

Otkriće izvora astrofizičkih neutrina

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16. studenog 2018.

povod

The IceCube Collaboration et al. *Science* **361** 146 (2018)

13. srpanj 2018.

RESEARCH ARTICLE

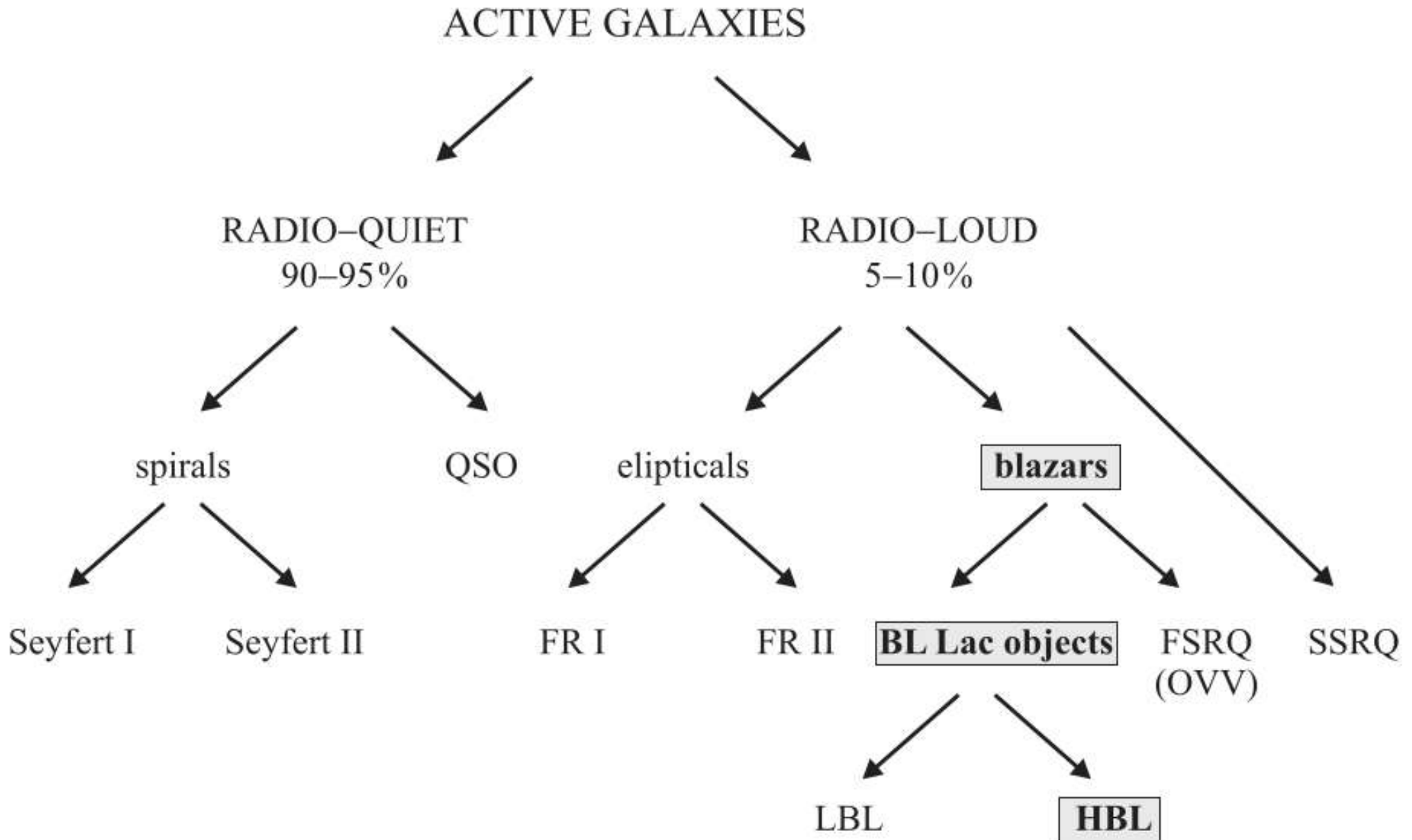
NEUTRINO ASTROPHYSICS

Multimessenger observations of a flaring blazar coincident with high-energy neutrino IceCube-170922A

