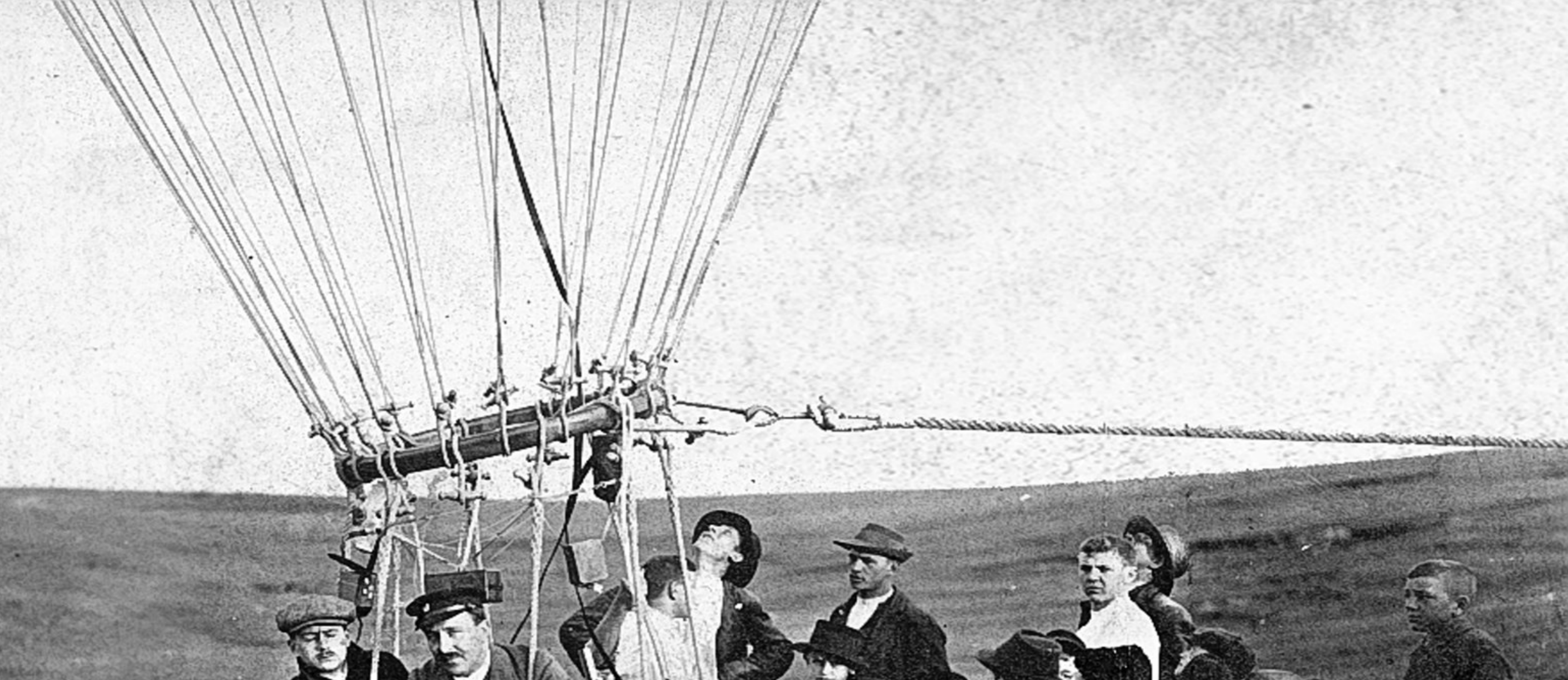
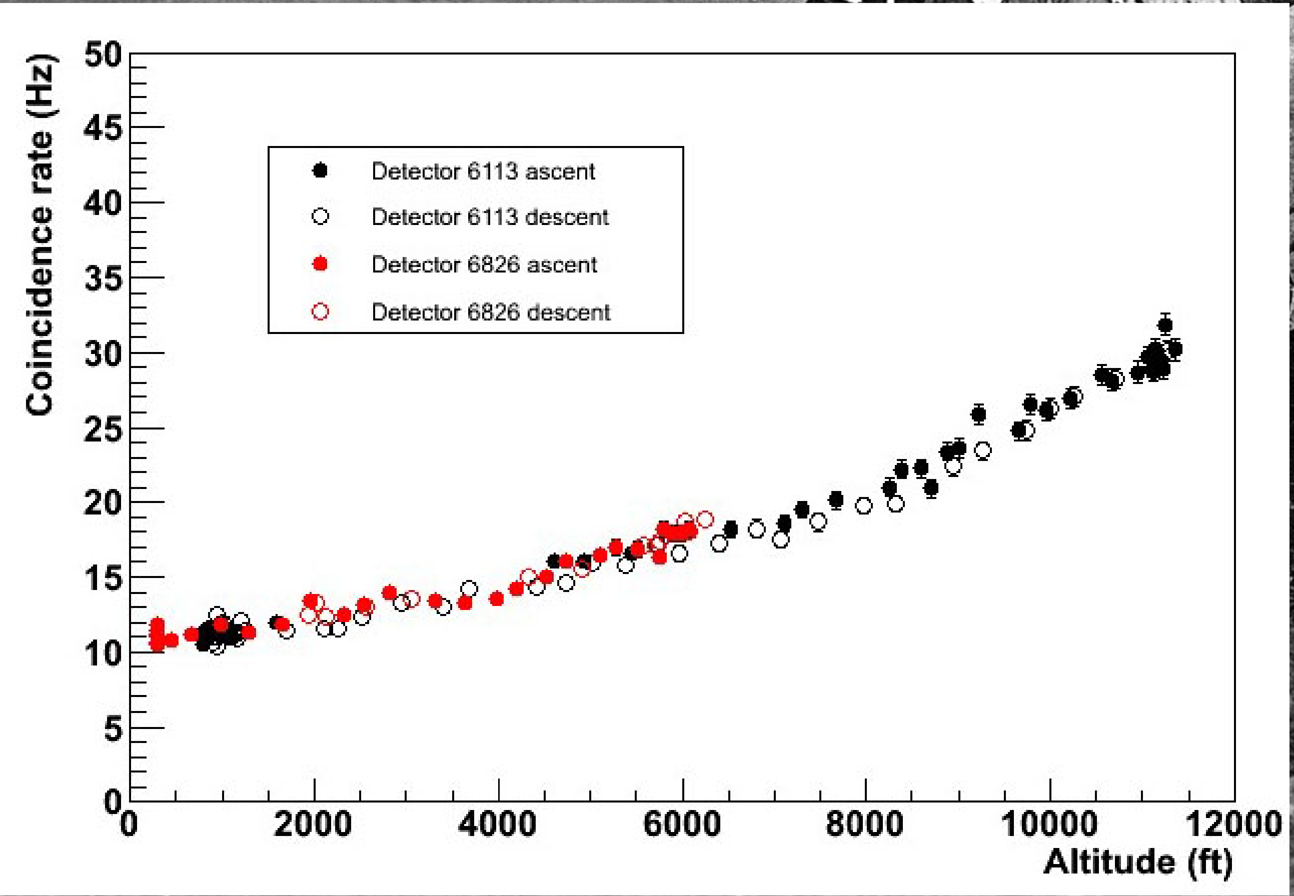
The Hunt for Extraterrestrial Neutrino Counterparts

I. Liodakis
Finnish Centre for Astronomy with ESO

Kavli-IPMU
APEC Seminar, 12 May 2022




Victor Hess


Coincidence rate (Hz)
Altitude (ft)
Detector 6113 ascent
Detector 6113 descent
Detector 6826 ascent
Detector 6826 descent
0
5
10
15
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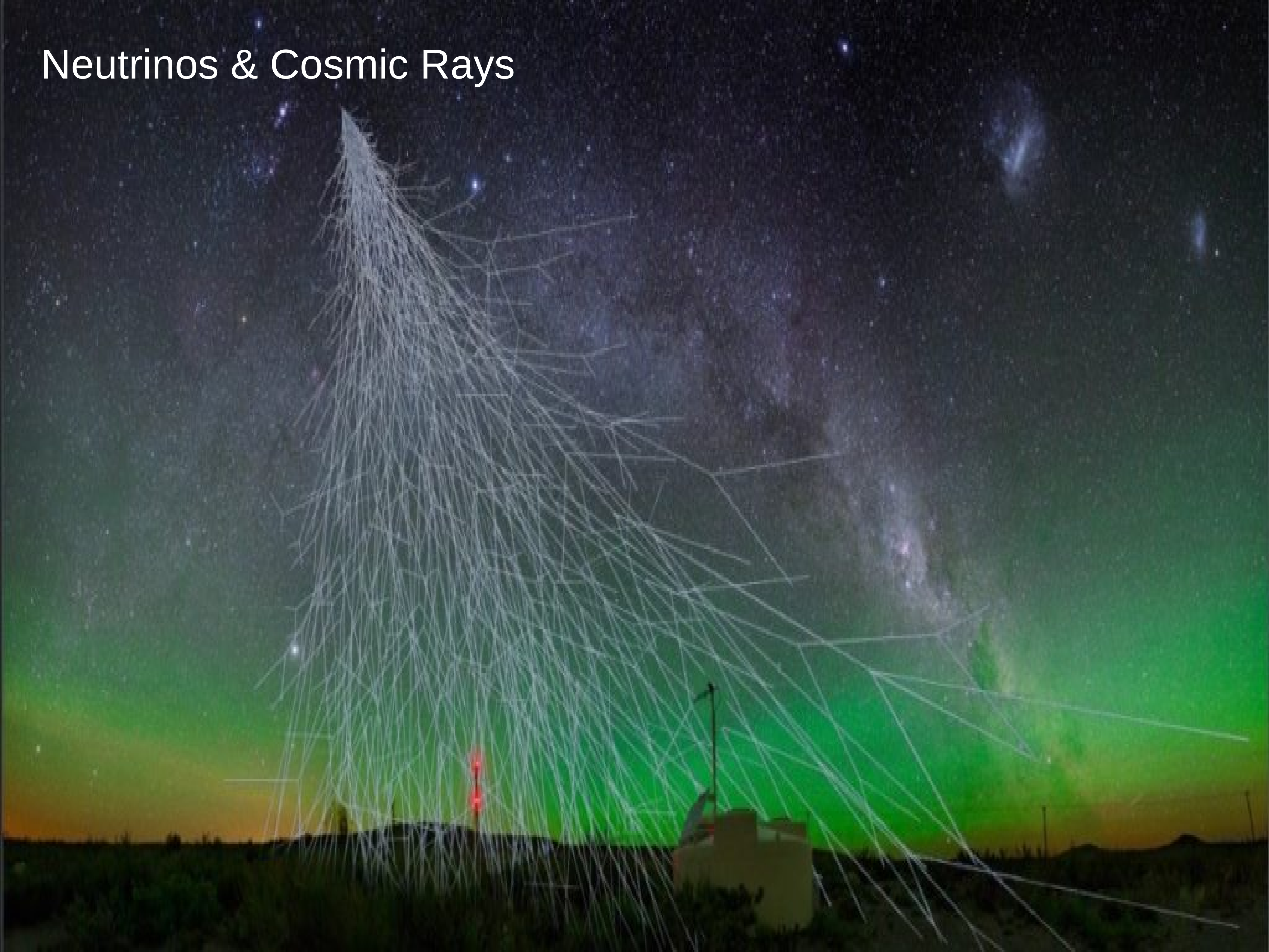
25
30
35
40
45
50
0
2000
4000
6000
8000
10000
12000

Neutrinos & Cosmic Rays



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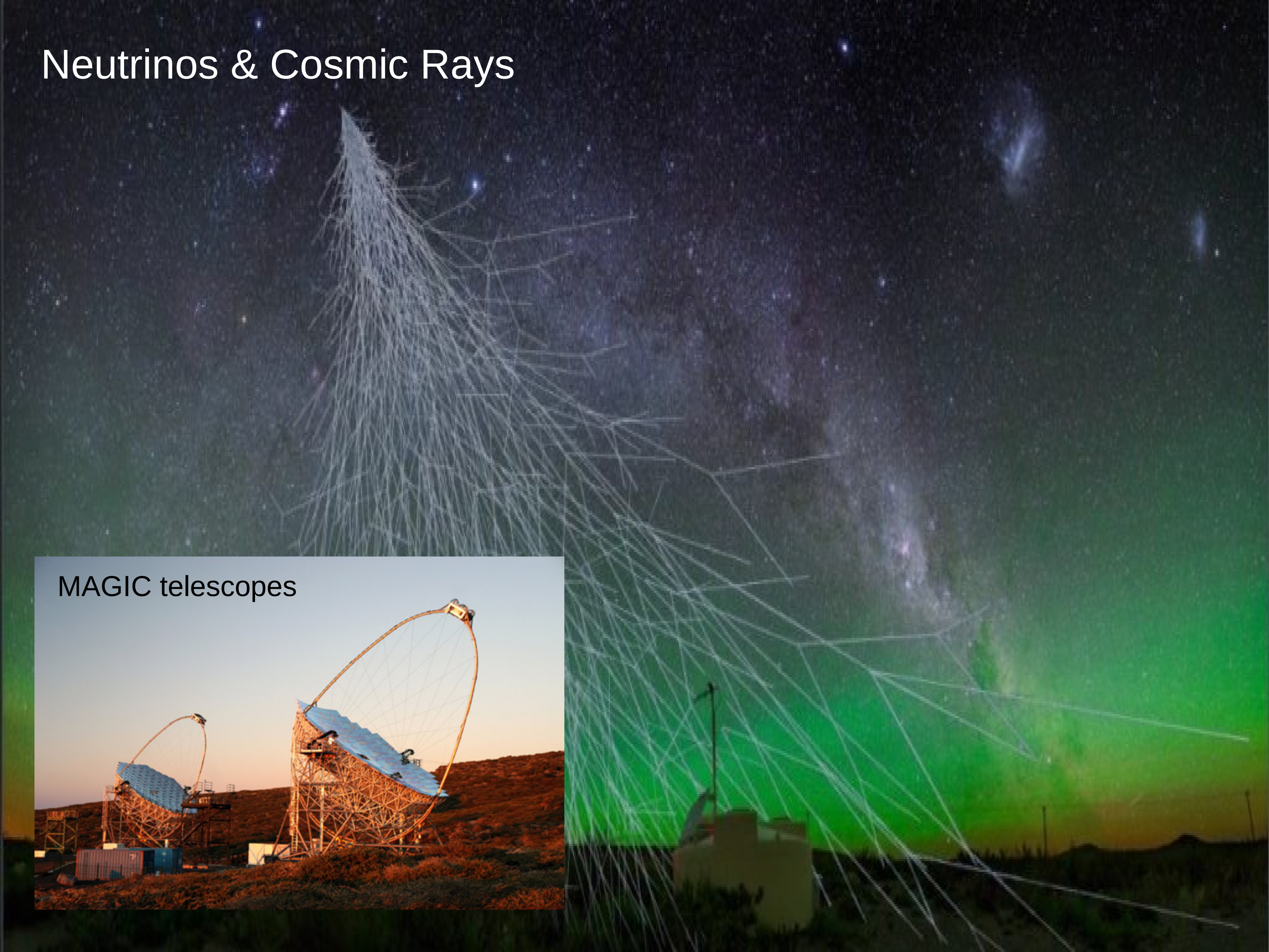

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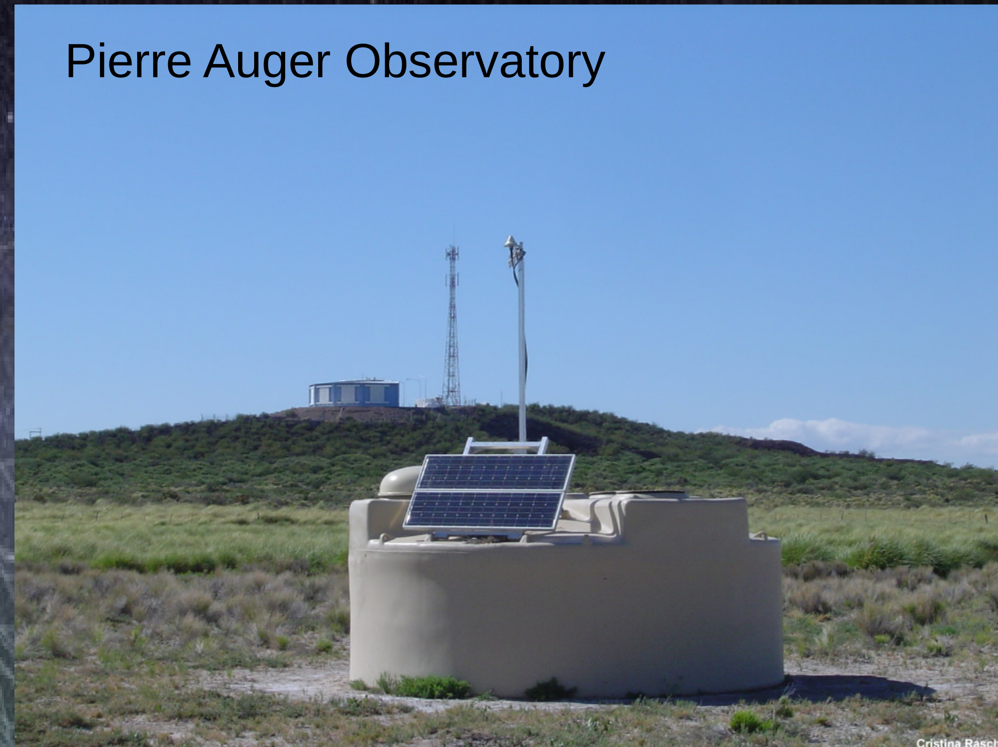
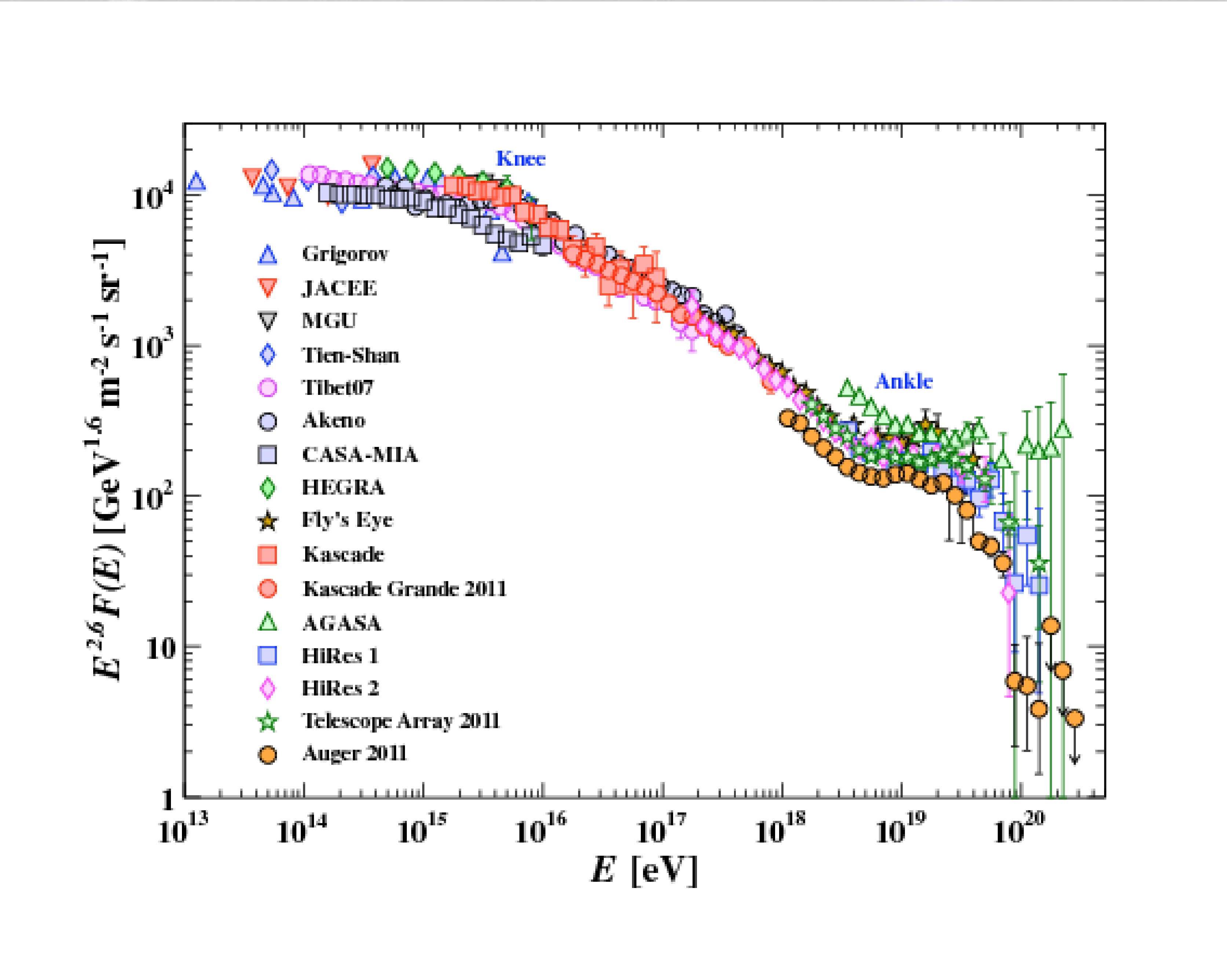


