrino expected connections. There are several persistent AGN flaring TeV sources with no correlation with these 54 IceCube events.
4) There is a puzzling disagreement in power spectra among HESE events and the through-going ones, why?

5) No self-narrow clustering occurred within the UHE neutrino events. They are quite collimated signals.
6) The 3 years of IceCube records (2013-2015) are going to be doubled soon (ICRC 2017); the doubled statistics may clarify the tau absence by a stronger statistical weight. This presentation show how.
Neutrino are well mixed and they oscillate along their flight from astrophysical sources to us leading to a democratic flavor flux

2.1 The simplest, the best: how many tau double bang?

Let us try to imagine the fate of an hadronic astrophysical neutrino: If it has been originated by any common pion $\pi^\pm$ or $K^\pm$ decay, first into $\mu^\pm$ and later on by muon decay, we would expect as a first approximation an astrophysical neutrino with no neutrino tau flavor

$$\Phi_{\nu_e} : \Phi_{\nu_\mu} : \Phi_{\nu_\tau} = 0 : 1 : 2.$$ 

$$\Phi_{\nu_e} : \Phi_{\nu_\mu} : \Phi_{\nu_\tau} = 0 : \frac{1}{3} : \frac{2}{3}.$$ 

$$\Phi_{\nu_e} : \Phi_{\nu_\mu} : \Phi_{\nu_\tau} = \frac{1}{3} : \frac{1}{3} : \frac{1}{3}.$$
The ICECUBE detection on 2013-2017 of a fast flavor change from muon rule track to a cascade rule (e, muon, tau) suggested the injection of an astrophysical new component made by electron, muon, tau and NC events.
Inside the last 54 High Energy Starting Event there are, in present data, 10 events above 200 TeV energy able to reveal double bang.
No Tau has been observed using its timed double bang: in 214 TeV-72 PeV energy windows

\[ E_{\nu_{\tau}} = 3.6 \text{ PeV} \]
The allowed energetic events that permit in future enhanced filtering, the eventual double bang may regards nearly 18 events.
Because there are 4 kind of events: Electron, Muon, Tau and NC:

The probability to NON observe a Tau 
Within N events above 200 TeV is simply

\[ P_{\text{No-Tau}} = \left( \frac{3}{4} \right)^N. \]

The consequent absence in the 914 days ICECUBE old data (see Fig. [II]) of any tau signal among 9 or 10 events is respectively only:

\[ P_{\text{No-Tau}}(9) = \left( \frac{3}{4} \right)^9 = 7.5\%, \quad P_{\text{No-Tau}}(10) = \left( \frac{3}{4} \right)^{10} = 5.6\%. \]
Additional puzzle: Tau versus muons
Why there are three muons and no tau?

Effective Areas at Final Cut
The case of muon suppression rate for an astrophysical scenario

\[
\Phi_{\nu_e} : \Phi_{\nu_\mu} : \Phi_{\nu_\tau} : \Phi_{\nu_{NC}} = \frac{3}{10} : \frac{1}{10} : \frac{3}{10} : \frac{3}{10}
\]

\[
P_{\text{No-}\tau} = \left( \frac{7}{10} \right)^9 = 4\%.
\]

\[
P_{\text{No-}\tau} = \left( \frac{7}{10} \right)^{10} = 2.82\%.
\]
Therefore there is already tension in non observing a tau neutrino \((if \ they \ are \ astrophysical)\)

**In a near future there may be more constrains:**

These probabilities are already telling us that the tau absence is in tension with the astrophysical interpretation. If the same estimate will be doublet by twice the event number (see Fig. 3) because a lower energy threshold at 100 TeV, or by a ten times larger ICECUBE 2 volume, we should wait for:

\[
P_{\text{No-\tau}} = \left(\frac{3}{4}\right)^{18} = 0.56%;
\]

This (a very near future hypothetical) case will exclude an astrophysical nature of ICECUBE events. On the same statistical view the larger acceptance for tau neutrino in ICECUBE respect muon neutrino (see Fig. 2) imply a contradictory statistical situation where among 10 events three

In this prospective the ten times tau absent event imply already a significant tension with present glorified astrophysical interpretation. These results will be greatly amplified by a doubled candidate number as twice the observed ones:

\[
P_{\text{No-\tau}} = \left(\frac{7}{10}\right)^{18} = 0.16%.
\]

