

Somewhere over the rainbow

Understanding all colors of blazar time sequences

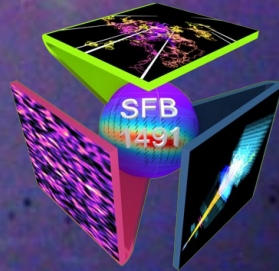
Julia Tjus | 18.06.2024

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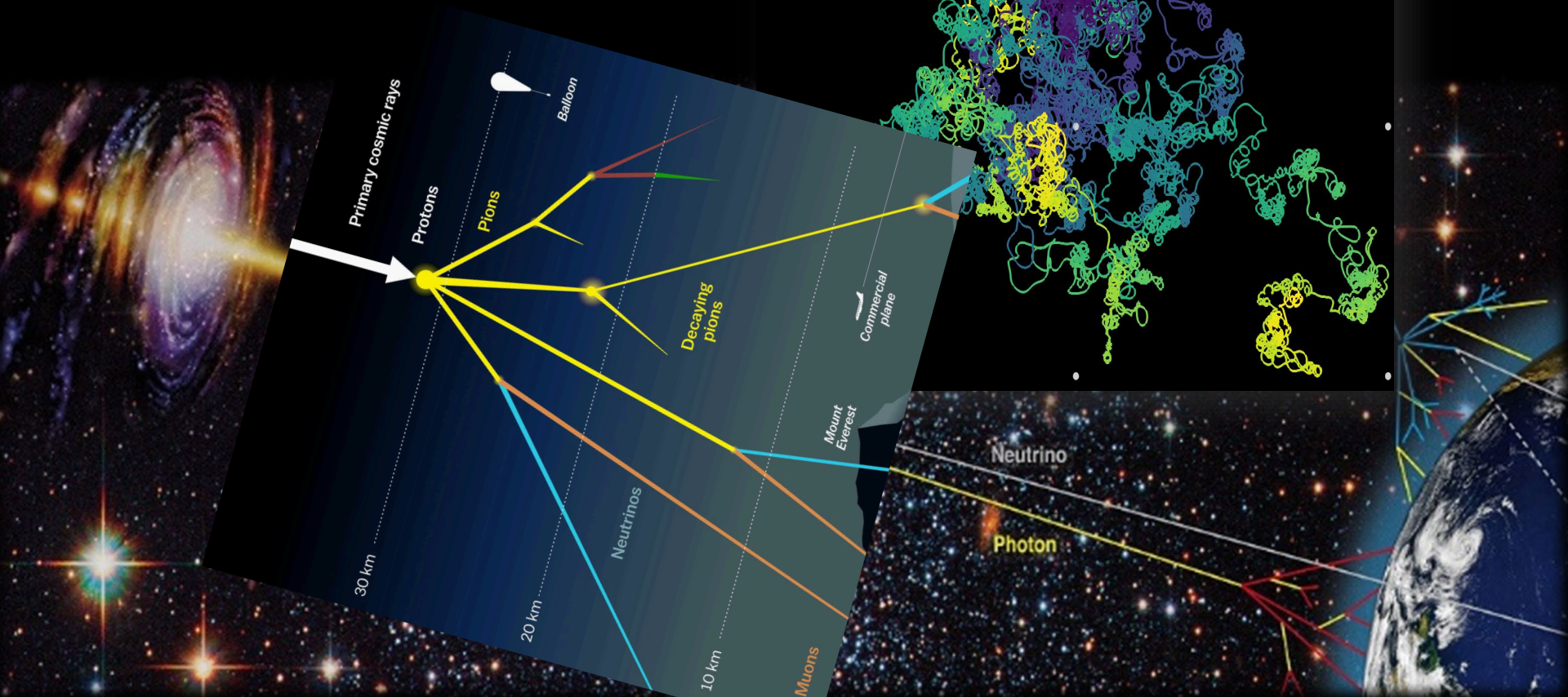


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Multimessenger astrophysics:

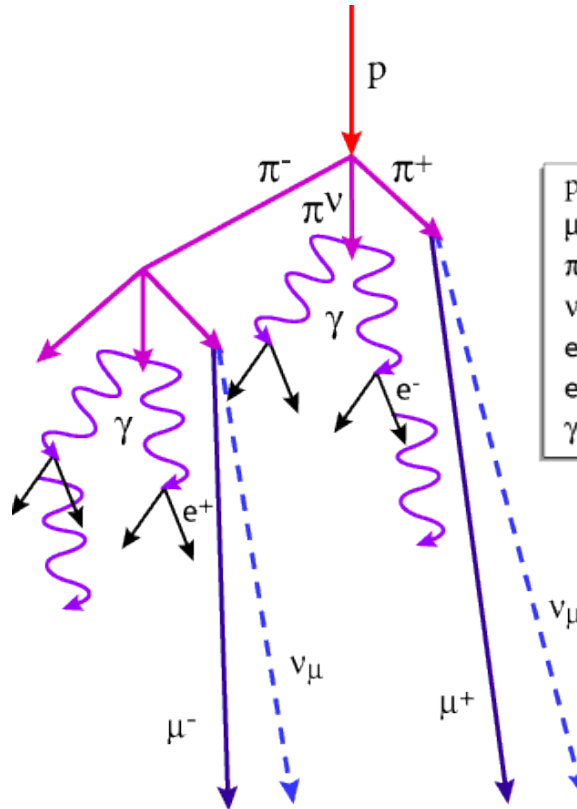
combination of astrophysics with fundamental aspects of matter



Information available today to investigate origin

Direct: cosmic rays

- Hadrons: Spectral behavior (all-particle and chemical composition)
MeV – ZeV
- Electrons: primary spectrum (local)
MeV – 20 TeV
- Anisotropy level
TeV – 10 PeV, EeV

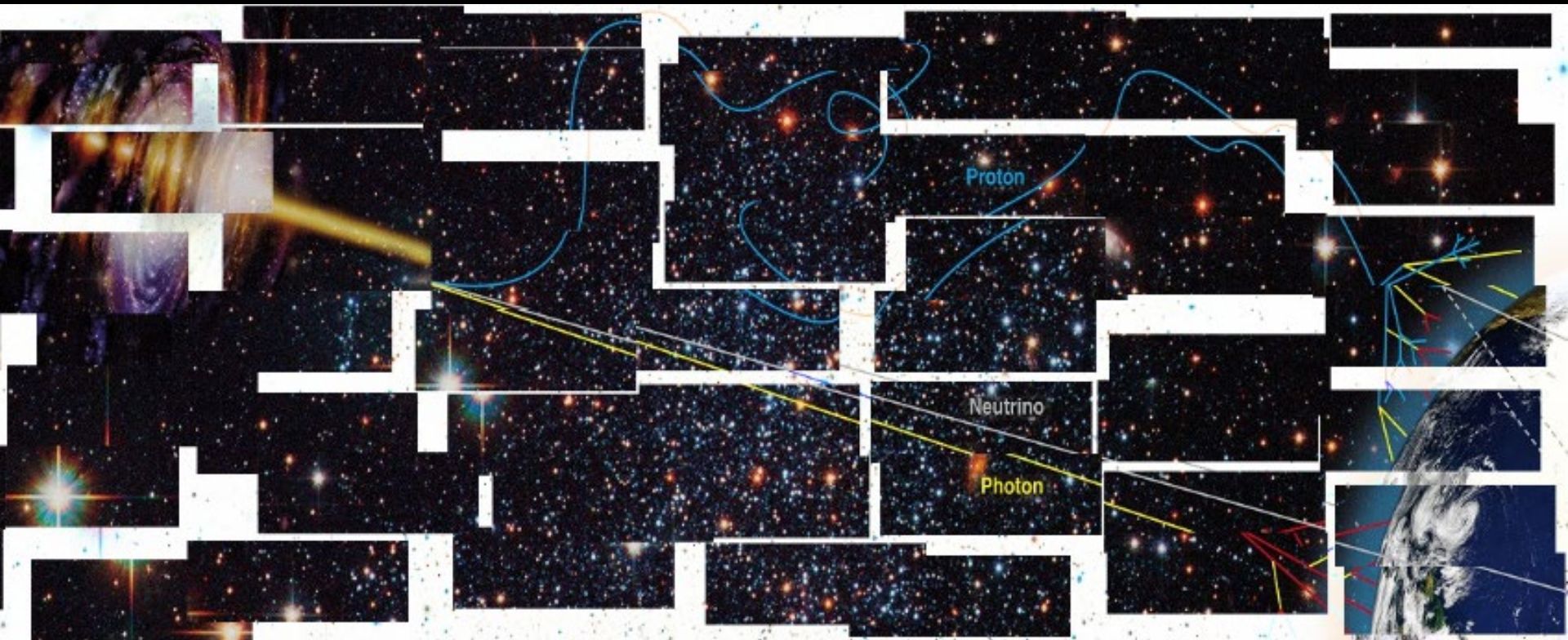


Indirect: e, ν, γ, ...