Pierre Auger Observatory


MAGIC telescopes

Neutrinos & Cosmic Rays



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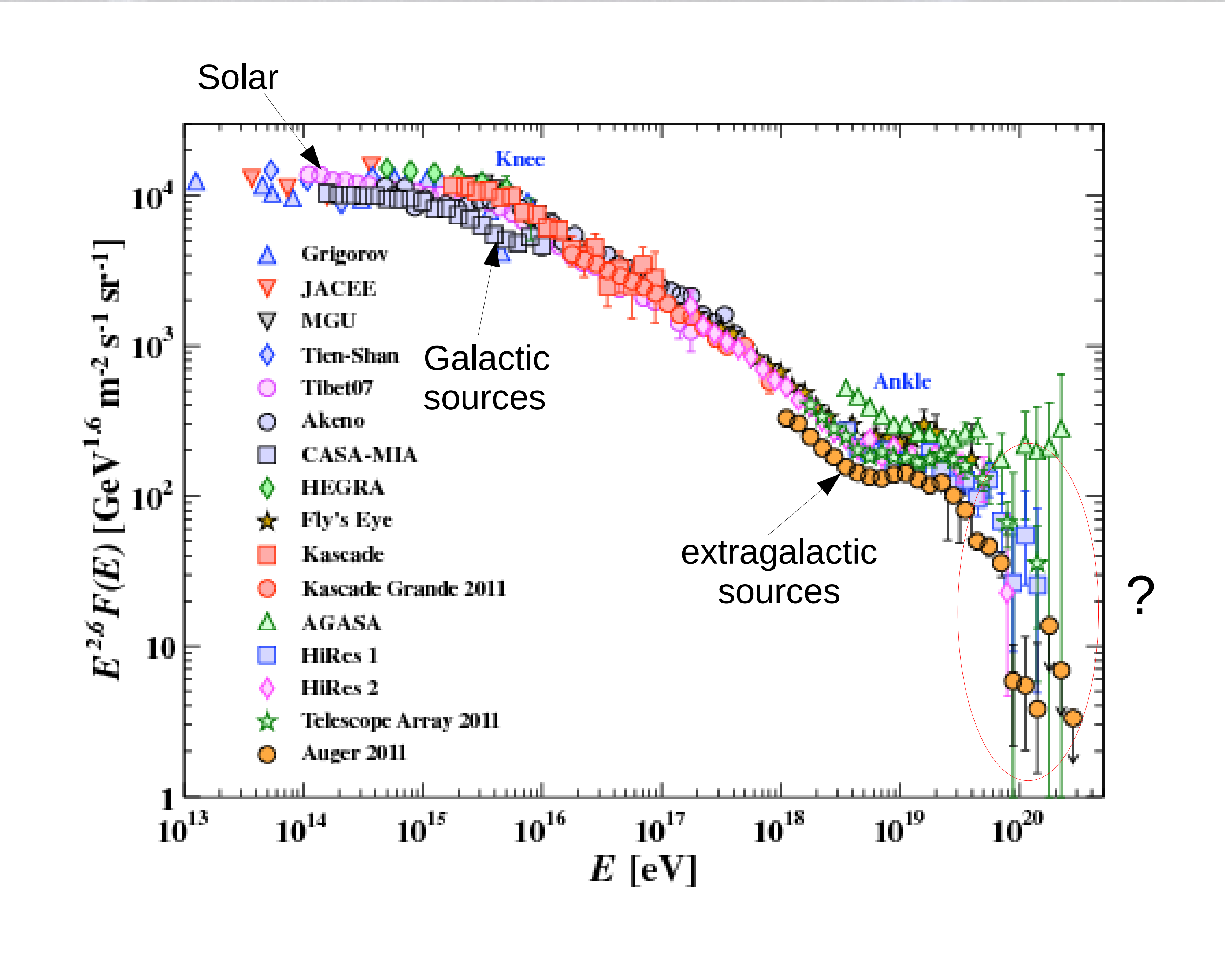

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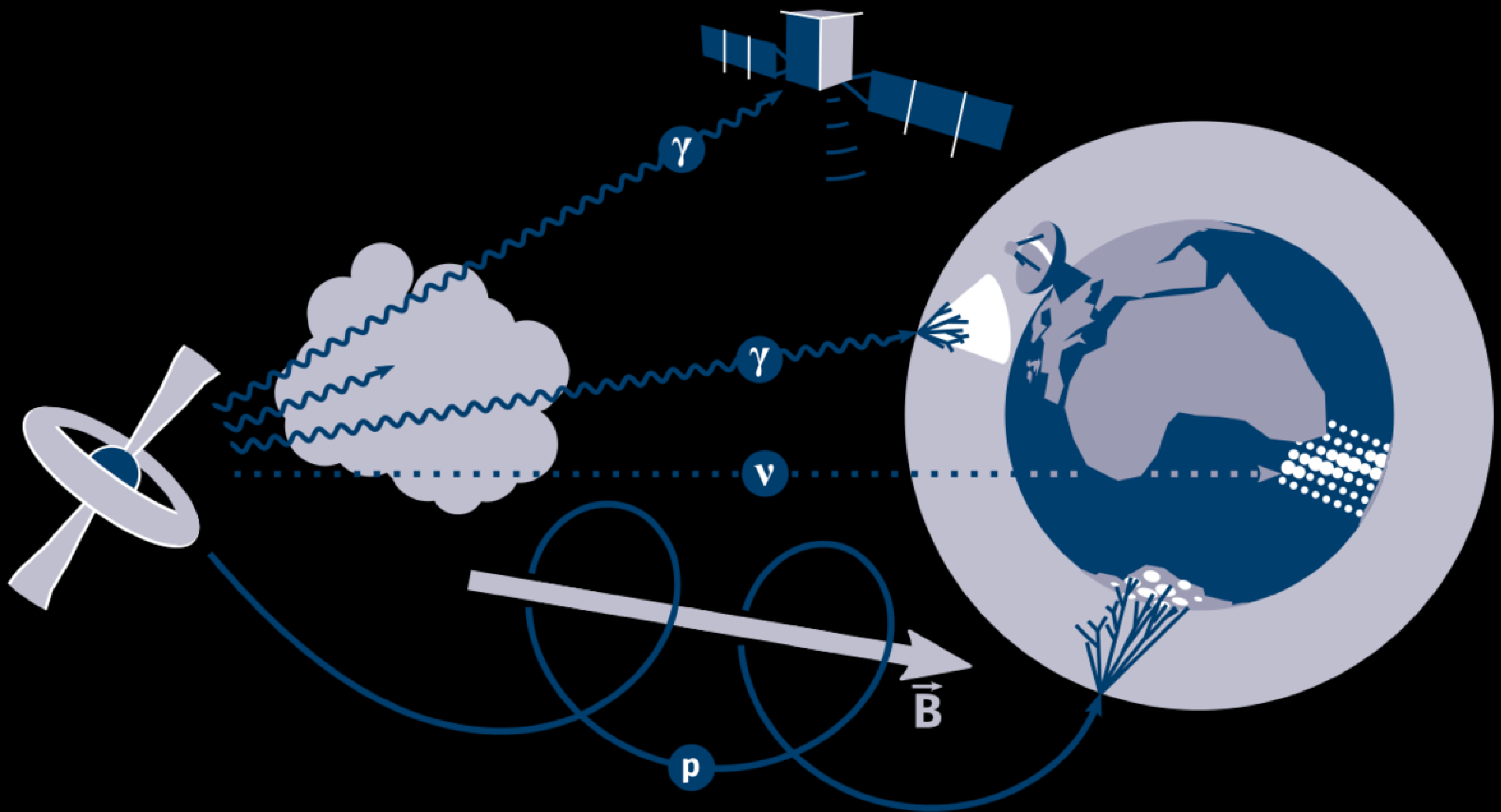
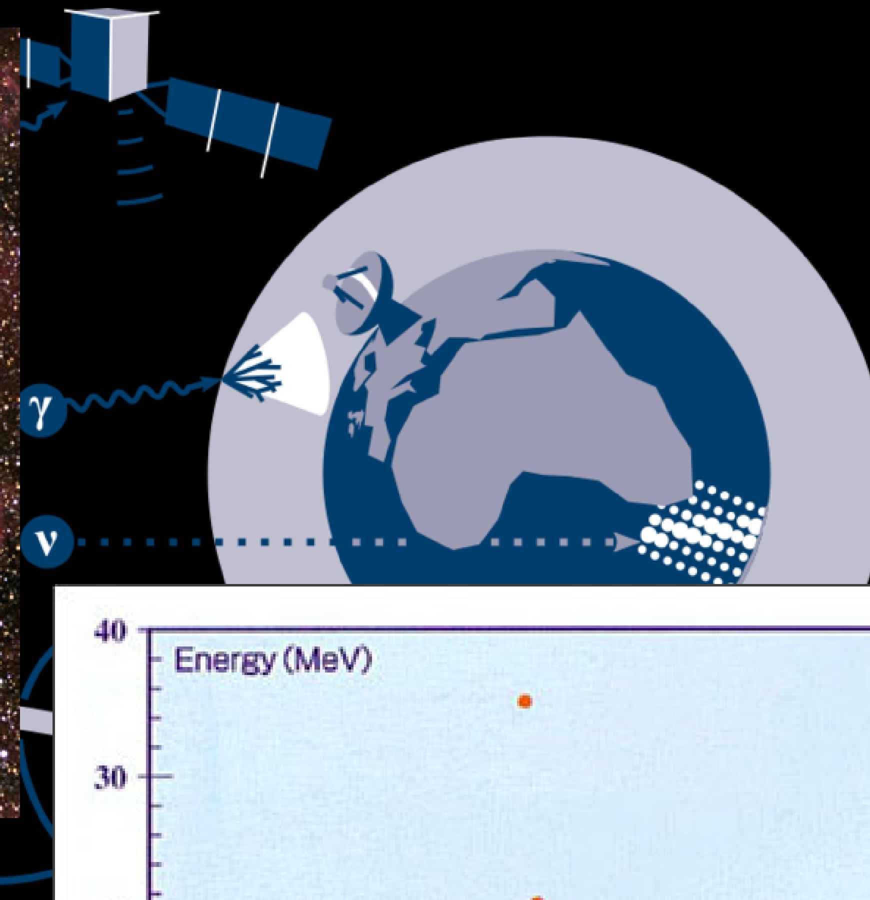
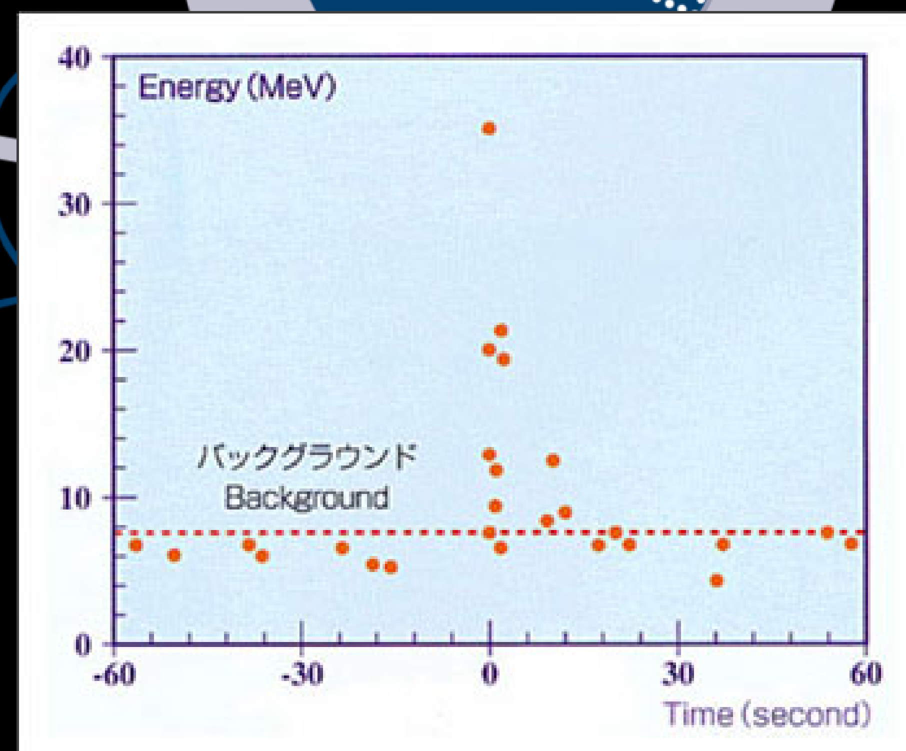