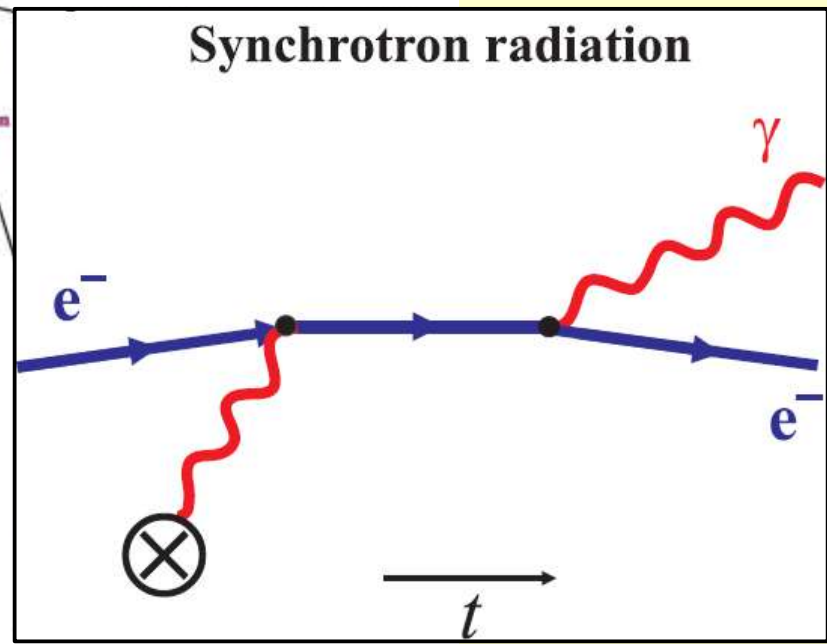
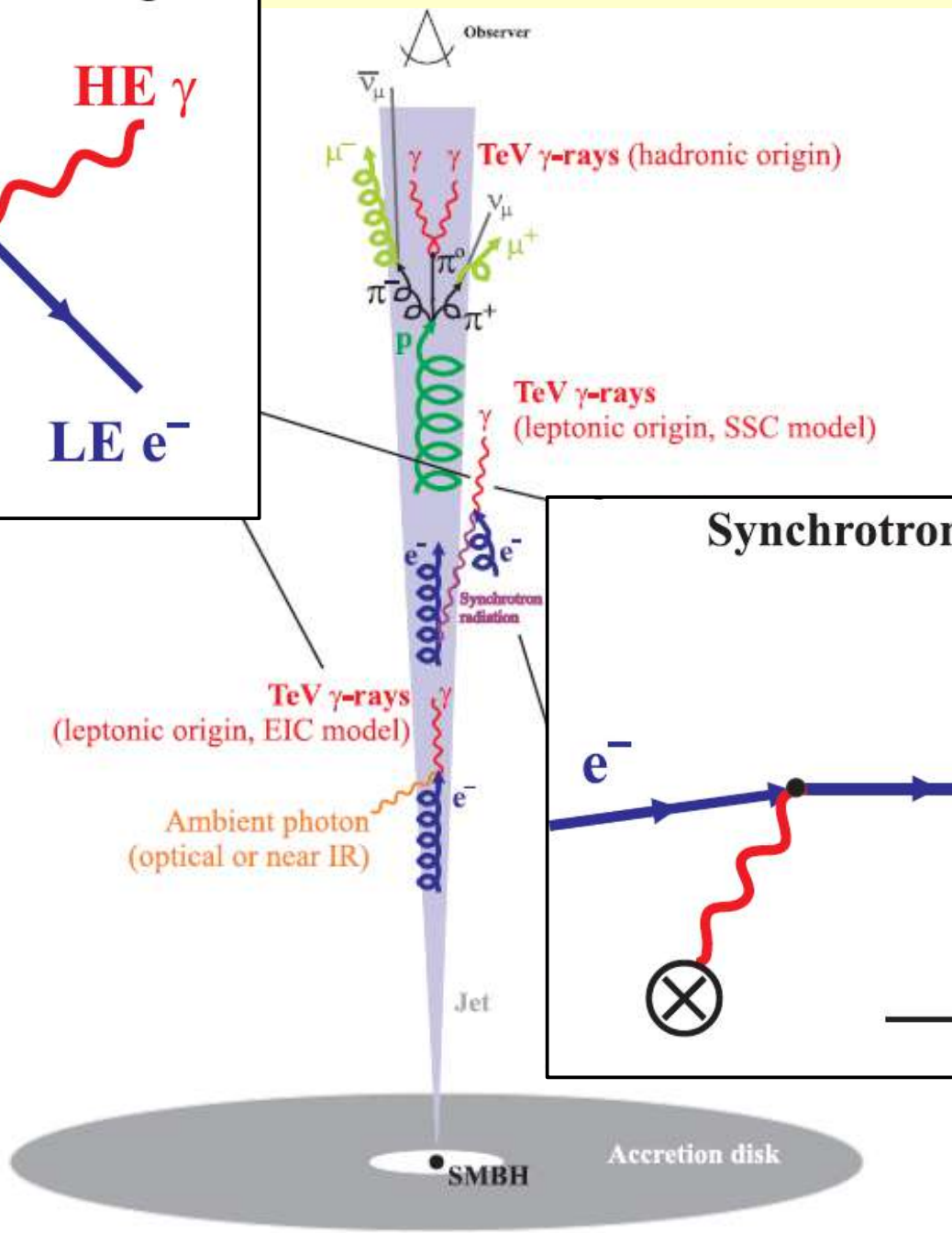
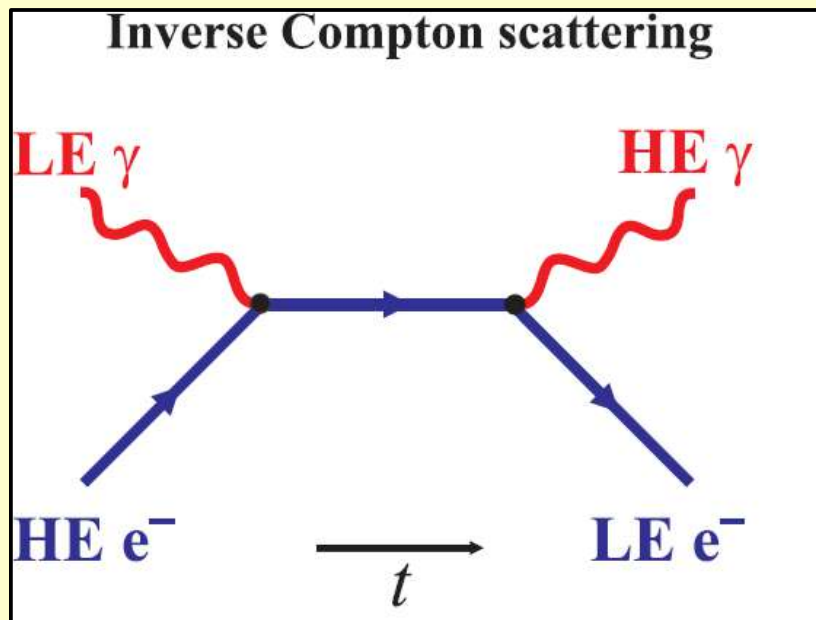
The IceCube Collaboration, *Fermi*-LAT, **MAGIC**, *AGILE*, ASAS-SN, HAWC, H.E.S.S., *INTEGRAL*, Kanata, Kiso, Kapteyn, Liverpool Telescope, Subaru, *Swift*/*NuSTAR*, VERITAS, and VLA/17B-403 teams*†