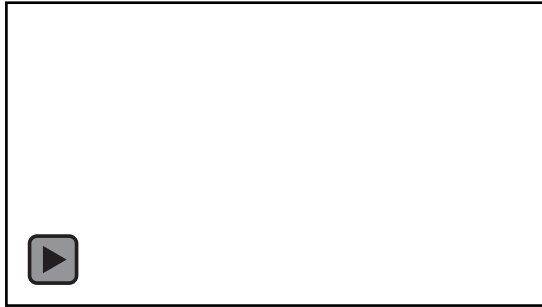
- Positronspectrum/ - fraction **MeV - TeV**
- Gammas: Sources, diffuse emission
MeV – 10(0) TeV
- Neutrinos: first detection
TeV – PeV

p = proton
μ = muon
π = pion
ν = neutrino
e⁺ = electron
e⁻ = positron
γ = photon

Multimessenger astrophysics: a puzzle from low to high-energy and including γ , ν , and GWs



Active Galactic Nuclei (AGN)



Animation: NASA/Walt Feimer

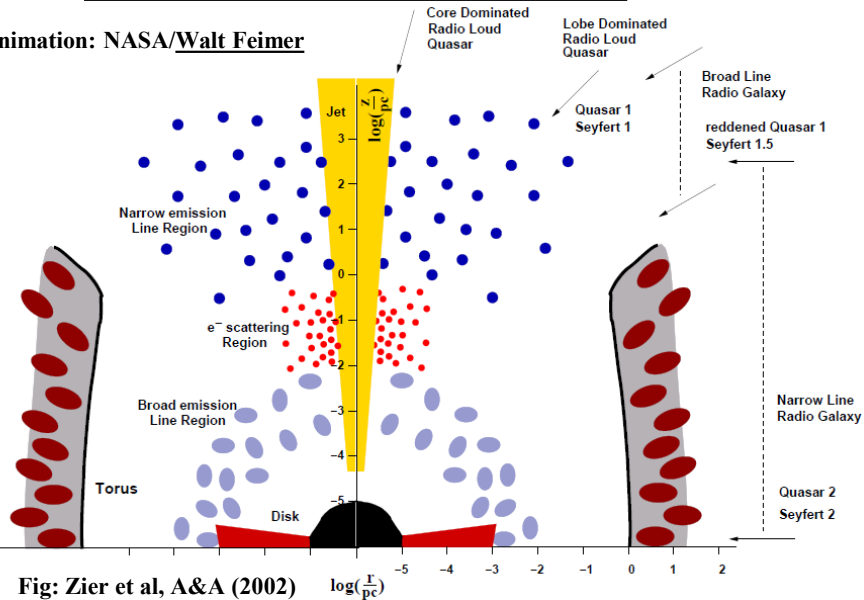
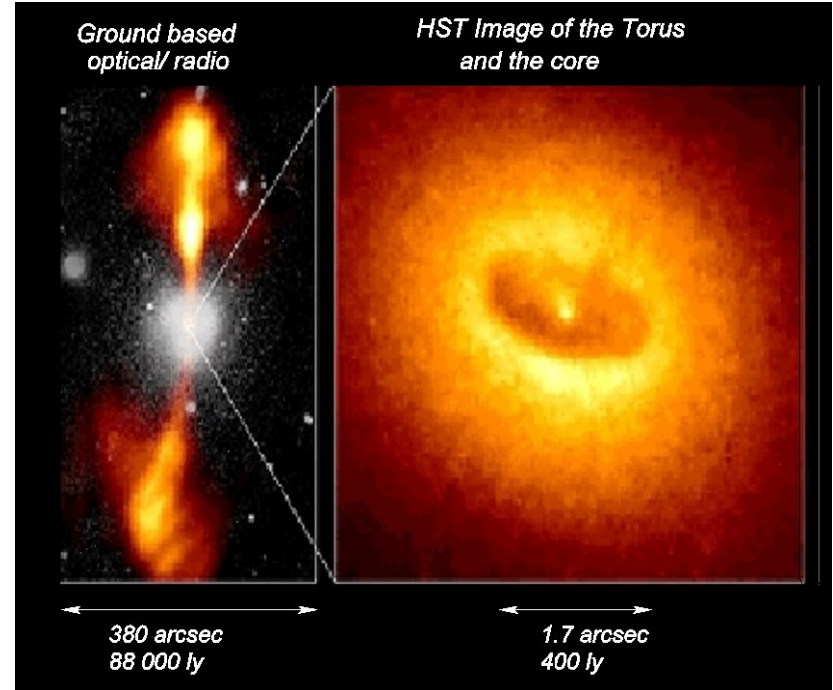
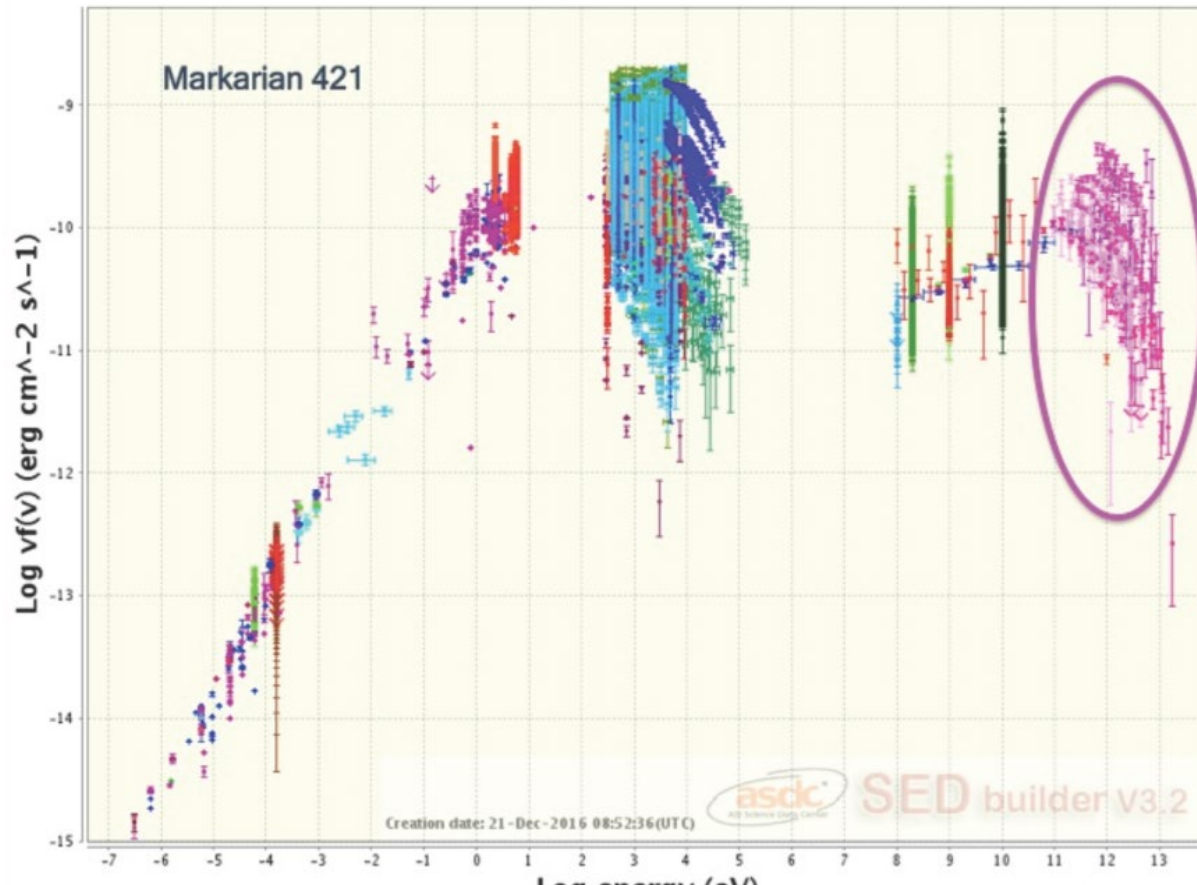


Fig: Zier et al, A&A (2002)