Galactic neutrino sources

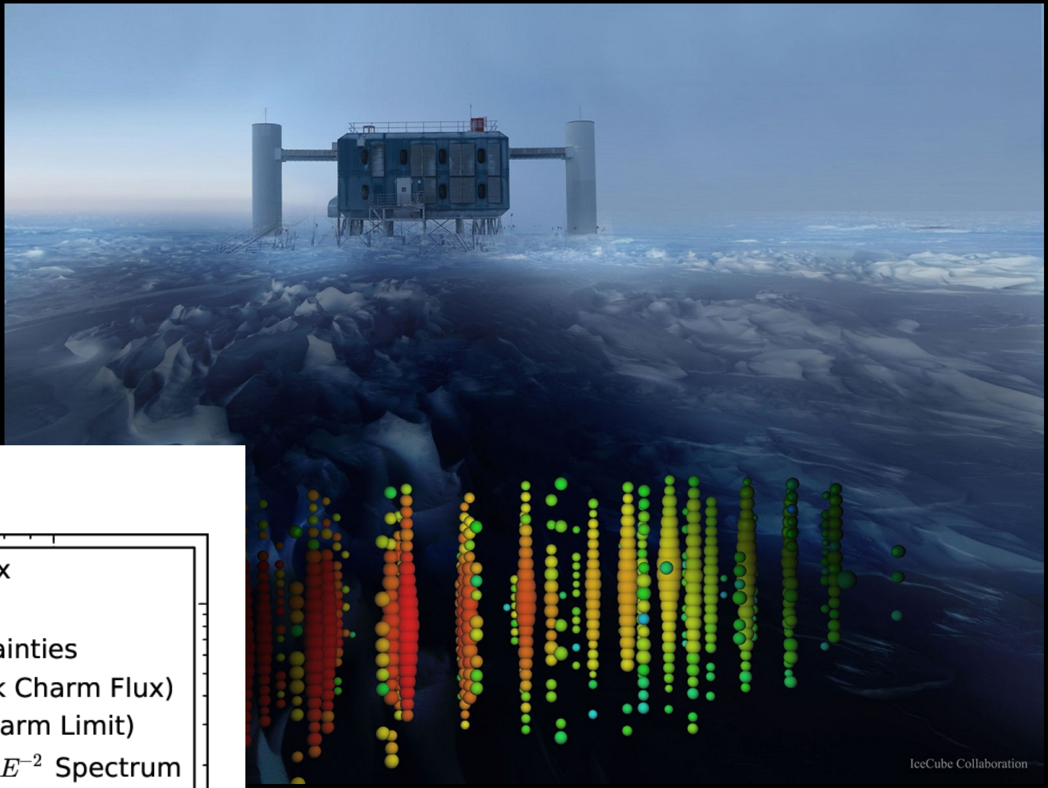
SN 1987A



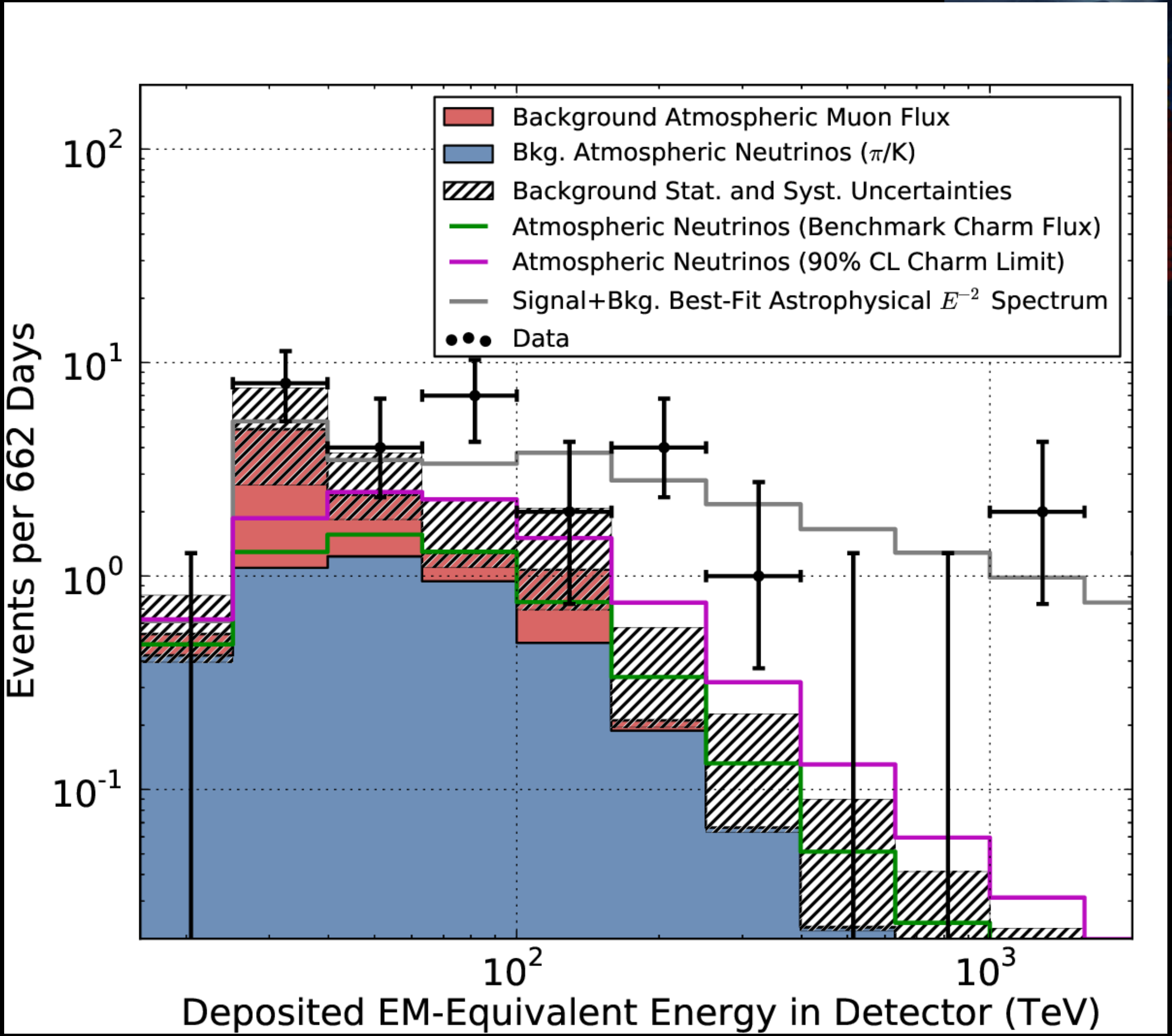


Super-kamiokande

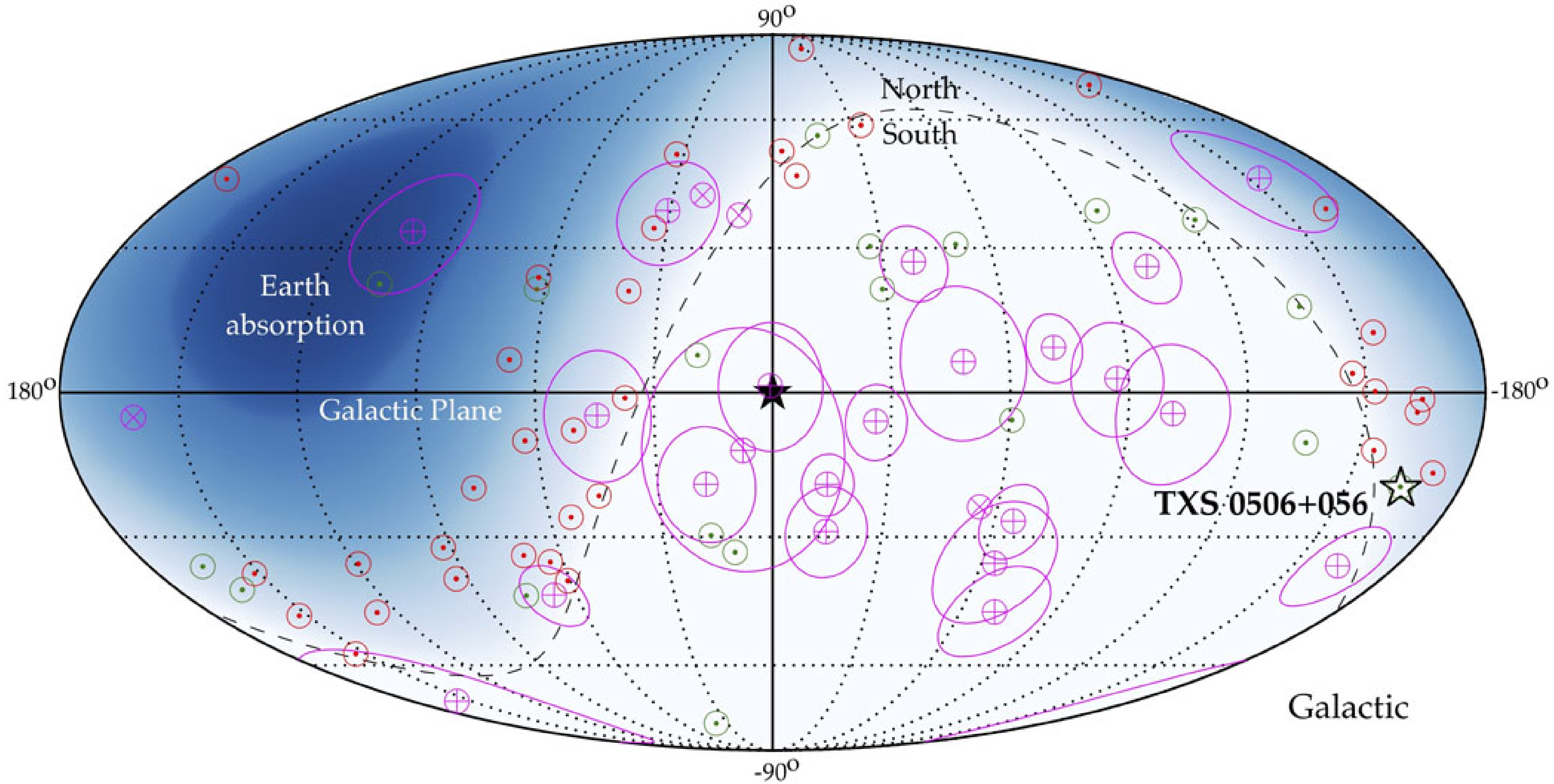
Extragalactic neutrino sources?



IceCube collaboration (2013)



Where are neutrinos coming from?



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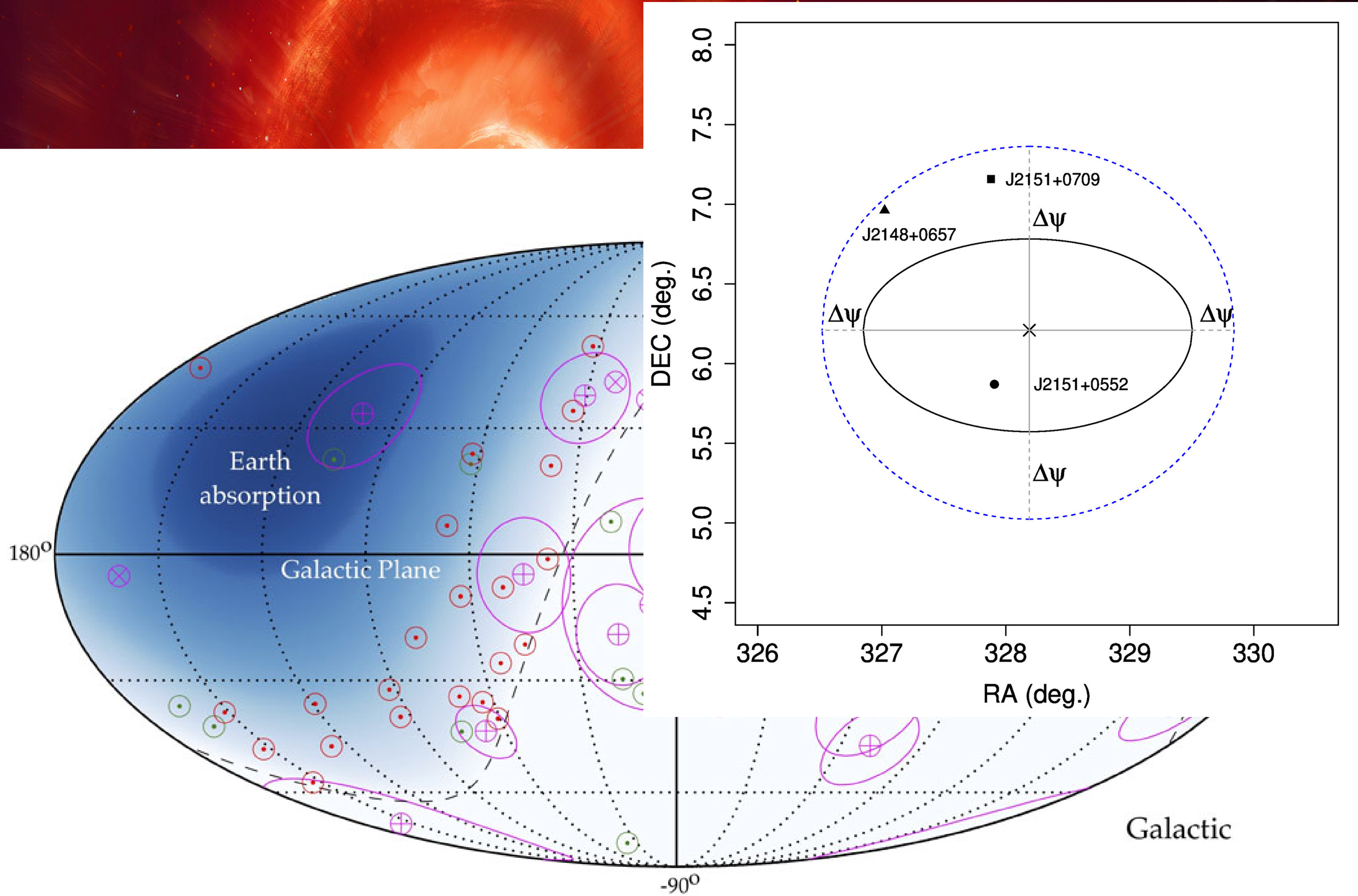
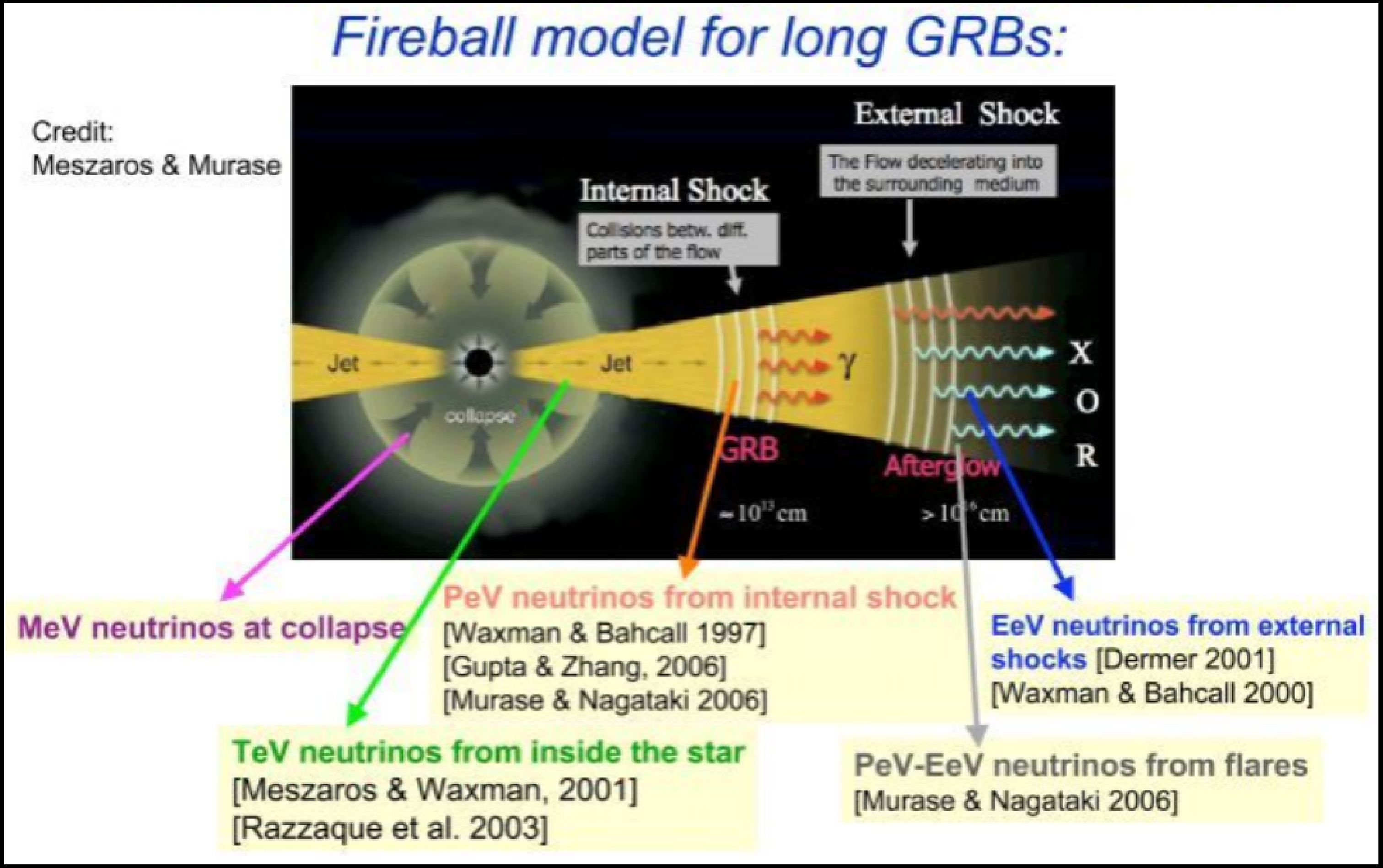


Possible source of neutrinos?



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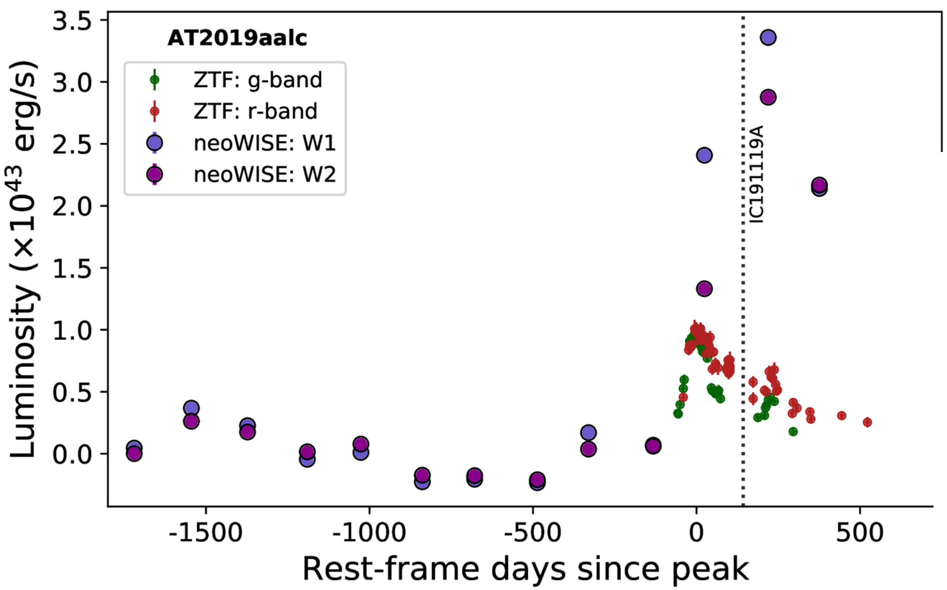
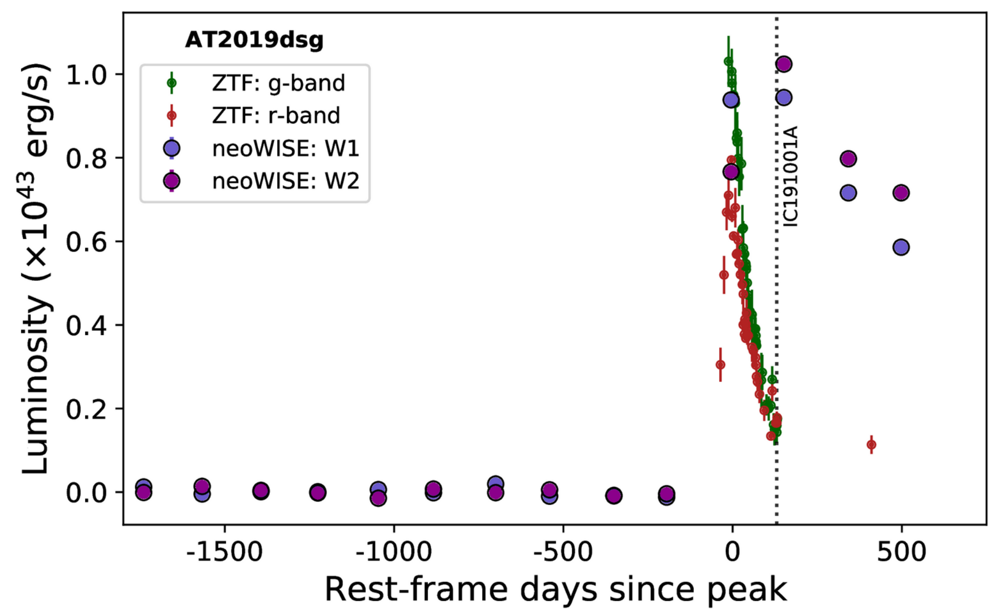
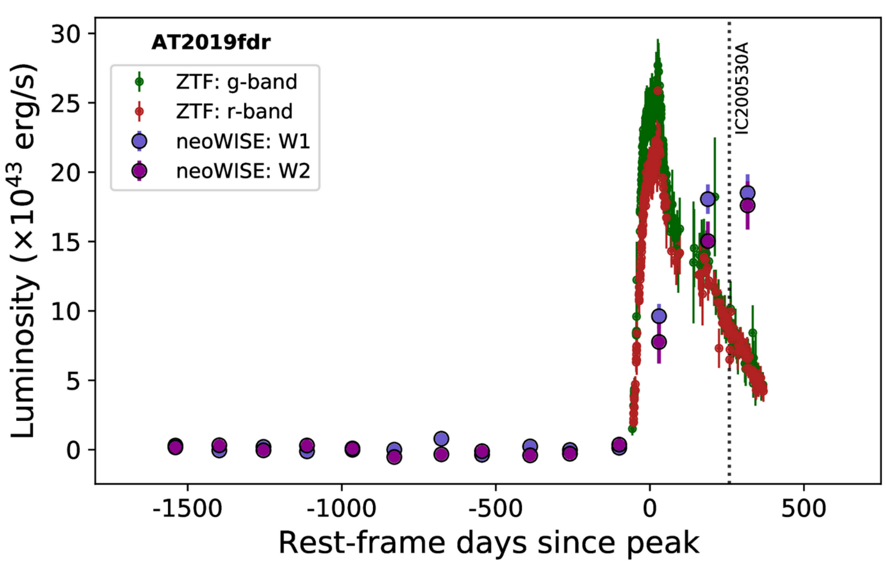


ll model for long GRBs:

MeV neutrinos at collaps

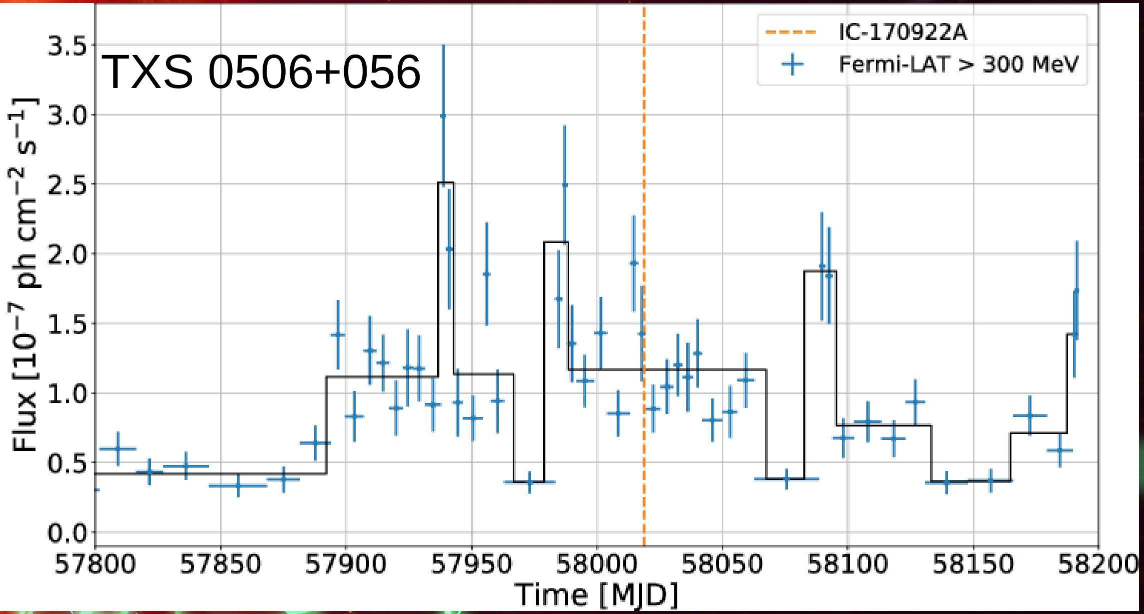


al. 2003]



Accretion flare "dust echoes"
Van Velzen et al., (2021)

First extragalactic neutrino emitter?



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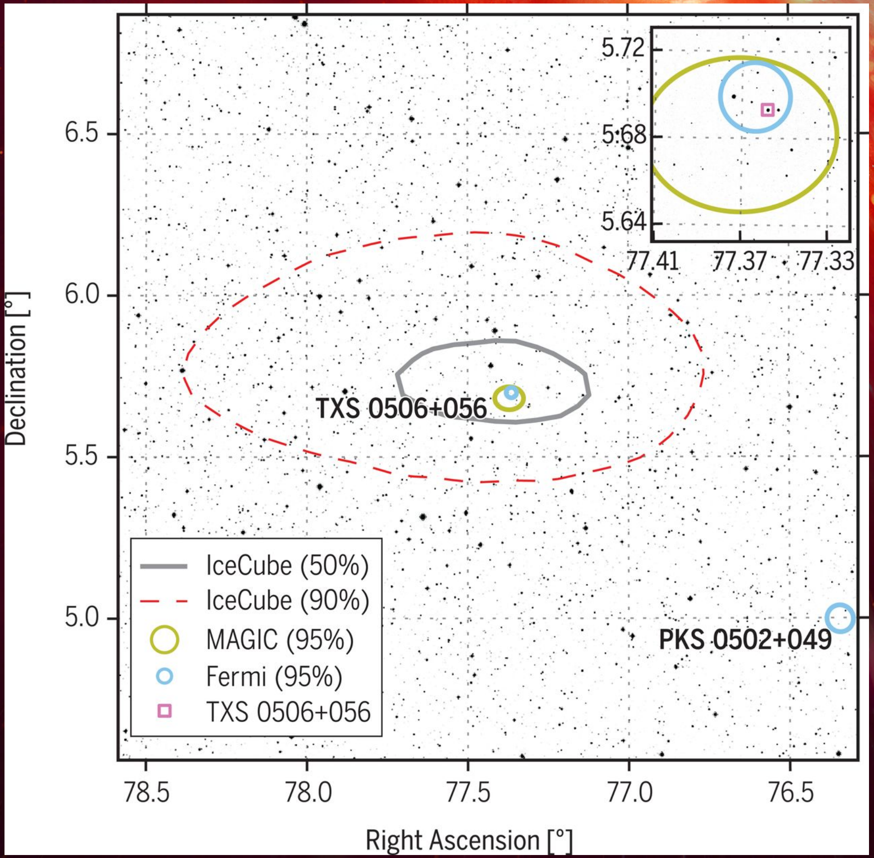

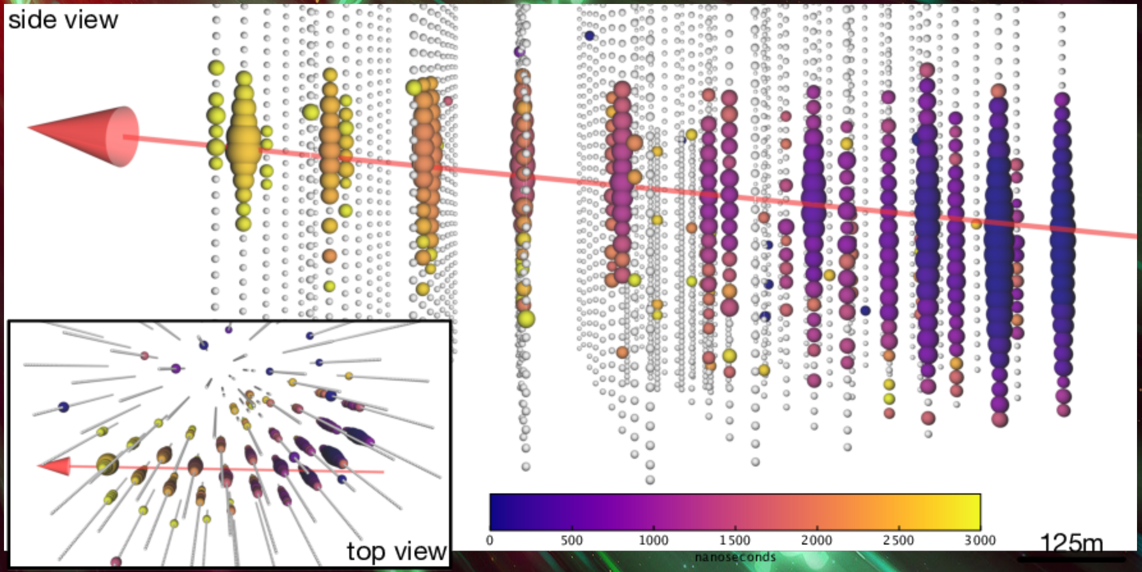

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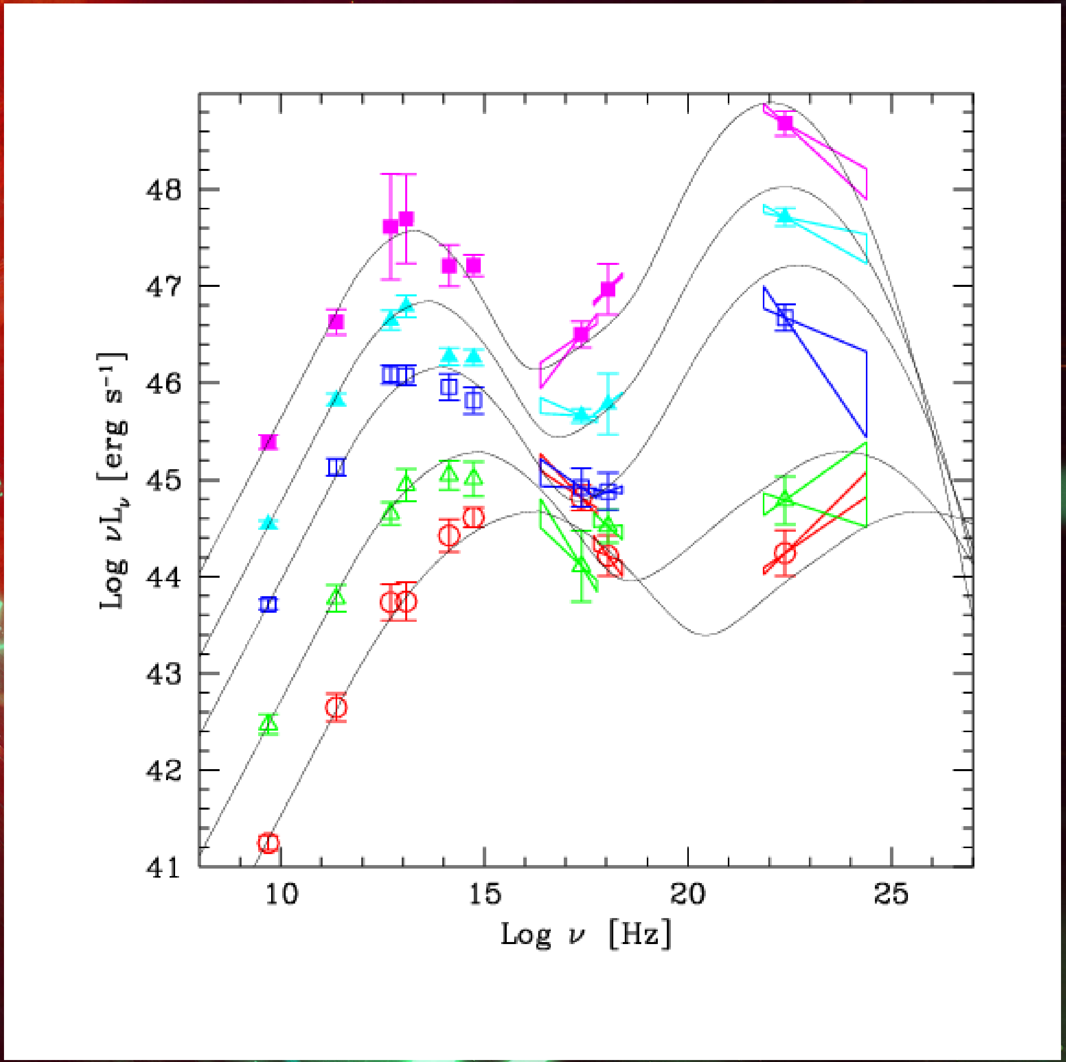

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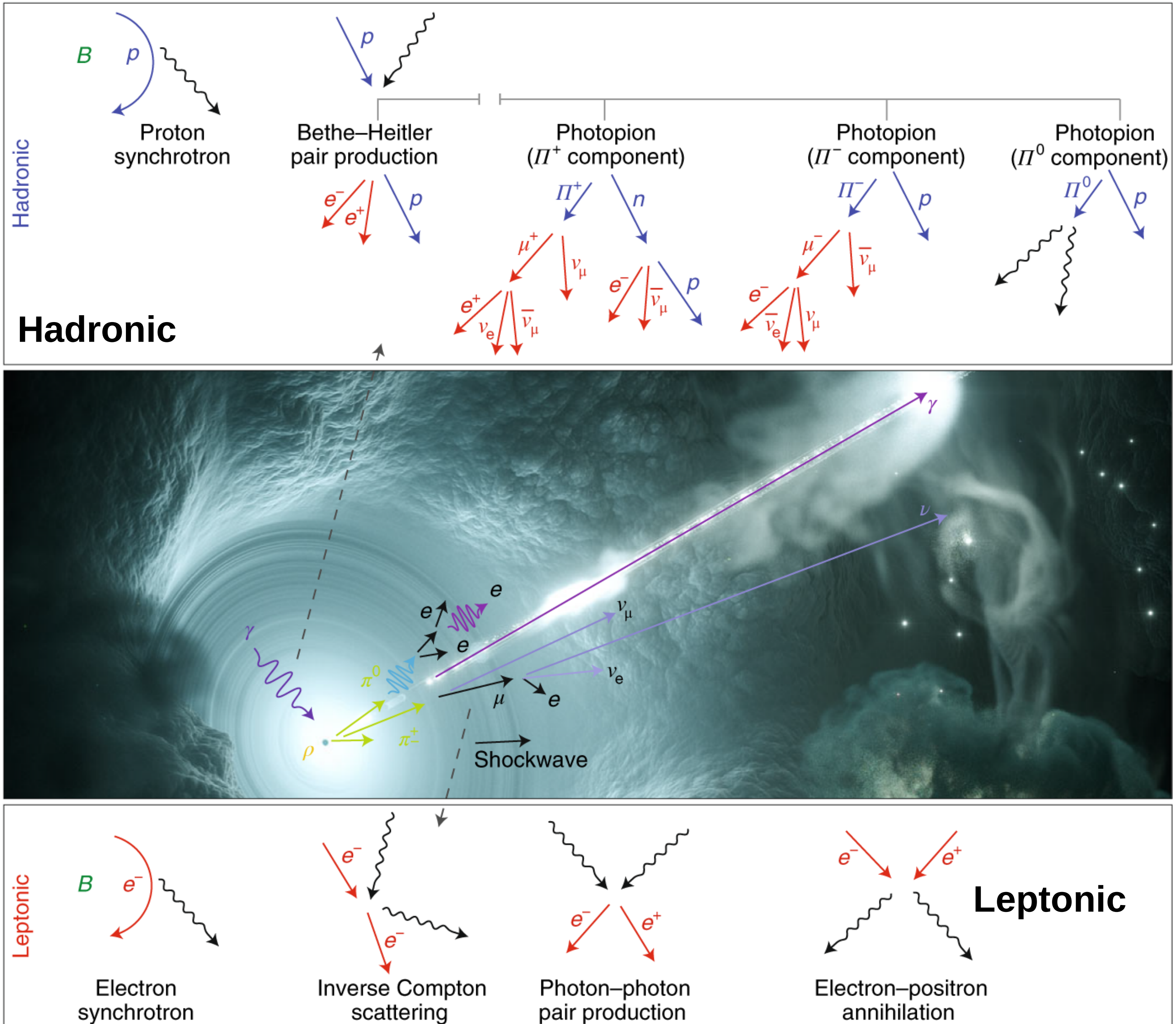

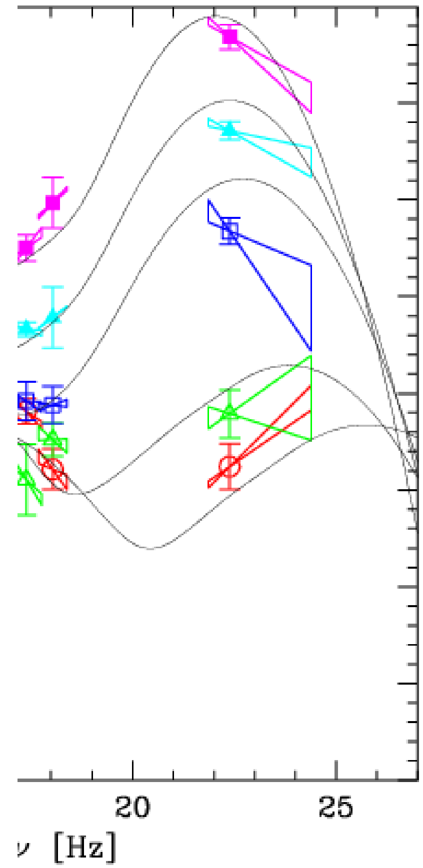

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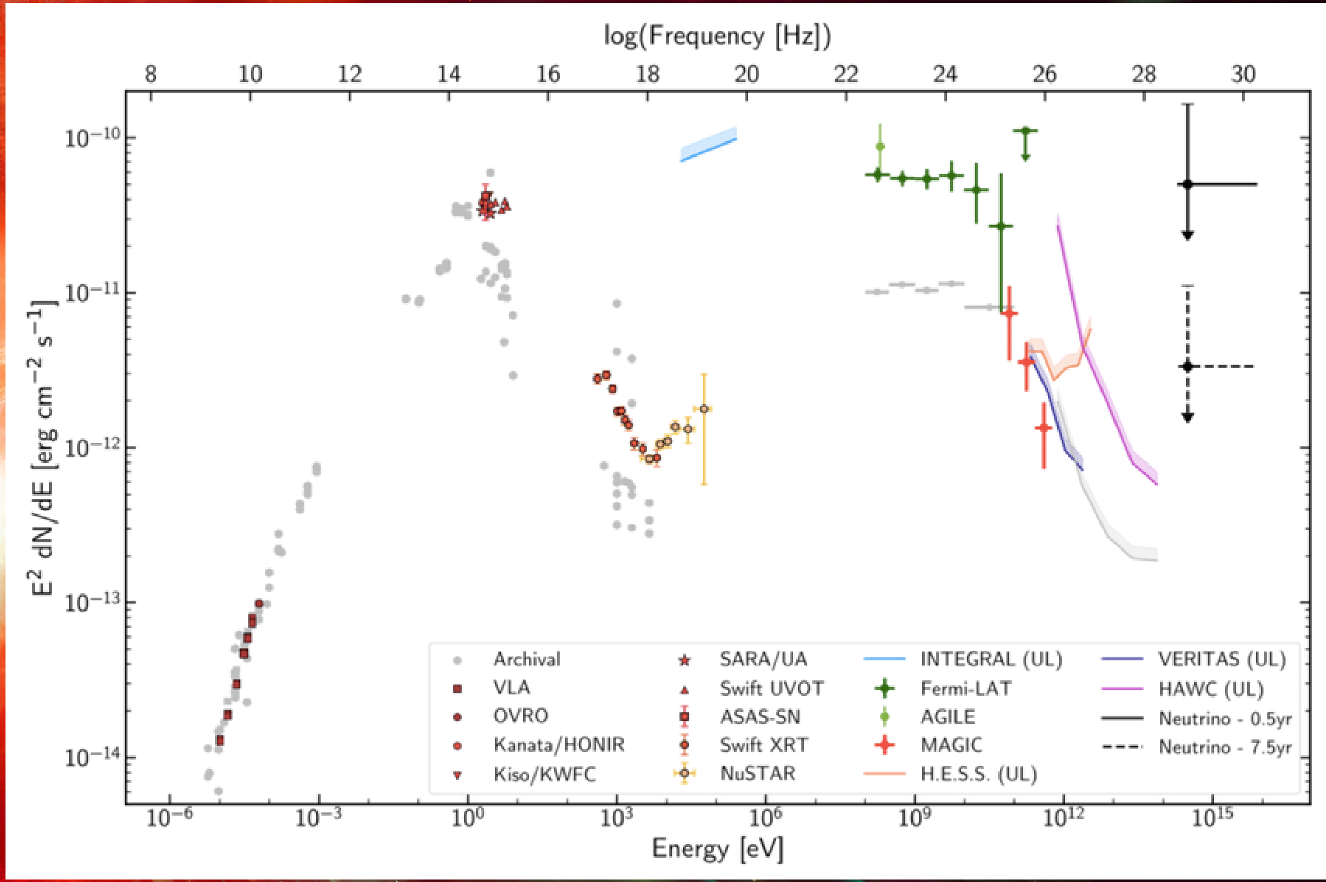