blazar



blazar



TeV γ -rays (leptonic origin, EIC model)

Ambient photon (optical or near IR)

blazar: TXS 0506+056

TXS 0506+056 

Canonical Name: TXS 0506+056
TeVCat Name: TeV J0509+056
EHE 170922A
Other Names: 3FGL J0509.4+0541
3FHL J0509.4+0542
VER J0509+057
Source Type: Blazar
R.A.: 05 09 25 (hh mm ss)
Dec.: +05 42 09 (dd mm ss)
Gal Long: 195.39 (deg)
Gal Lat: -19.63 (deg)
Distance: $z=0.3365$
Flux: 0.016 (Crab Units)
Energy Threshold: 110 GeV
Spectral Index: 4.8
Extended: No
Discovery Date: 2017-10
Discovered By: **MAGIC**

TeVCat

an online catalog for TeV Astronomy

<http://tevcat.uchicago.edu/>

5,7 milijardi svjetlosnih godina

MAGIC

astrofizički neutrino

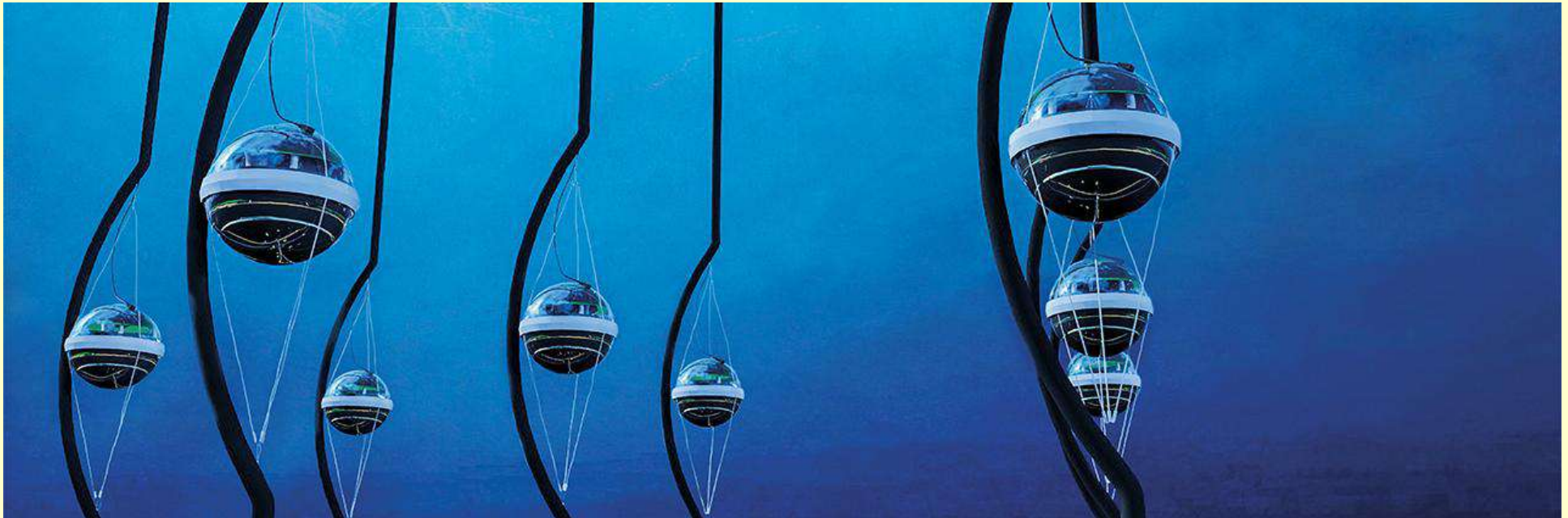
LEPTONI				KVARKOVI				
	približna masa ($\text{MeV}c^{-2}$)	naboj (e)	spin (\hbar)		približna masa ($\text{MeV}c^{-2}$)	naboj (e)	spin (\hbar)	
ν_e elektronski neutrino	<0,000 002 2	0	$\frac{1}{2}$	prva generacija	u gornji	0,002	$+\frac{2}{3}$	$\frac{1}{2}$
e elektron	0,511	-1	$\frac{1}{2}$		d donji	0,005	$-\frac{1}{3}$	$\frac{1}{2}$
ν_μ mionski neutrino	<0,17	0	$\frac{1}{2}$	druga generacija	c čarobni	1,3	$+\frac{2}{3}$	$\frac{1}{2}$
μ mion	105,7	-1	$\frac{1}{2}$		s strani	0,104	$-\frac{1}{3}$	$\frac{1}{2}$
ν_τ tauonski neutrino	<15,5	0	$\frac{1}{2}$	treća generacija	t vršni	170	$+\frac{2}{3}$	$\frac{1}{2}$
τ tau	1780	-1	$\frac{1}{2}$		b dubinski	4,2	$-\frac{1}{3}$	$\frac{1}{2}$

