

# Blazars as neutrinos factories



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## Abstract

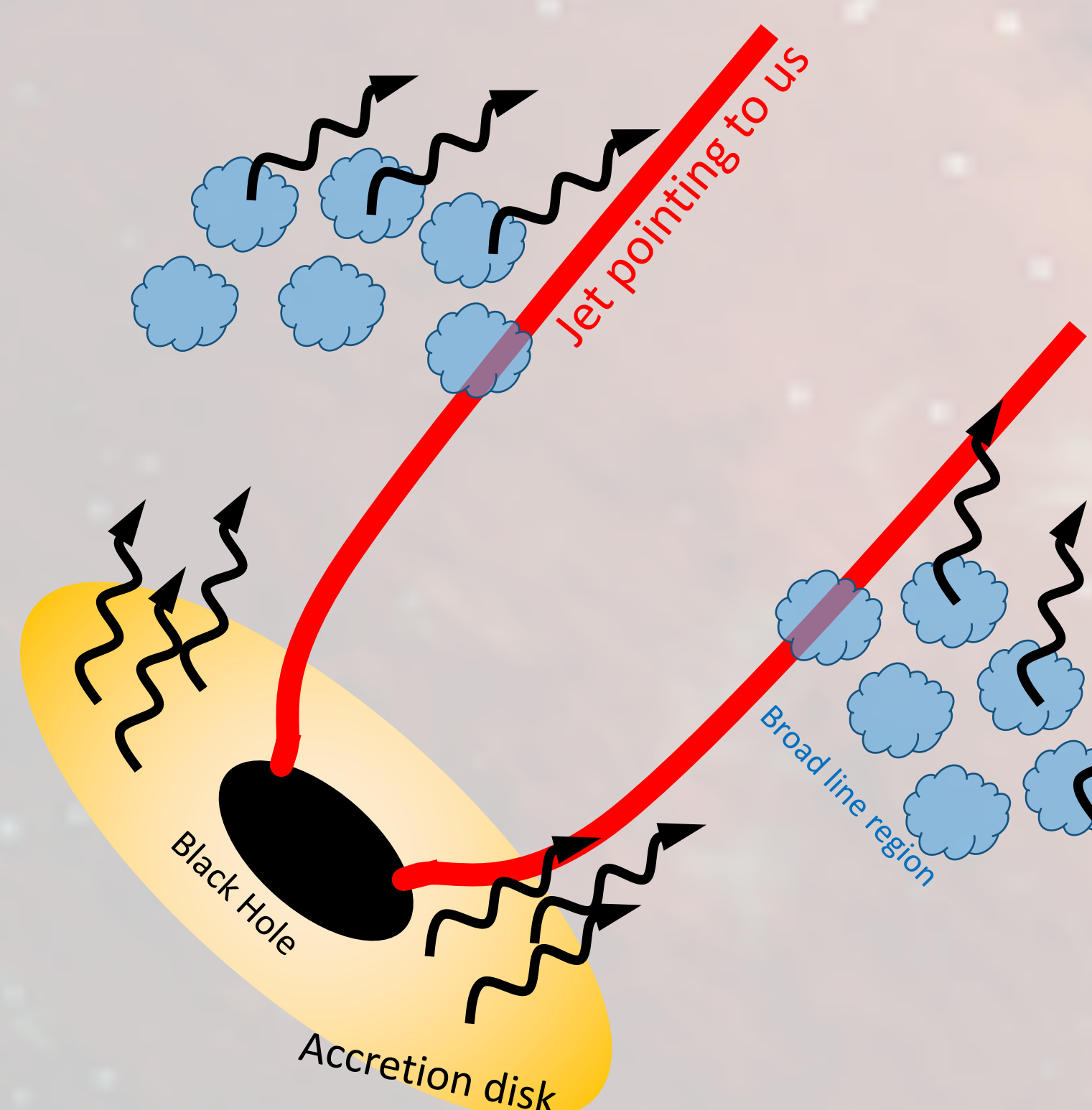
The relativistic effects owing to the beaming of the jet, that is pointing at us, make **blazars the most energetic**, persistent particle **accelerators of the Universe**. Recent observations show the evidence for a possible correlation between neutrinos detected by IceCube and a flaring BL Lac object (the case of TXS0506+056). Based on a simple theoretically-motivated framework, we postulated **a direct proportionality between high-energy  $\gamma$ -ray and neutrino fluxes from BL Lac objects**. [1]



## What are Blazars?

Blazar objects are a subclass of jetted Active Galactic Nuclei with the jet pointing to us. They are characterised by strong variability at all frequencies and an intense emission in the  $\gamma$ -ray band. This makes Blazar the most energetic extragalactic  $\gamma$ -ray sources. Blazars are divided in:

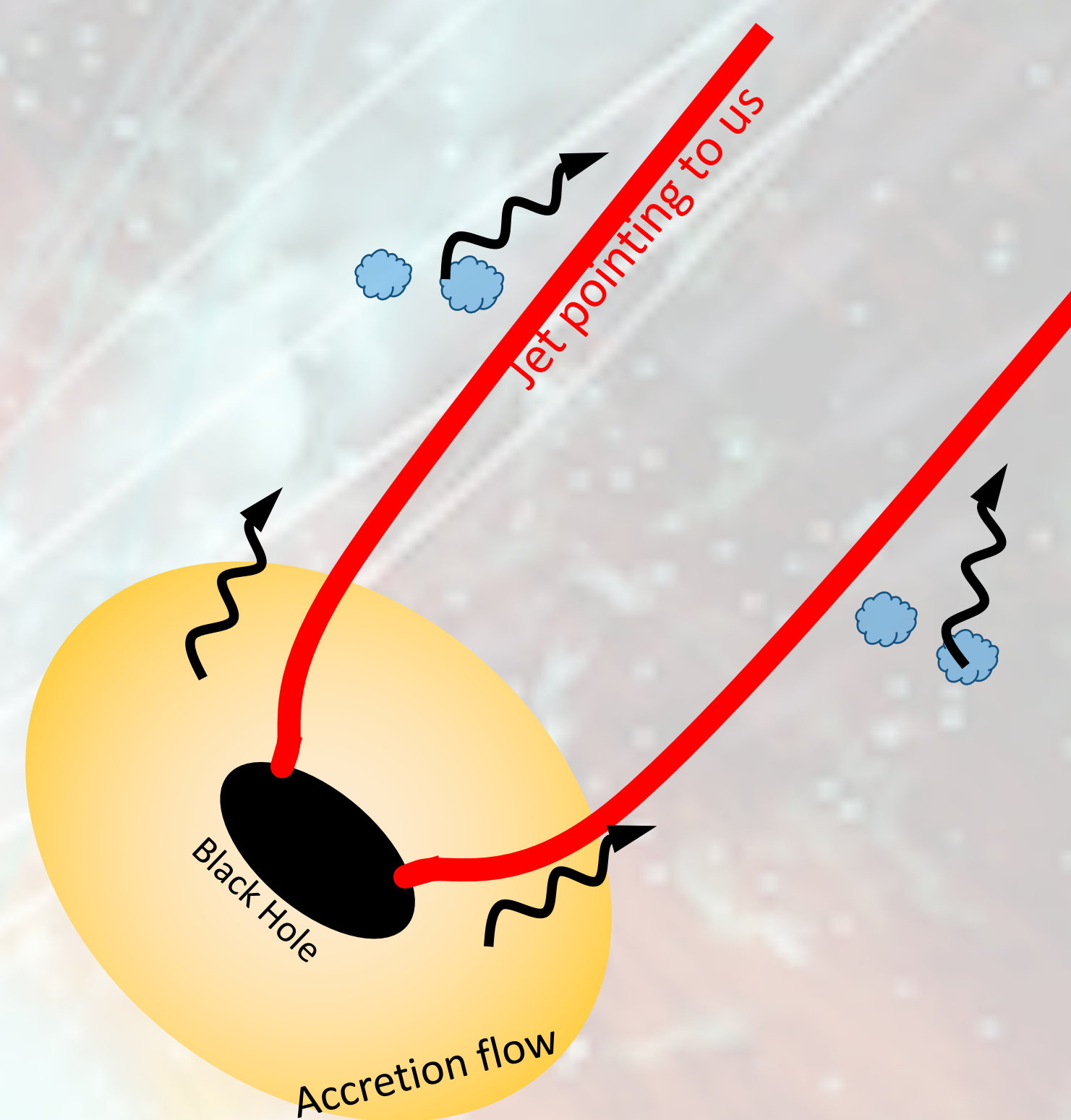
FSRQs



- Extremely powerful in  $\gamma$ -ray band
- Rich radiative environment
- Rare in the Universe

Ideal environment to for  $p\gamma$  reaction **but probably too rare to produce the entire neutrino events detected by IceCube.**