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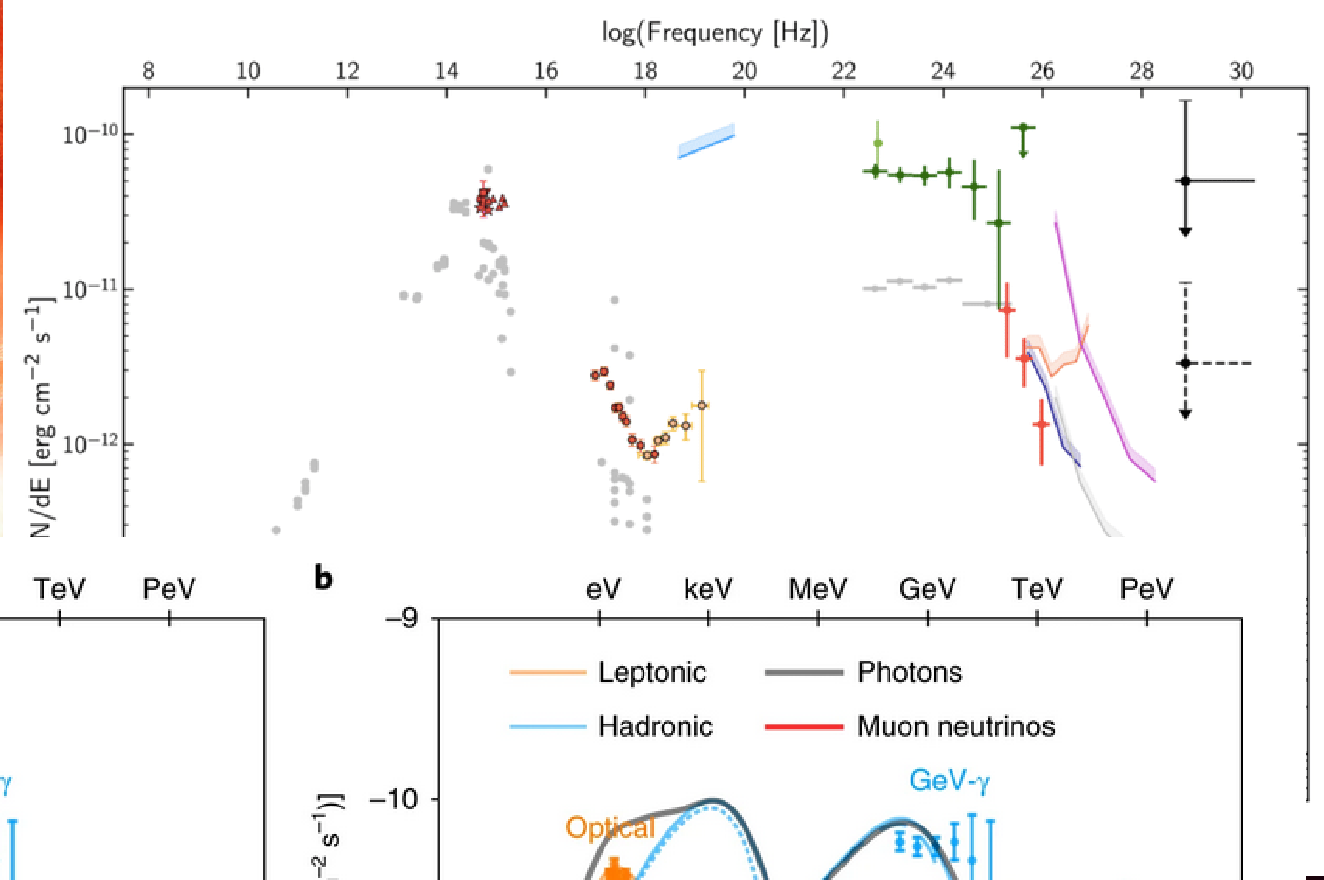
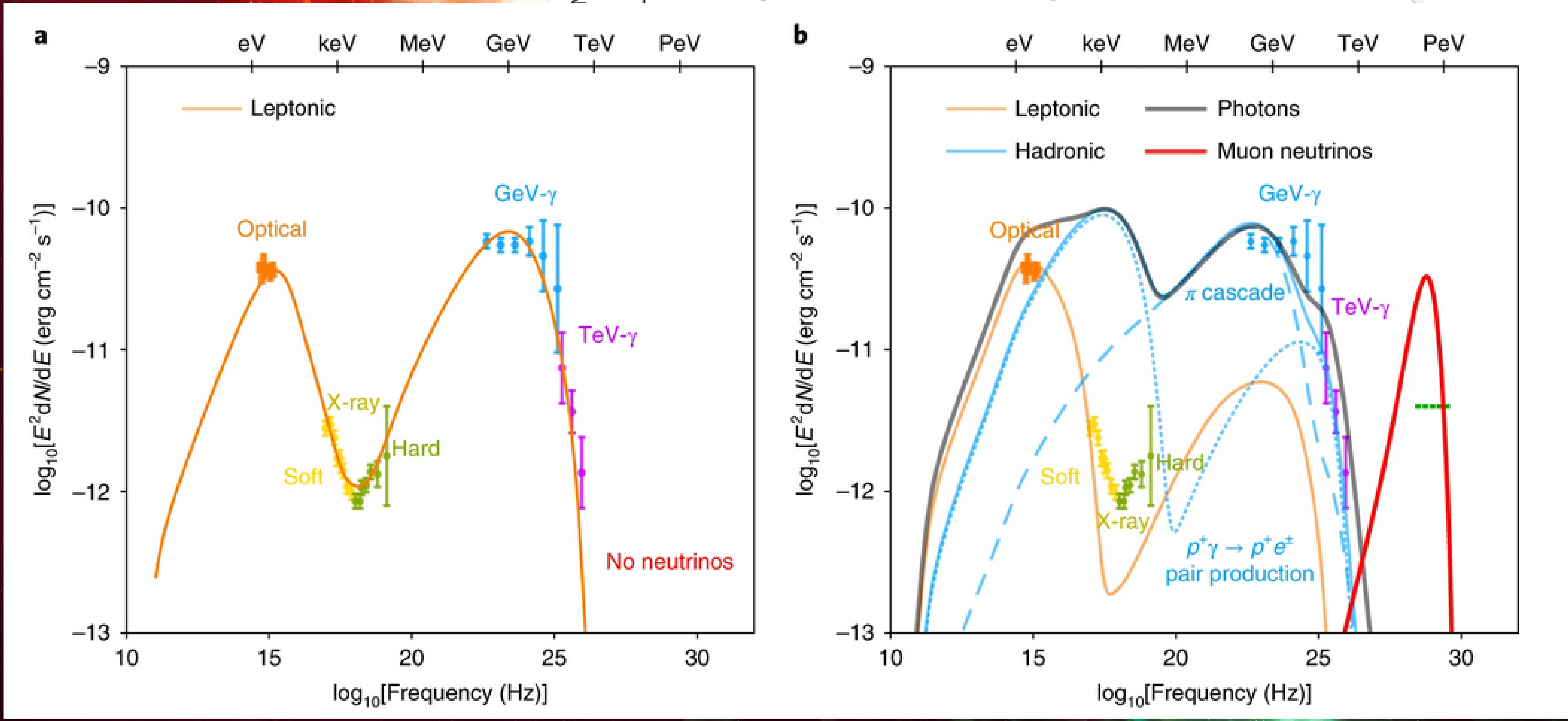


Gao et al., (2019)



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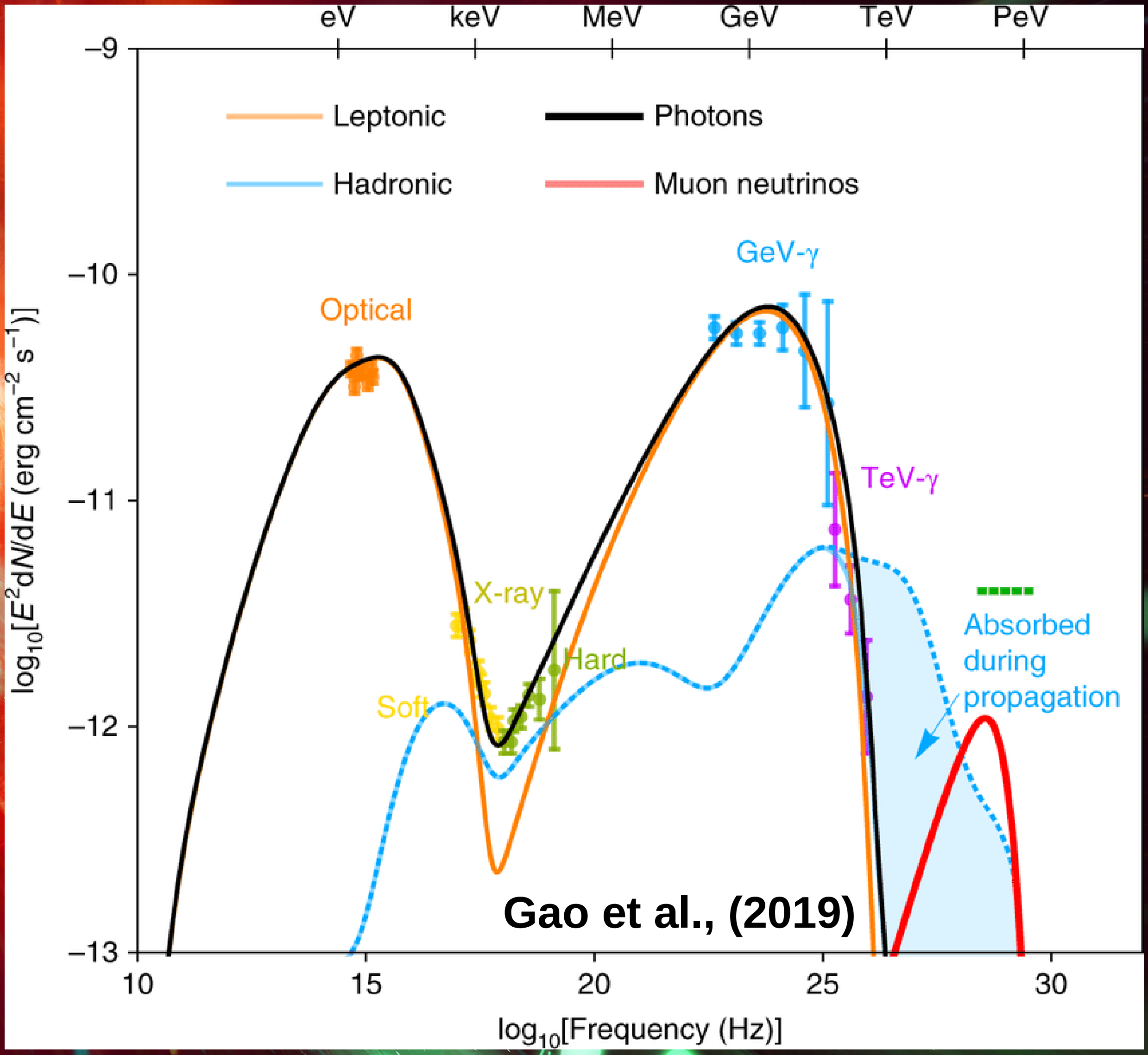
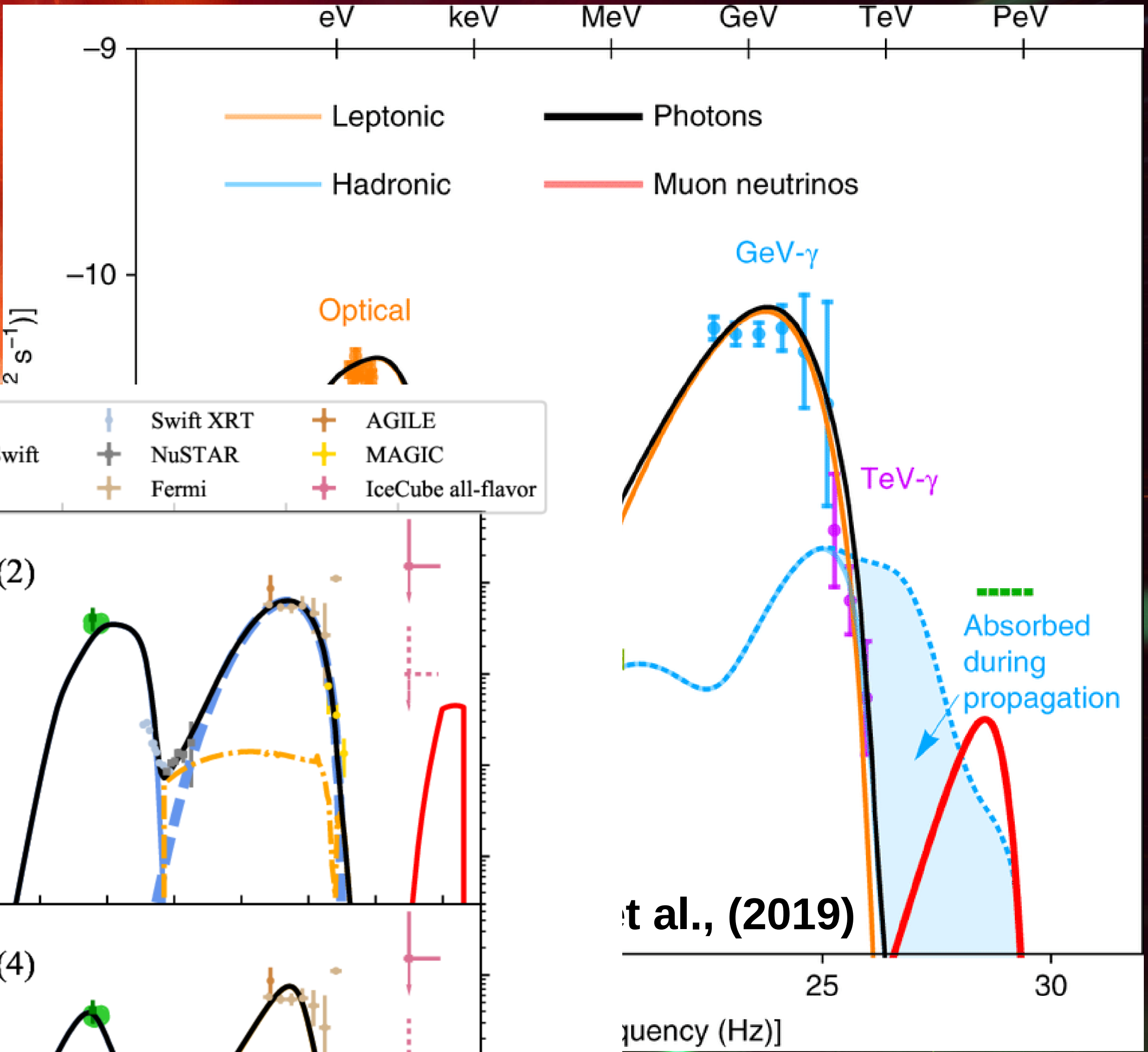
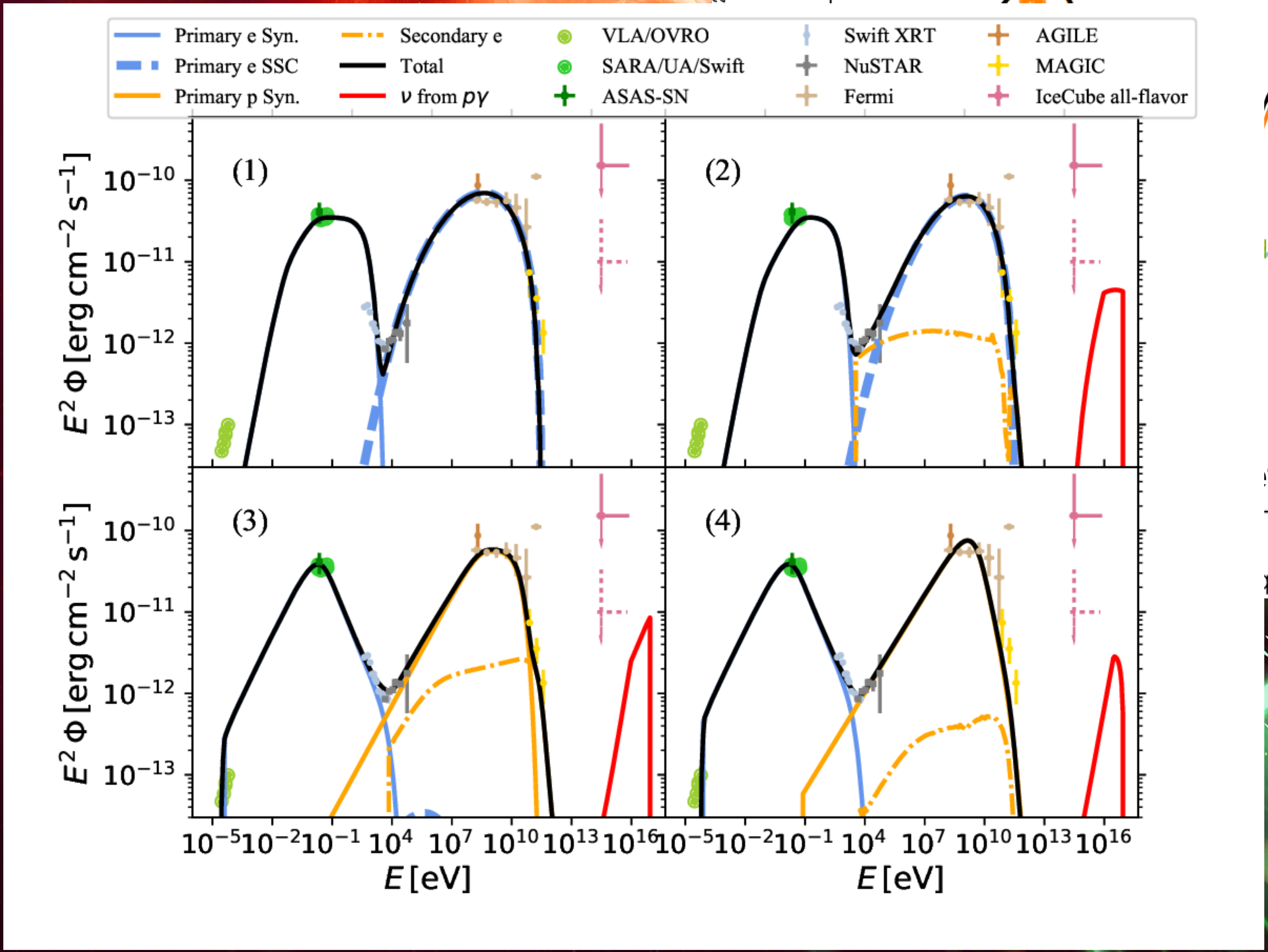


First extragalactic neutrino emitter?