astrofizički neutrino

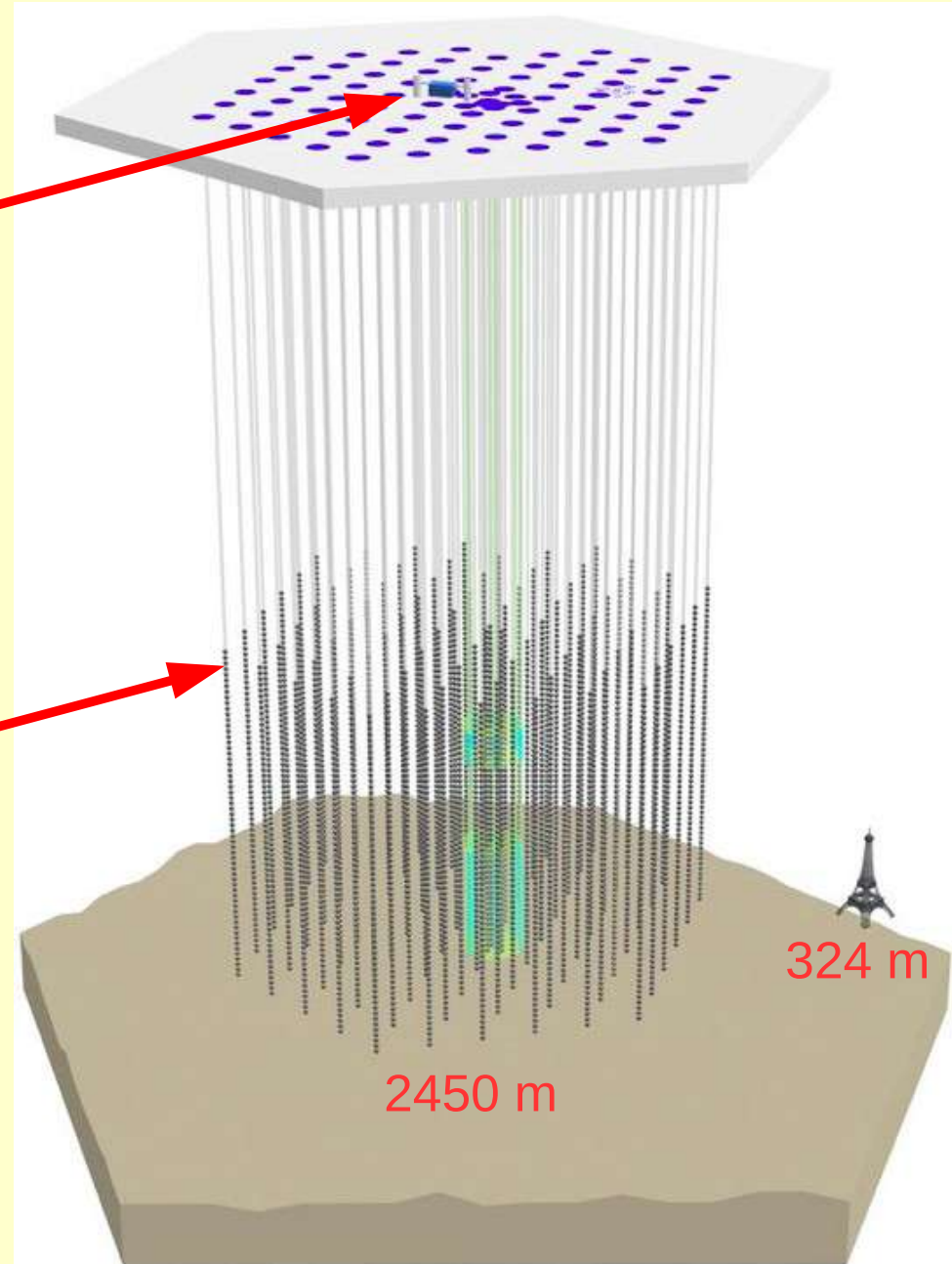
- iskazuje samo slabo međudjelovanje (jako mali doseg) i gravitacijsko (koje je za elementarne čestice zanemarivo)
- prolazi kroz tvar kao da je nema (duljina interakcije za 1 TeV neutrino u vodi je 2,5 milijuna km)
- tok solarnih neutrina na Zemlji je 65 milijardi po kvadratnom cm po sekundi
- približno 1 kvadratni metar puta taj tok daje 650 bilijuna (milijun milijuna) po sekundi
- masa svih neutrina koji su prošli kroz sve ljude koji su ikada živjeli, tijekom cijelog života, je oko 0,15 grama