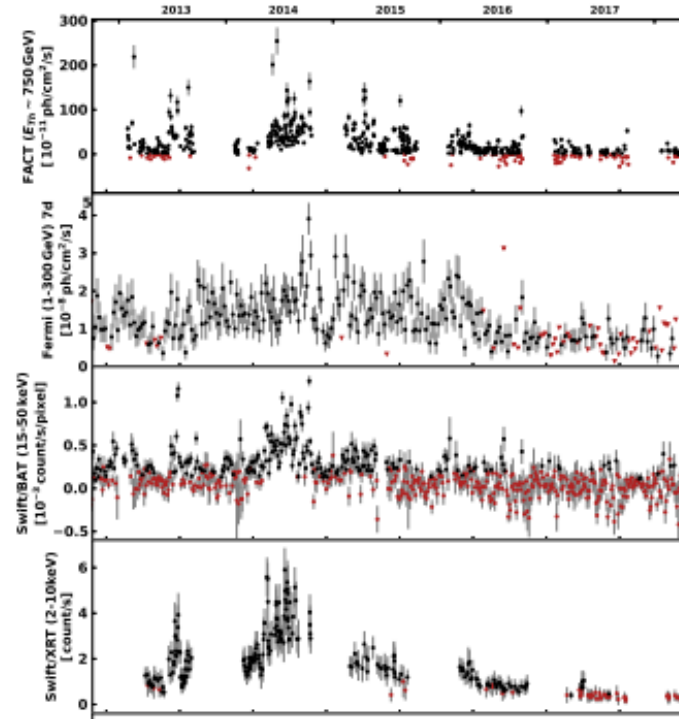
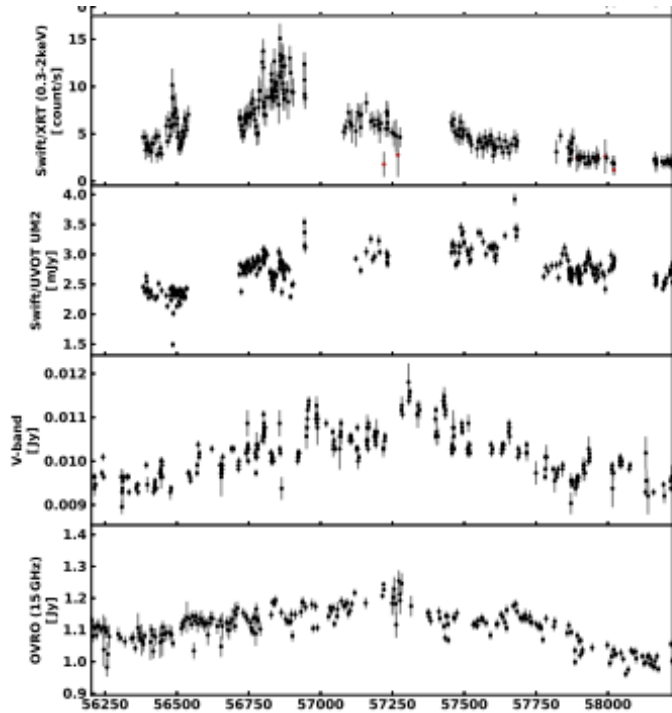


NGC4042, Credit: Hubble

Energy distribution (Example Mkn421)



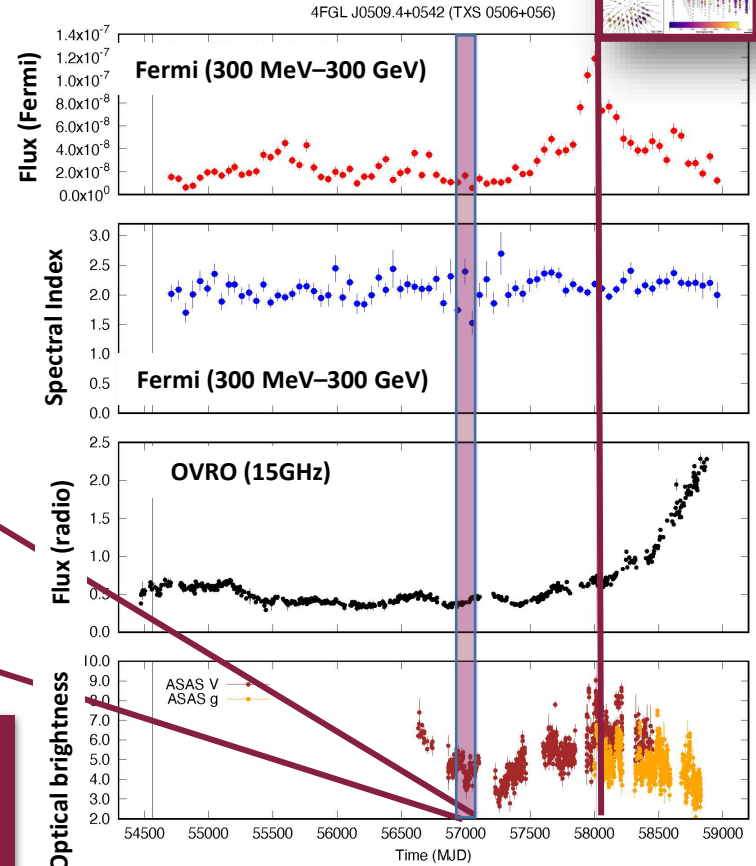
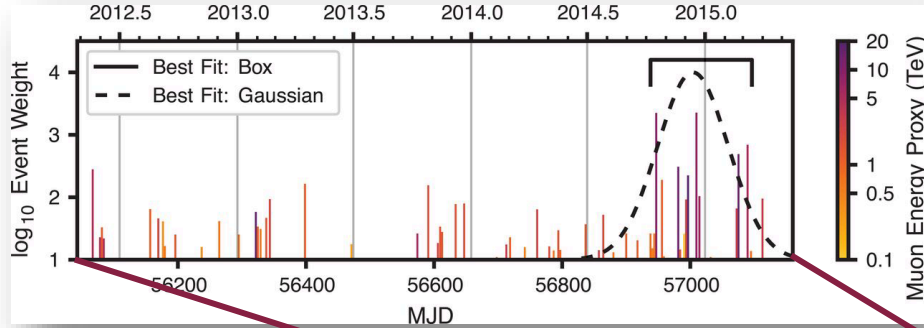
Example lightcurve Mkn501