Zhang et al., (2019)





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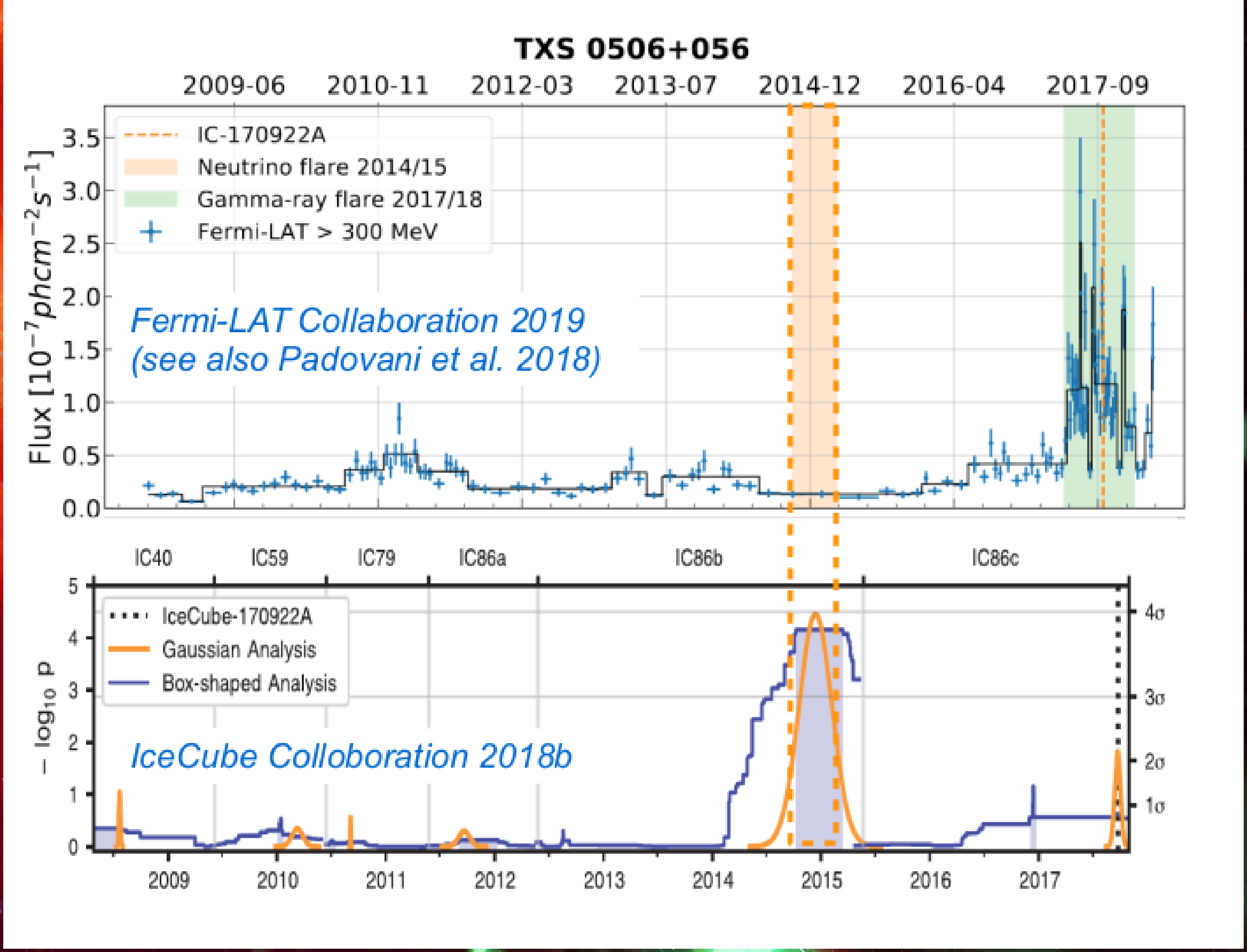

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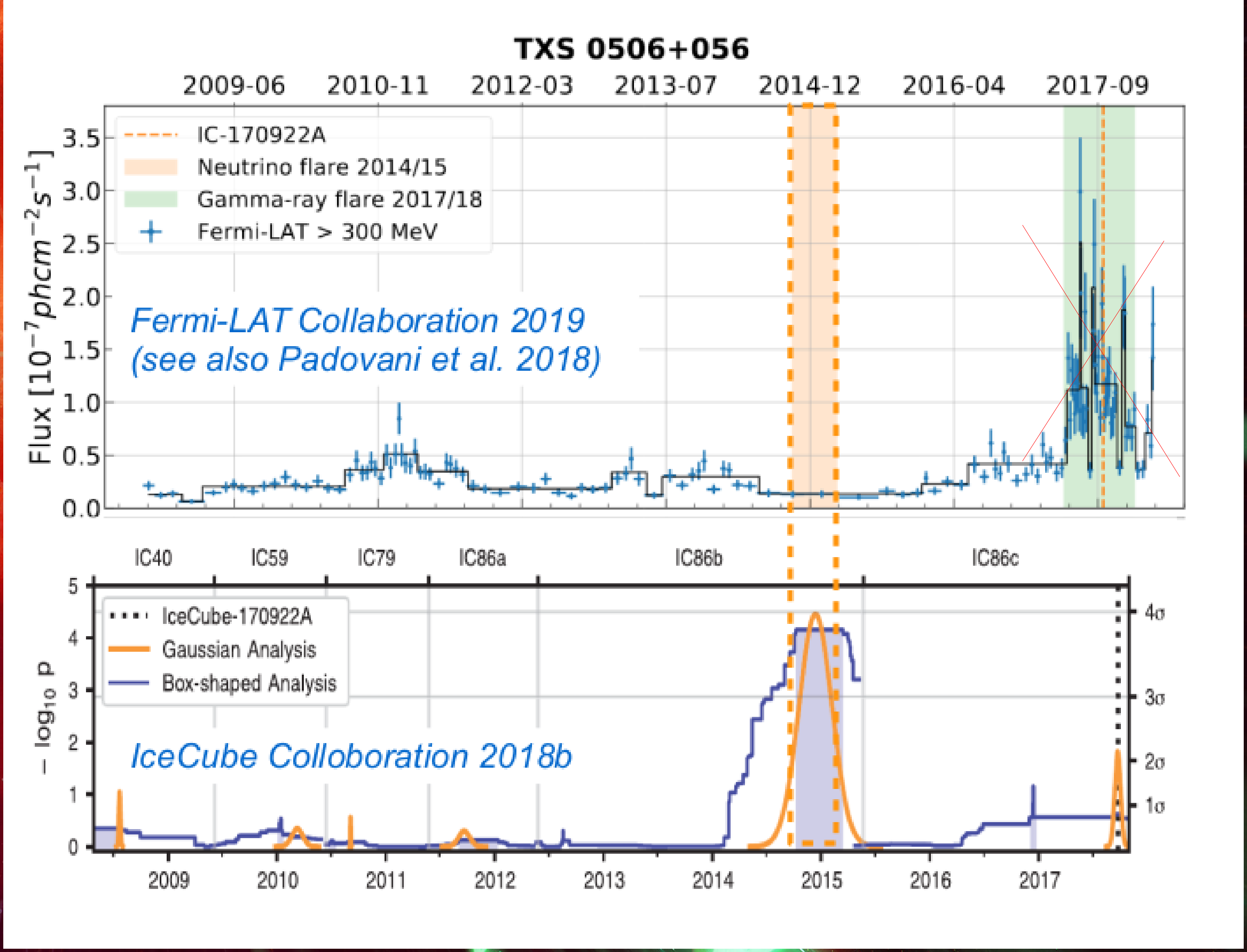
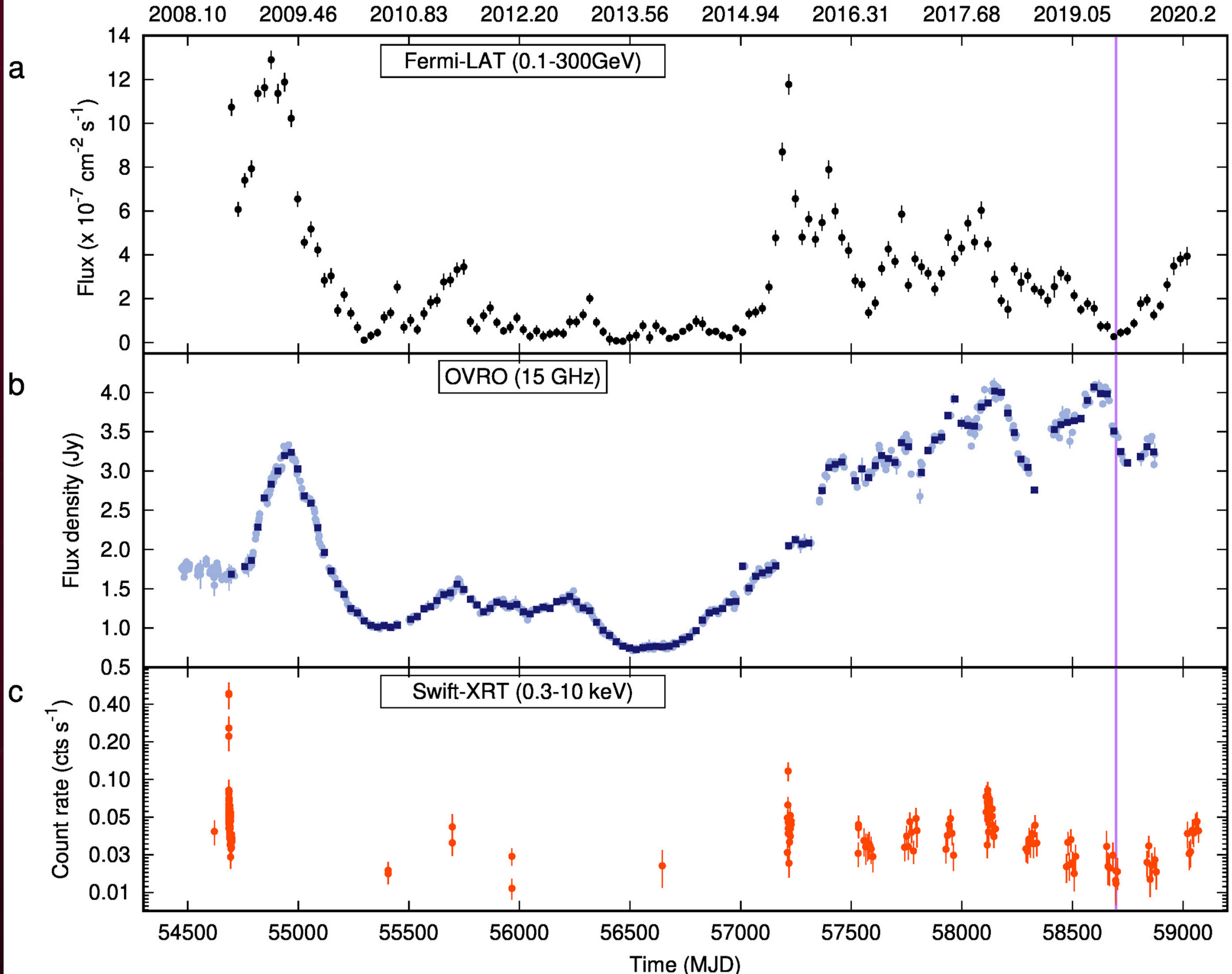
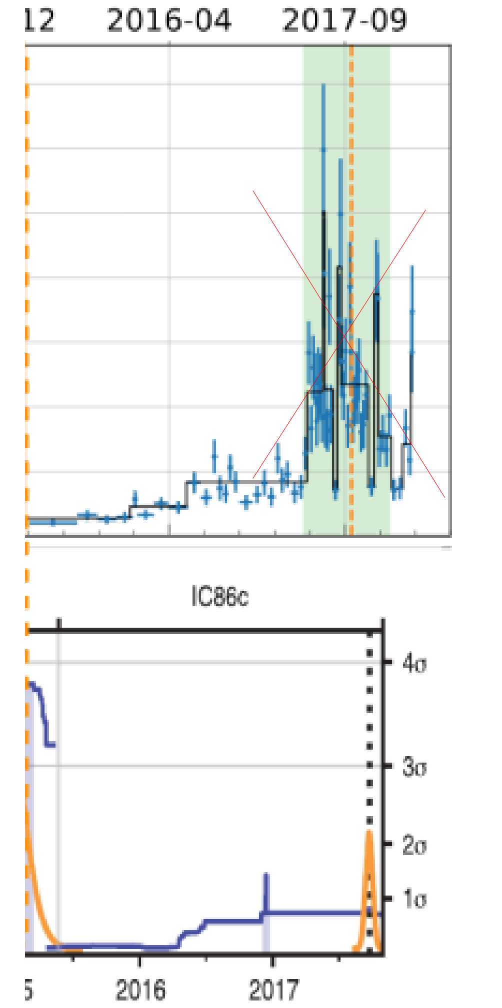


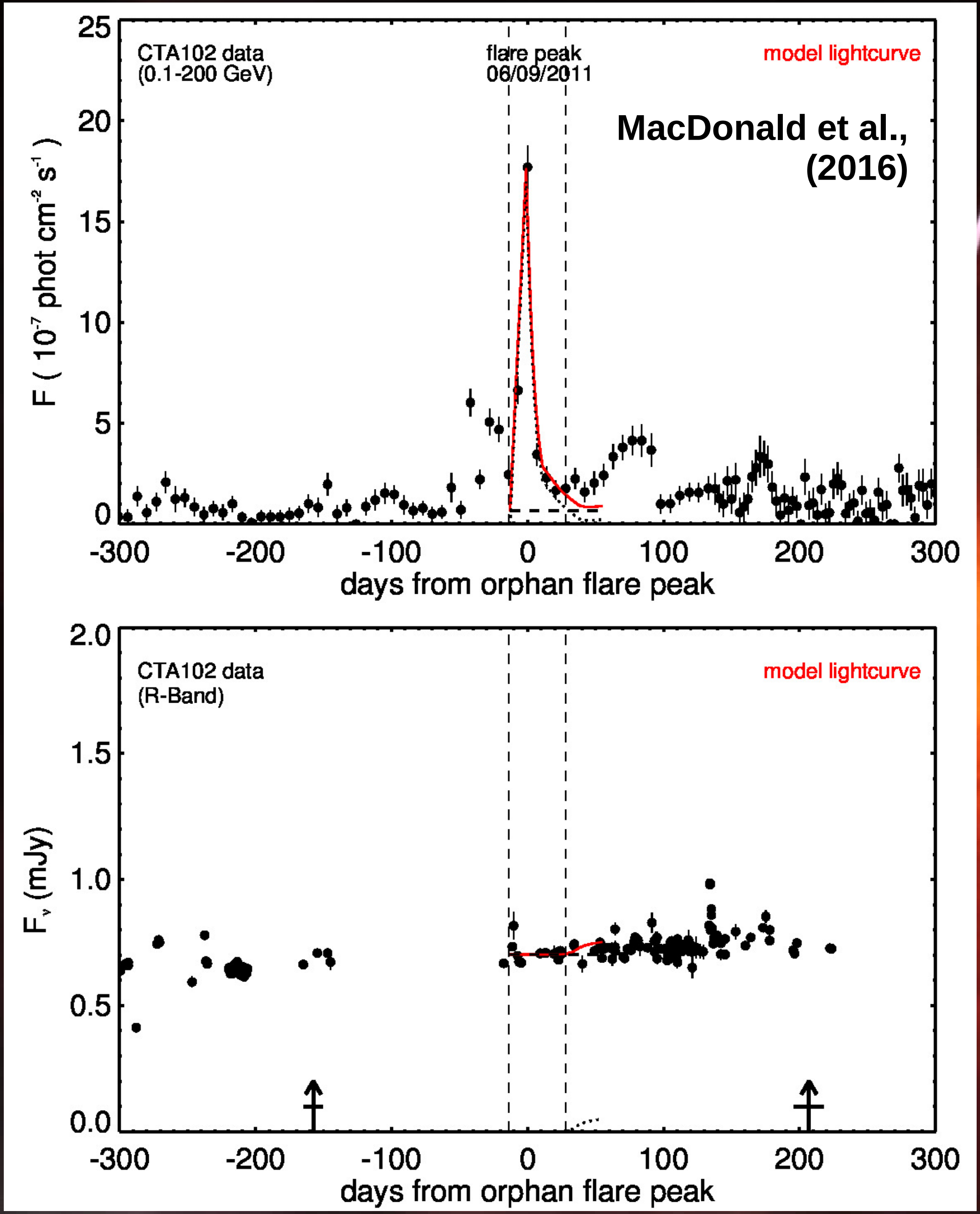
First extragalactic neutrino emitter?