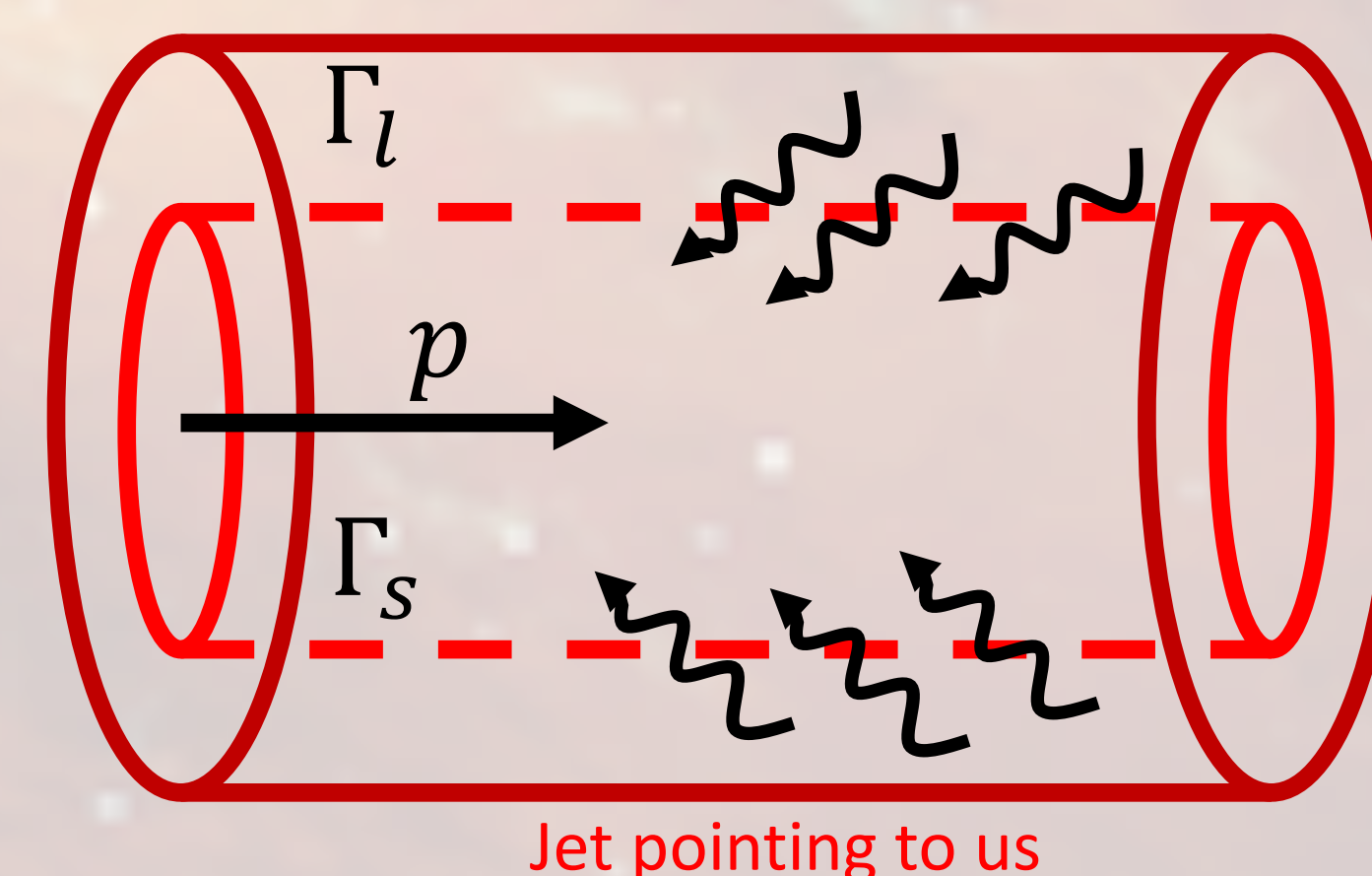
BL Lacs



- Emission at TeV band
- Low accretion rate
- Abundant in the nearby Universe

Inefficient to produce  $\nu$  from  $p\gamma$  reaction

BUT



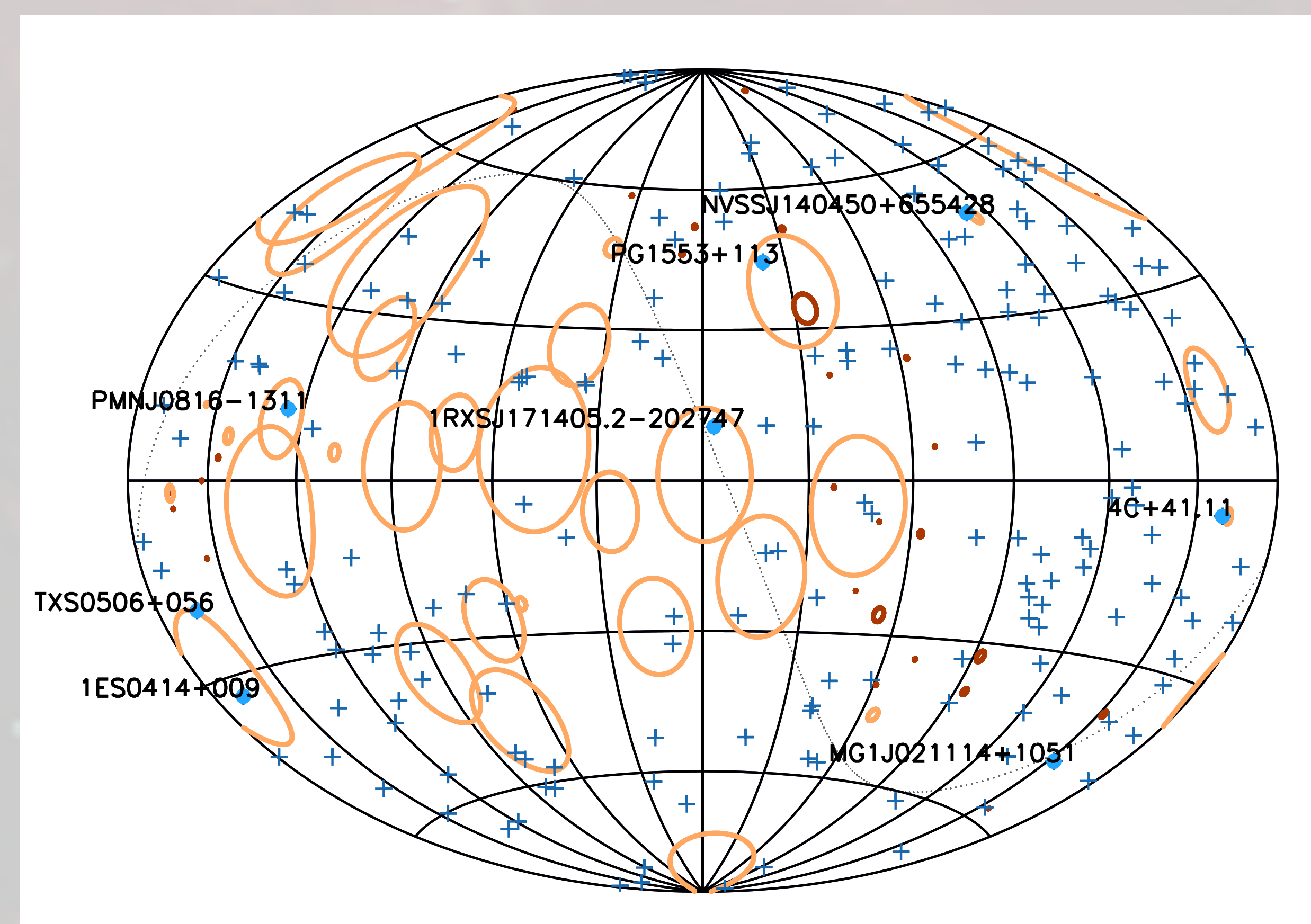
The presence of a structured jet could potentially boost the BL Lac emission up to the level required by the  $\nu$  detected by IceCube! [2]

**TXS0506+056** is the associate source of  $\nu$  event 1709922A detected by IceCube. It is a **BL Lac object** of the 2FHL catalogue!

We considered the BL Lacs of the Fermi 2FHL catalogue (sourced detected above 50GeV) as main  $\nu$  emitters. Assuming a simple linear relation between  $\gamma$ -ray and neutrino fluxes,  $F_\gamma$  and  $F_\nu$ . We obtain a neutrino flux for each source and the expected count rate observed by IceCube and Km3NeT [1].

TXS is not the only BL Lac in a spatial correlation with a neutrino event. There are other potential 7 BL Lac objects of 2FHL catalogue in spatial correlation with a  $\nu$  event. We have studied the emission properties of the sources potentially associated with neutrinos. [3]

Where are the  $\nu$  from Mkn421, the brightest BL Lac object in the sky? Why we do not have clear detection of neutrino events from this source? Is there a mechanism that suppresses the emission of Mkn421, but not other BL Lac? **STAY TUNED...**



Sky map in galactic coordinates reporting the reconstructed direction of the neutrinos detected by IceCube (orange and red circles). BL Lacs of 2FHL catalogue (blue crosses) and the name of 8 BL Lac in spatial correlation with neutrino events.

## References:

- [1] Righi C., Tavecchio F., Guetta D., 2017, A&A, 598, A36
- [2] Tavecchio F., Ghisellini G., Guetta D., 2014, ApJ, 793, L18
- [3] Righi C., Tavecchio F., Pacciani L., 2018, MNRAS, submitted