Multimessenger emission with TXS0506+056



Neutrino excess @ $\sim 3\sigma$ in 2014/2015

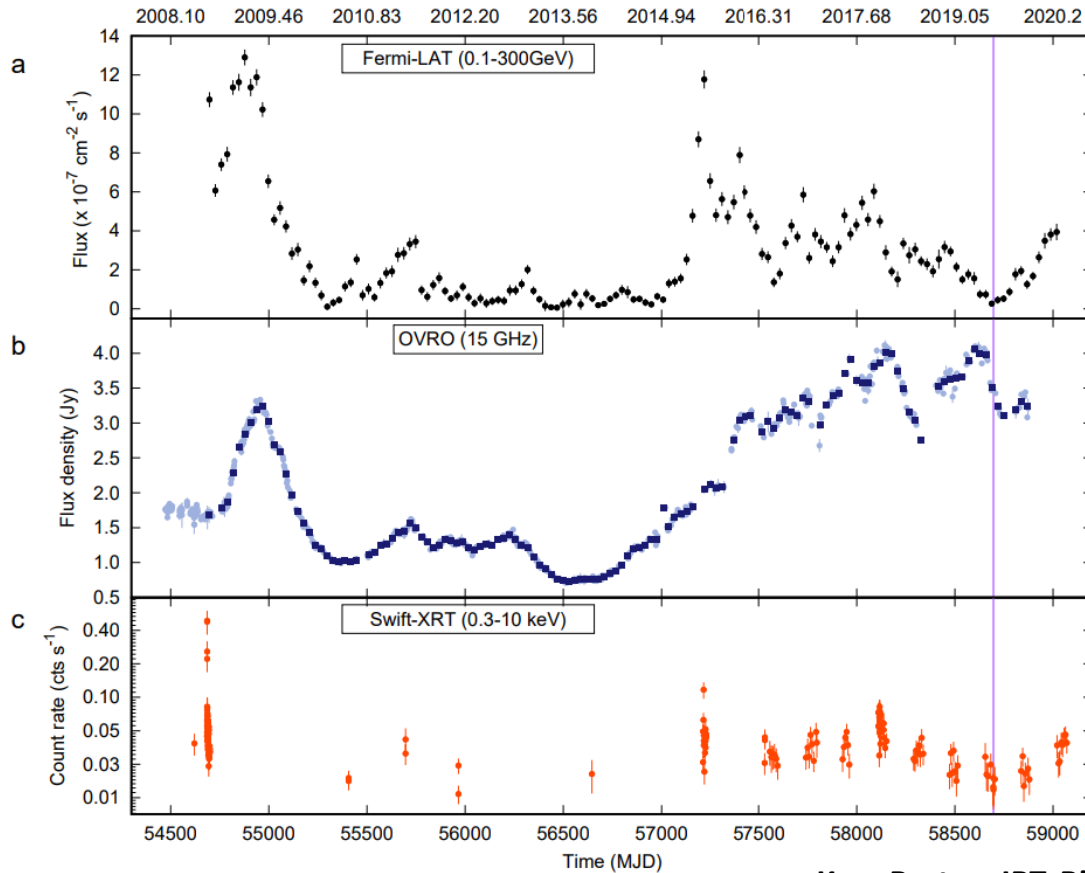


Aartsen et al (IceCube Coll), Science (2018)