PKS1502+106, Kun et al., (2021)





Orphan γ-ray flares?



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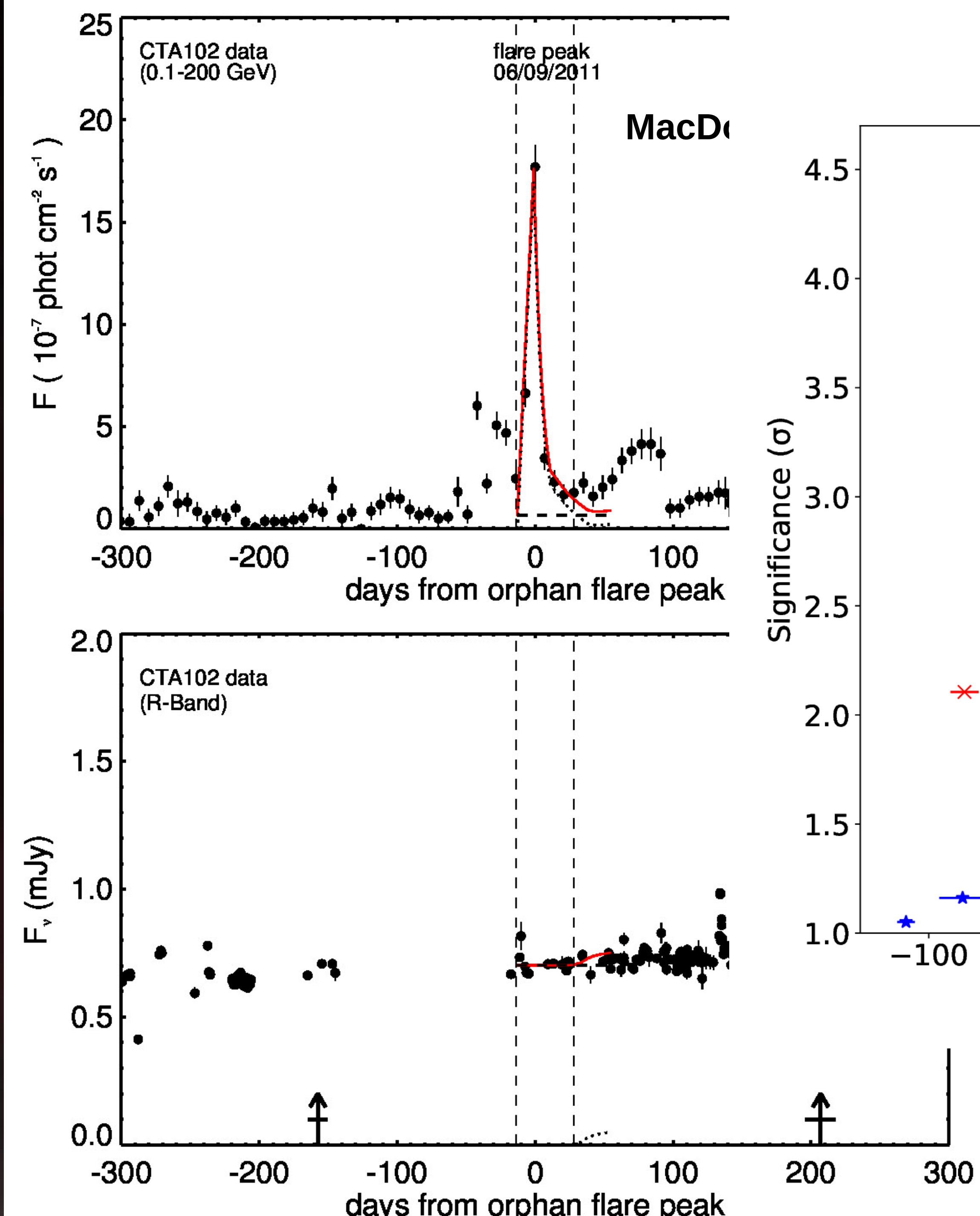
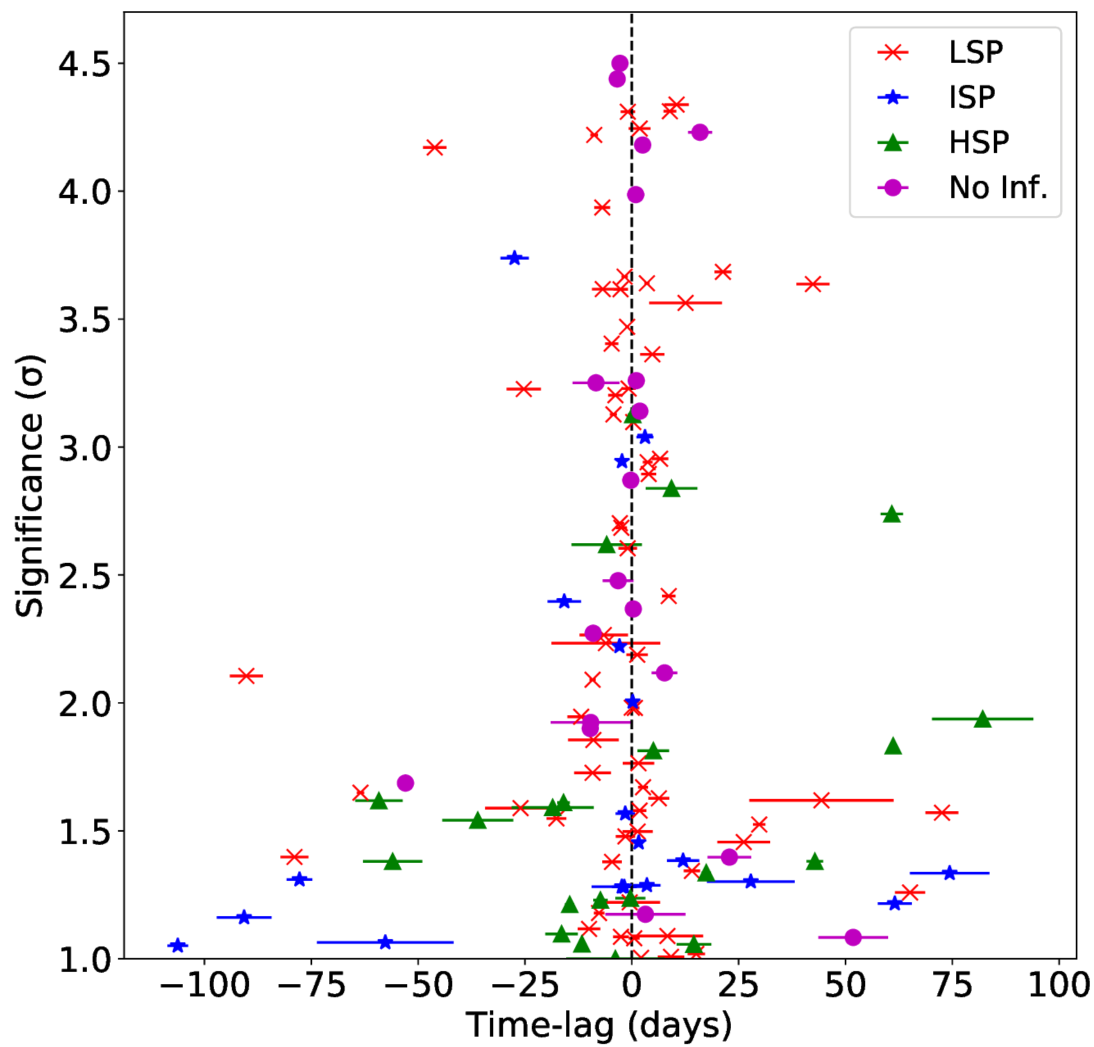
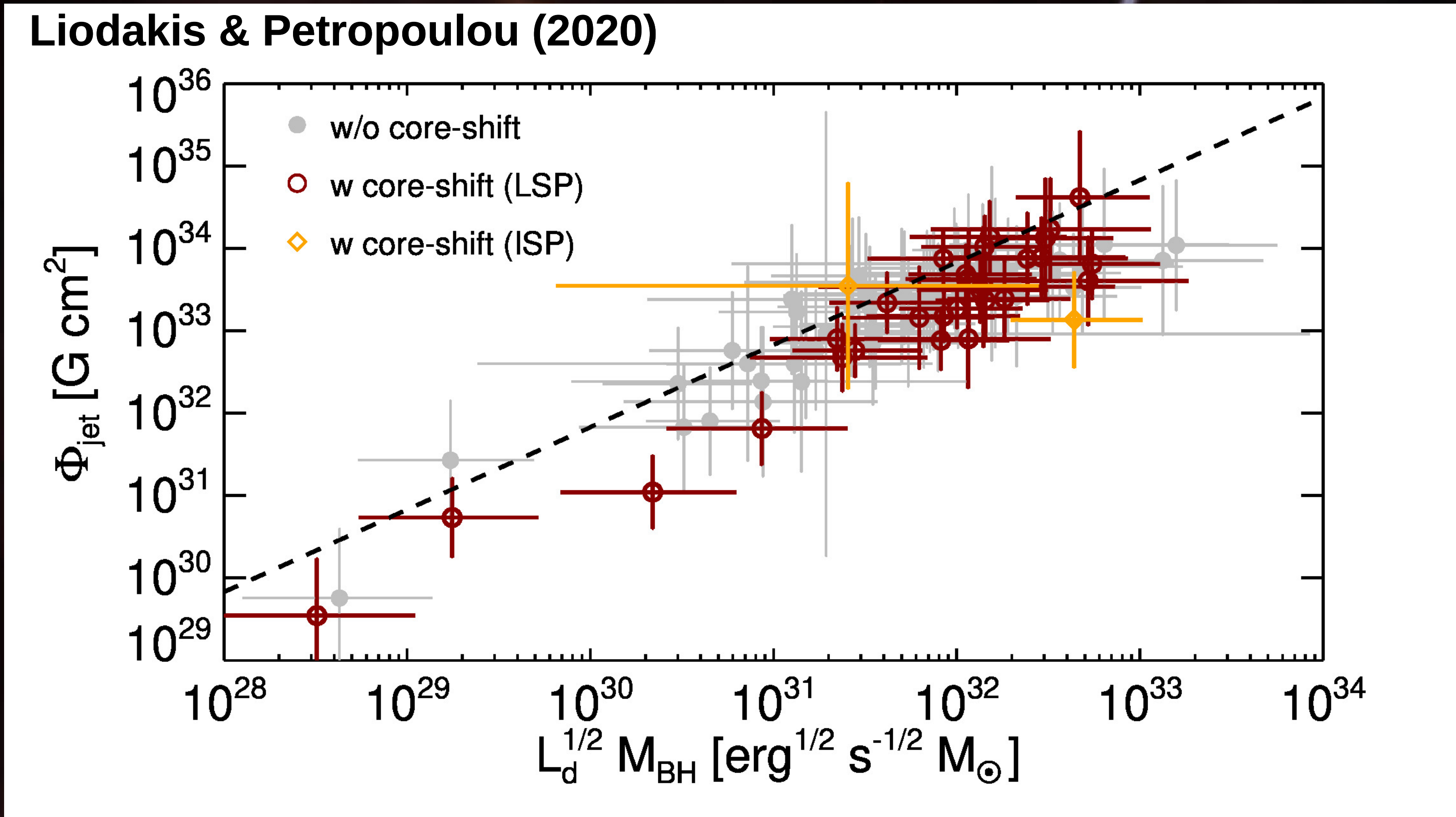


Liodakis et al., (2019)



121/178 sources show a correlation
~20% of γ-flares are orphan!

Can protons explain the high emission?



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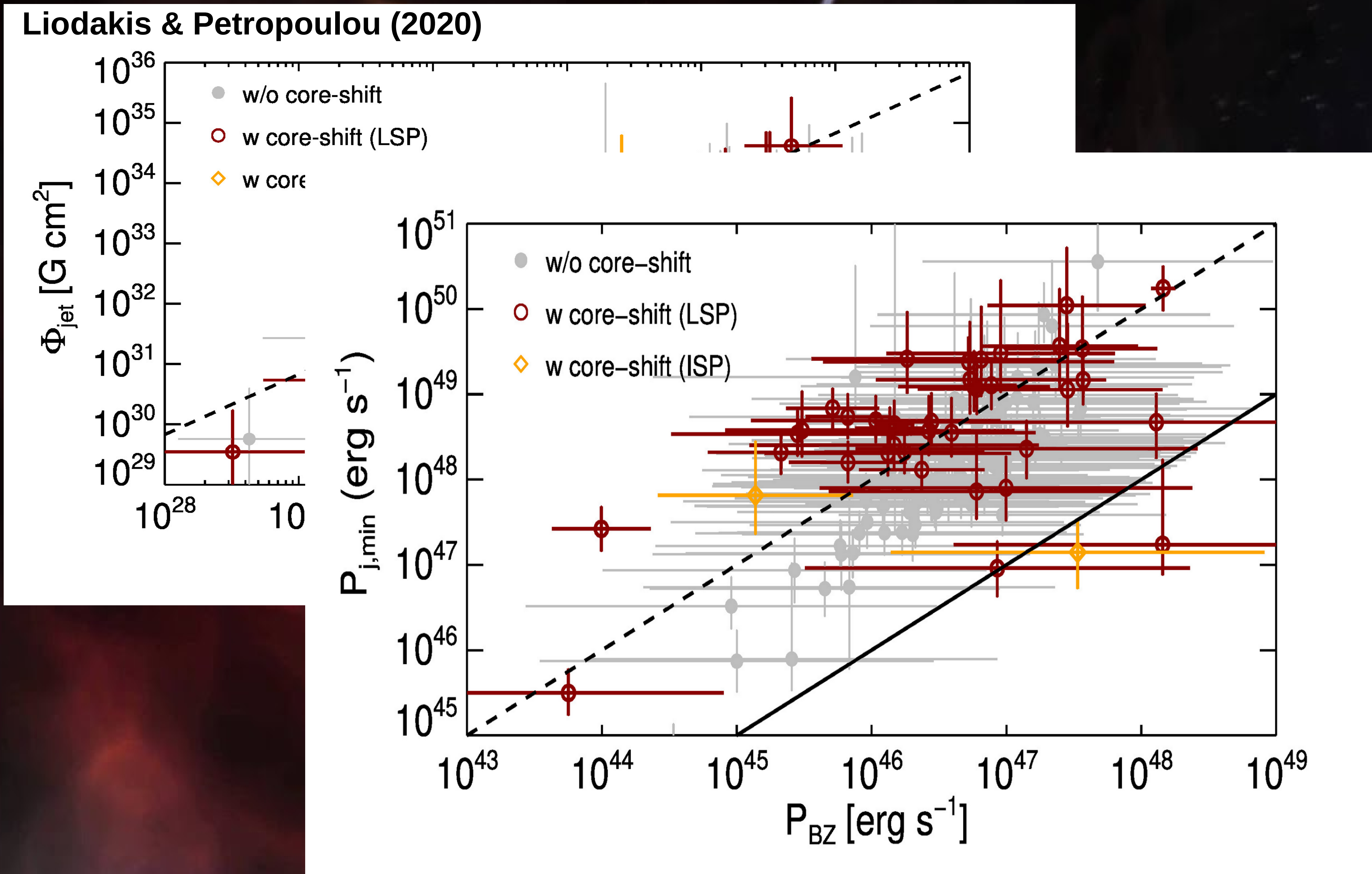
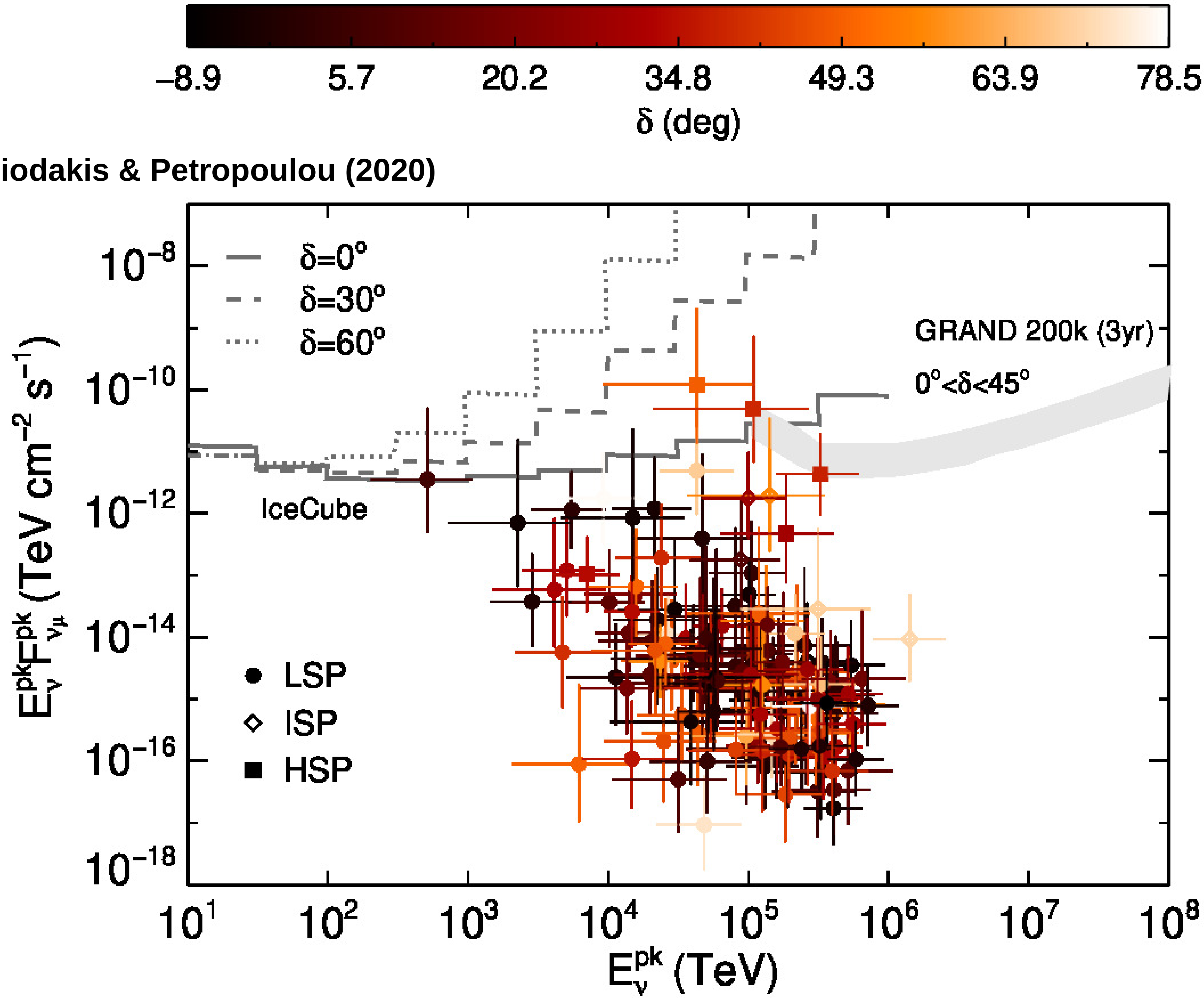
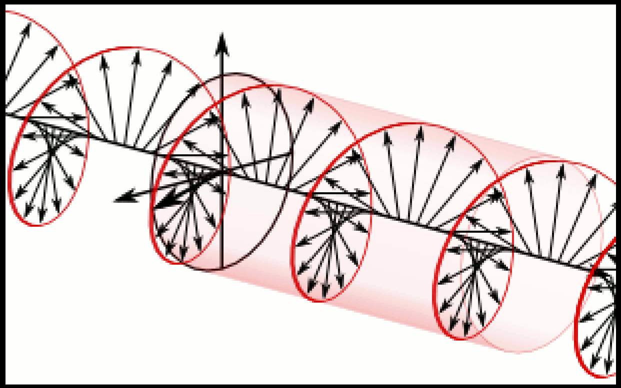