No tau appearance within 18 near future records may imply at 99.84% level the inconsistence of the ICECUBE astrophysical neutrino origin.
Charmed neutrinos are more tuned with the ICECUBE data

• Finally the alternative interpretation of atmospheric charmed neutrino signals made by electron and muon neutrino and by their antiparticles and by their common neutral current will imply a final observed flux well tuned with ICECUBE data:

\[
\Phi_{\nu_e} : \Phi_{\nu_\mu} : \Phi_{\nu_\tau} : \Phi_{\nu_{NC}} = 1 : 1 : \frac{1}{10} : \frac{21}{30}
\]

Once we normalize the expected flux it becomes:

\[
\Phi_{\nu_e} : \Phi_{\nu_\mu} : \Phi_{\nu_\tau} : \Phi_{\nu_{NC}} = \frac{30}{84} : \frac{30}{84} : \frac{3}{84} : \frac{21}{84}
\]
Indeed prompt Tau it is suppressed: one over ten respect muon ones: none or just one is expected in twenty or more in ICECUBE candidate events
Charmed neutrino may better coexist with no tau in ICECUBE also in future no record events

The consequent probability to not observe a tau in a charmed frame it is

\[ P_{\text{No}-\tau} = \left( \frac{81}{84} \right)^{10} = 69.5\% \]

Therefore it is quite natural to not being observing Tau events. In a near future, the doubling of the data, the expected probability may becomes

\[ P_{\text{No}-\tau} = \left( \frac{81}{84} \right)^{18} = 51.96\%, \quad P_{\text{No}-\tau} = \left( \frac{81}{84} \right)^{20} = 48.3\%. \]
No Glashow resonance? Additional argument for a soft spectra as the prompt one making a cut at Glashow edge: No Astronomy
3. Conclusion

The absence of tau signal in old three years record of IceCube data is allowed within a $P_{N_0 - \tau} = 5.6 - 7.5\%$ narrow windows of possibility assuming an astrophysical interpretation, while it quite a probable outcome in a prompt charmed neutrino scenario $P_{N_0 - \tau} = 69.5\%$. The very near double future $18 - 20$ candidate events above 200 TeV in IceCube for the last 6-7 years record, the eventual persistent absence of the tau it will lead to $P_{N_0 - \tau} = 99.7\%$ or at $P_{N_0 - \tau} = 98\%$ probability, assuming that IceCube events are of astrophysical nature. To accept the astrophysical neutrino nature we will expect two or even more tau events within the next future 20 candidates. For instance the probability to have at least two tau in astrophysical vision within 20 events is:

$$P_{N_\tau = 2} = \left( \frac{3}{4} \right)^{18} \cdot \left( \frac{1}{4} \right)^2 \cdot 10 \cdot 19 = 6.7\%. \quad (3.1)$$

Thus, in a near future either we should observe several tau double bang, otherwise the neutrino astronomy is at stake, more or less severe. Only and mainly the tau air-shower road-map $[14]$ it might open in a guaranteed way our eyes to a neutrino sky, as in present and future experiments $[15], [16], [18]$. 

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D.Fargion, P.Plova, Presented by M.Casolino
No Tau signals favor atmospheric charm Neutrino in ICECUBE scenario

- The absence of tau signal in old three years record of IceCube data is allowed within a $P(\text{No Tau}) = 5.6\%$ or $7.5\%$ narrow windows of possibility assuming an astrophysical interpretation, while it quite a probable outcome in a prompt charmed neutrino scenario.

- The very nearness of 18 or 20 candidate events above 200 TeV in IceCube for the last 6-7 years record, will test the eventual $P(\text{No Tau})=99.7\%$ or at $P(\text{No Tau}) = 98\%$ probability, assuming

- that IceCube tau events will be none or just one (of astrophysical nature). To accept the astrophysical neutrino nature we will expect two or even more tau events within the next future 20 candidates. Atmospheric charmed neutrinos may solve the puzzle: therefore
Therefore: il Bello della storia is:
As in the famous italian spot: No Martini, No party..

No Tau? No Astronomy!
Many Thanks for the attention, indeed
References

   Conferences, 99, 08002 (2015)
   Supplements, 256, 213 (2014)
Anyway it should be said that prompt neutrino are expected at a little lower rate below the ICECUBE data.

![Graph from Physical Review D 78, 043005 (2008)](image-url)