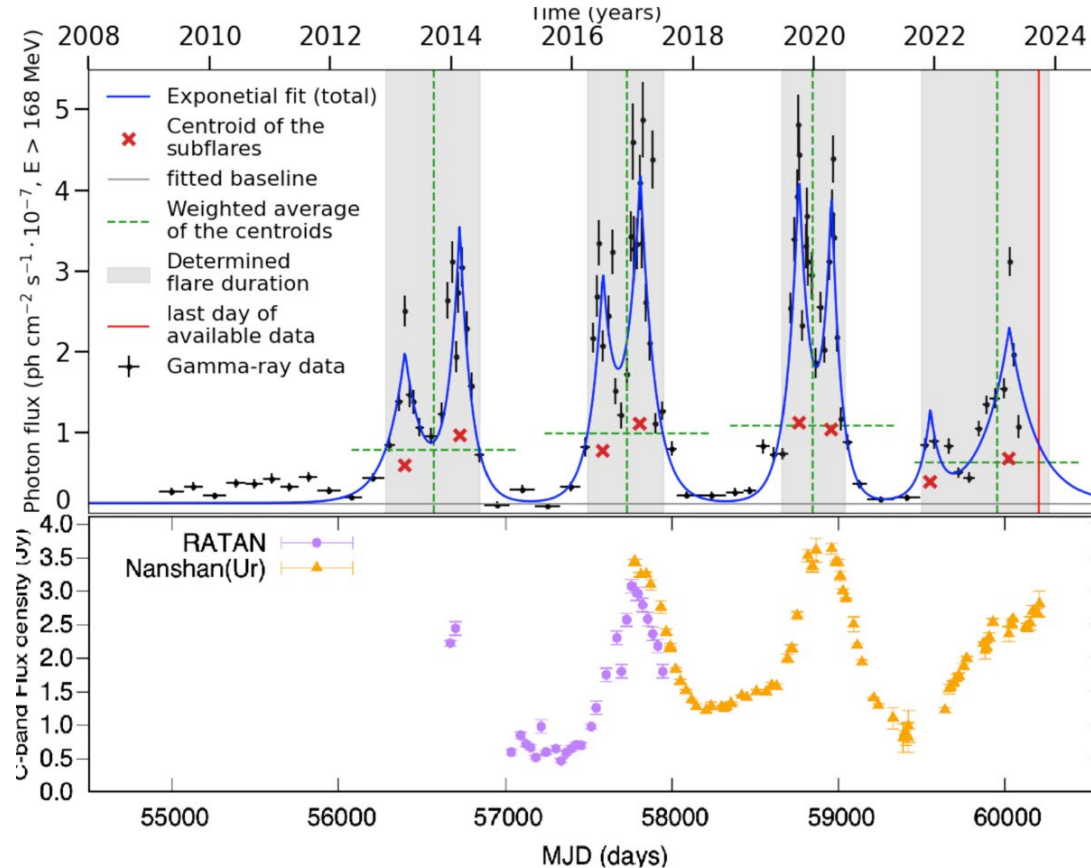
- Two potential neutrino flares of very different nature:
 - 2014/2015: ~ 100 days long, ~ 10 TeV in energy, no MM activity
 - 2018: 1 neutrino with ~ 300 TeV energy, coincident γ -ray flare

Fig: Emma Kun, Budapest

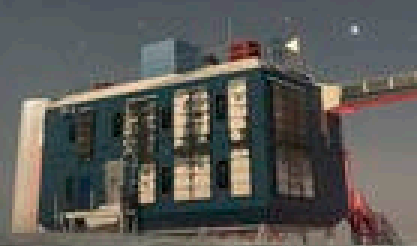
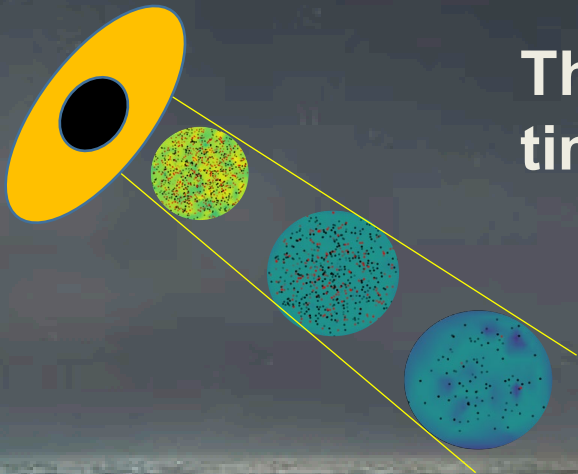
PKS1502+106