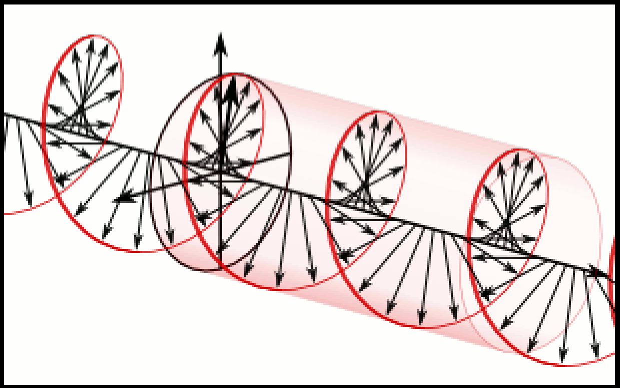
Liodakis & Petropoulou (2020)

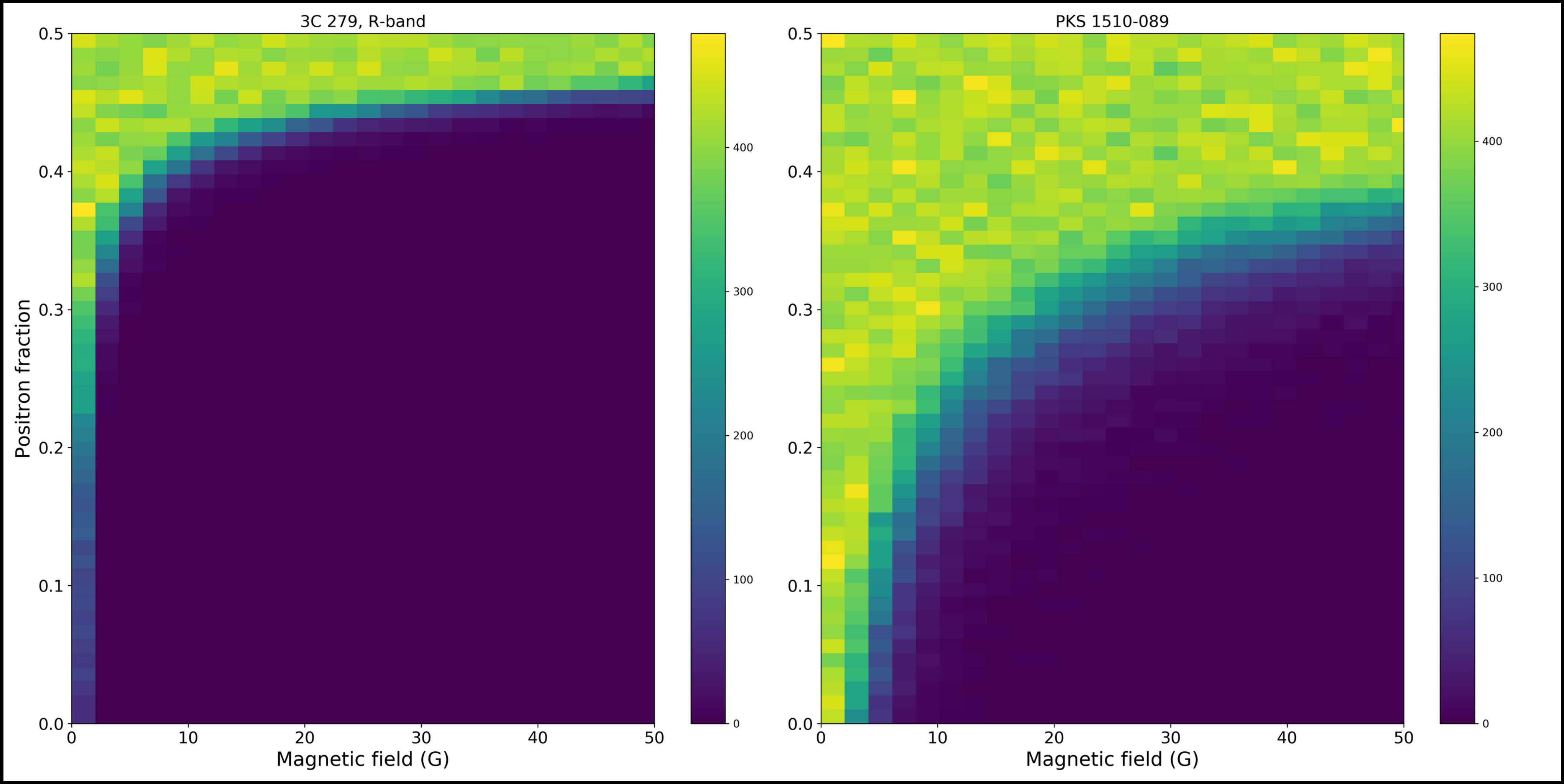


Optical circular polarization?

Liodakis et al., (2022)



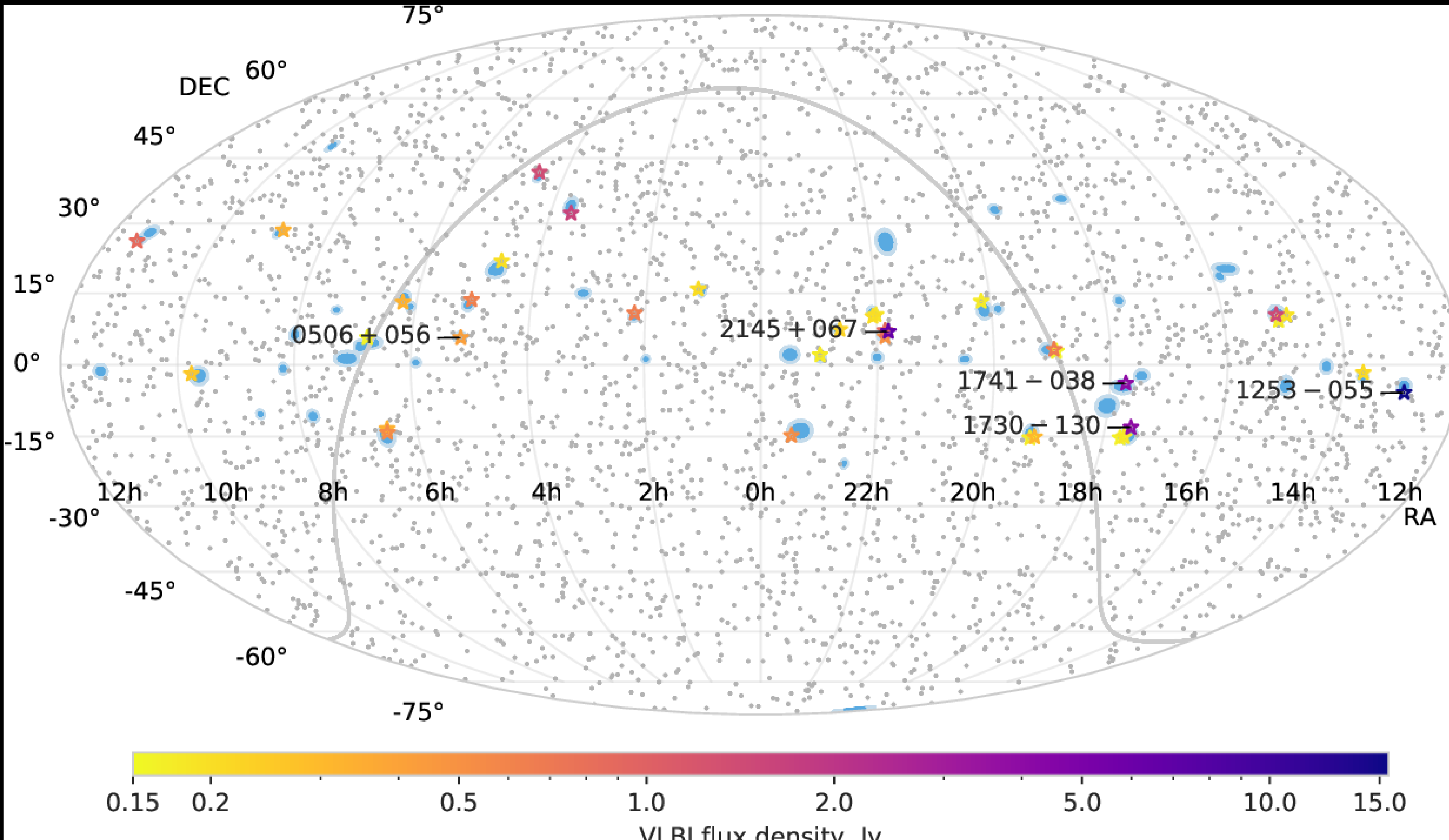




Radio emission to the rescue?

Plavin et al., 2020

3388 VLBI detected AGN at 8GHz



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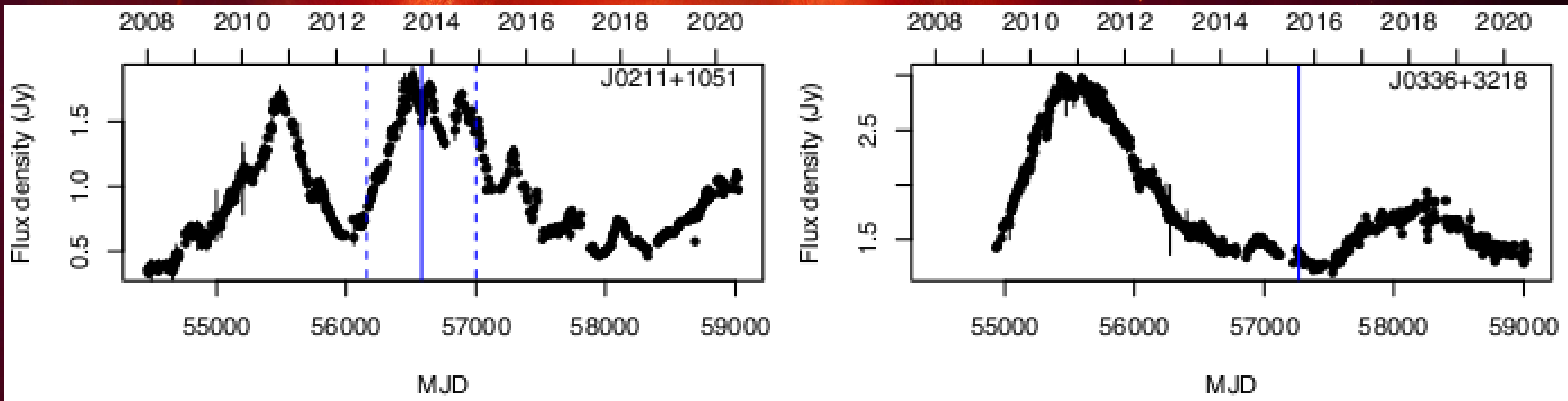
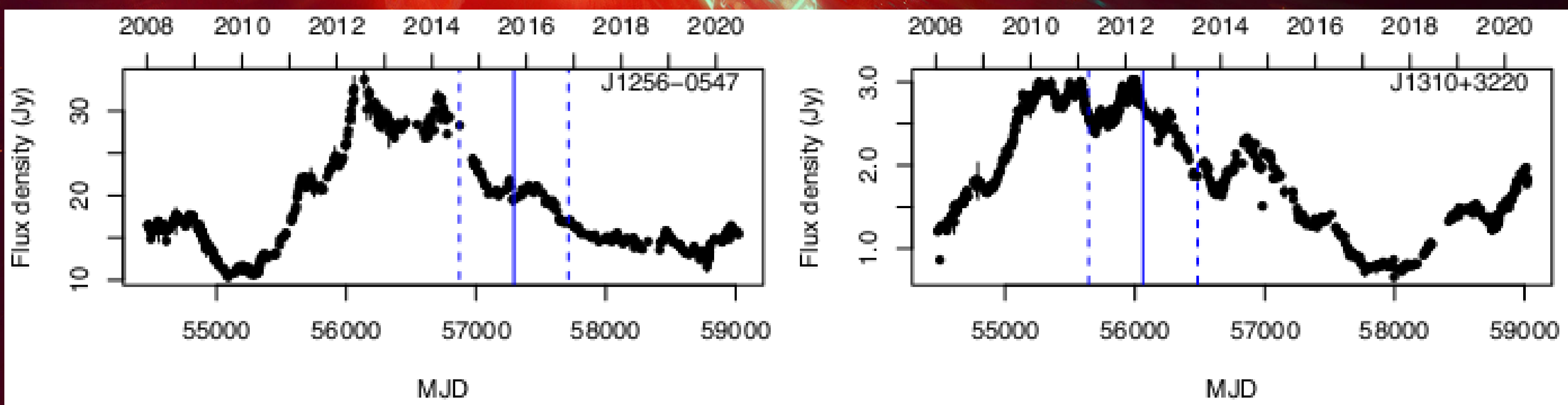




OVRO ~1800 jetted AGN
Hovatta et al.[+Liodakis] (2021)
~2σ association between blazars and neutrinos
9/20 sources are γ-ray dark!

OVRO's multimessenger survey

- Unbiased sample selection
- Both γ-ray bright and γ-ray dark AGN
- 5500 sources
- ~10 day cadence for 5 years
- Survey started January 2021

OVRO's multimessenger survey

Unbiased sample selection

Both γ-ray bright and γ-ray dark AGN

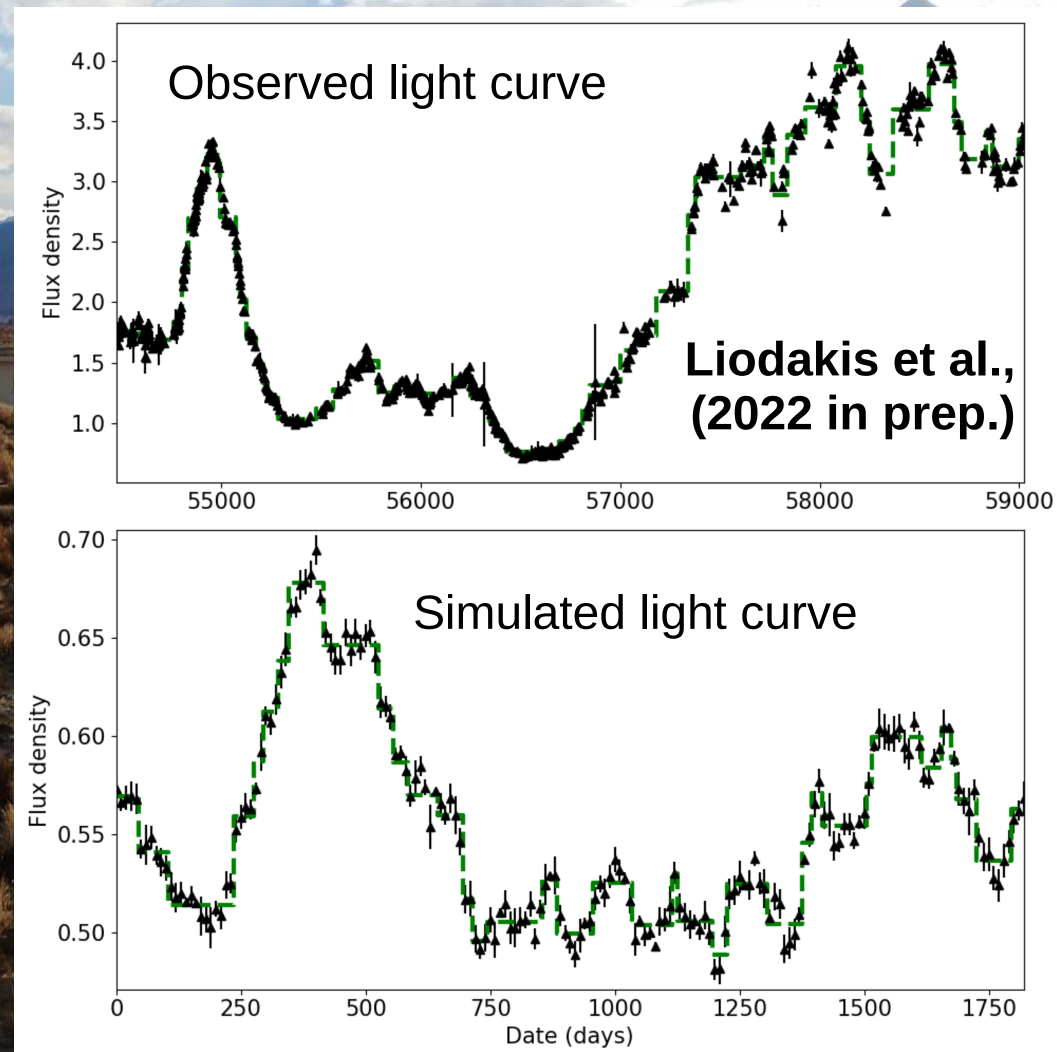
5500 sources

~10 day cadence for 5 years

Survey started January 2021

Forecasting AGN-neutrino association

If neutrino luminosity correlates with radio flux we will achieve a >4σ association



Summary

The search for extragalactic neutrinos emitters continues...

Blazars still the most promising candidate sources, but with a lot of open questions

If blazars make neutrinos, those are made through hybrid processes, most likely subdominant proton population

We may soon understand the connection between neutrinos and AGN that will gives new ways to uncover unknown particle physics.