„Easier“ example: sources with quasi-periodic oscillations



Thank you for listening –
time for questions 😊



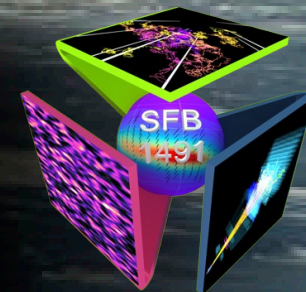
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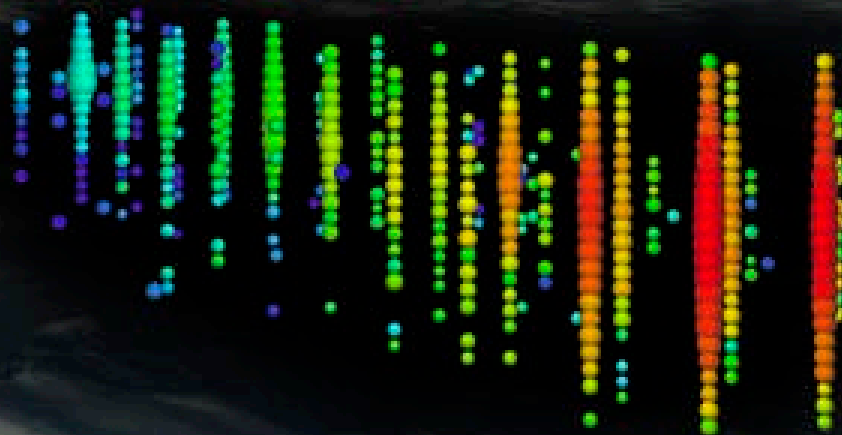
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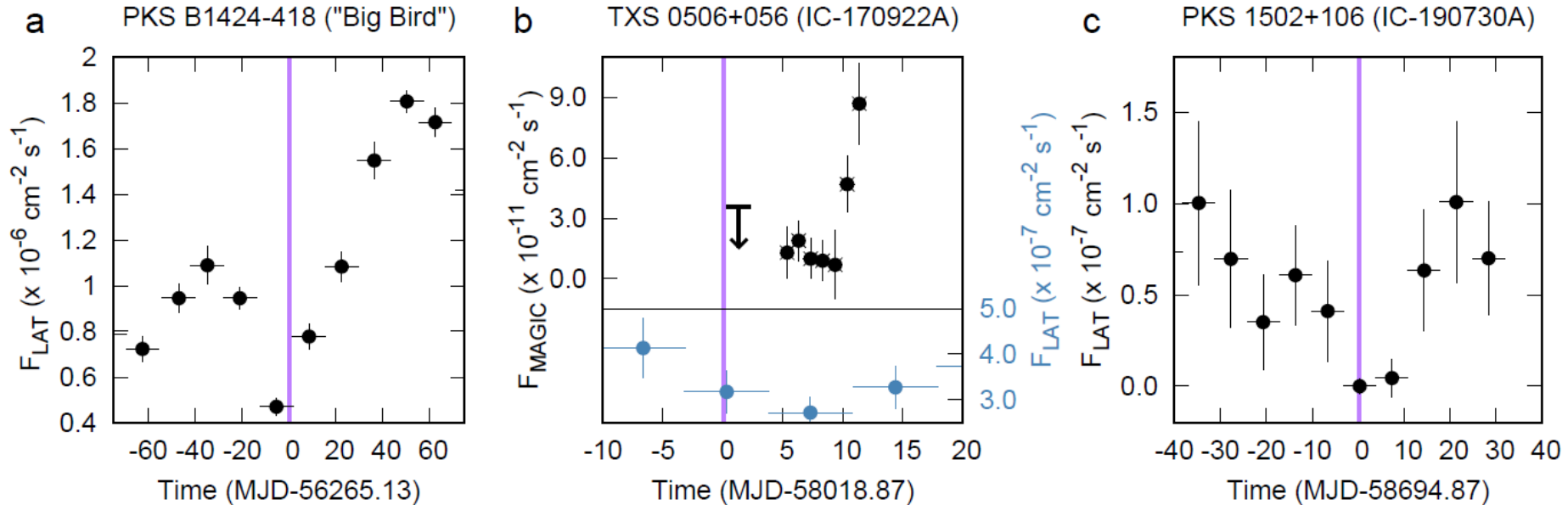
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Time-domain of AGN



Kun, Bartos, JBT, Biermann, Halzen, Mez'zo ApJL (2021)

Neutrinos arrive in γ -minima? Possible if gas density extreme: photon absorption