IceCube

- Južni pol, detektor obujma kubičnog kilometra
- 60 optičkih modula po nizu, 86 nizova
- 275 atmosferskih neutrina na dan (oko 100000 na godinu)
- **oko 100 astrofizičkih neutrina na godinu**

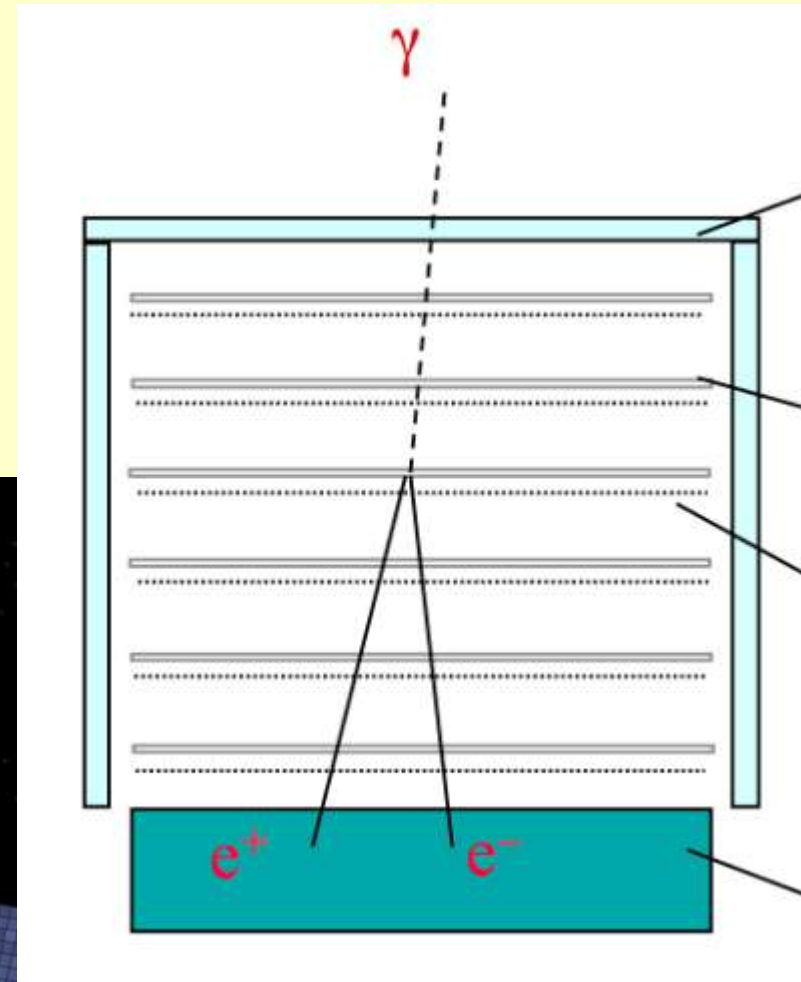
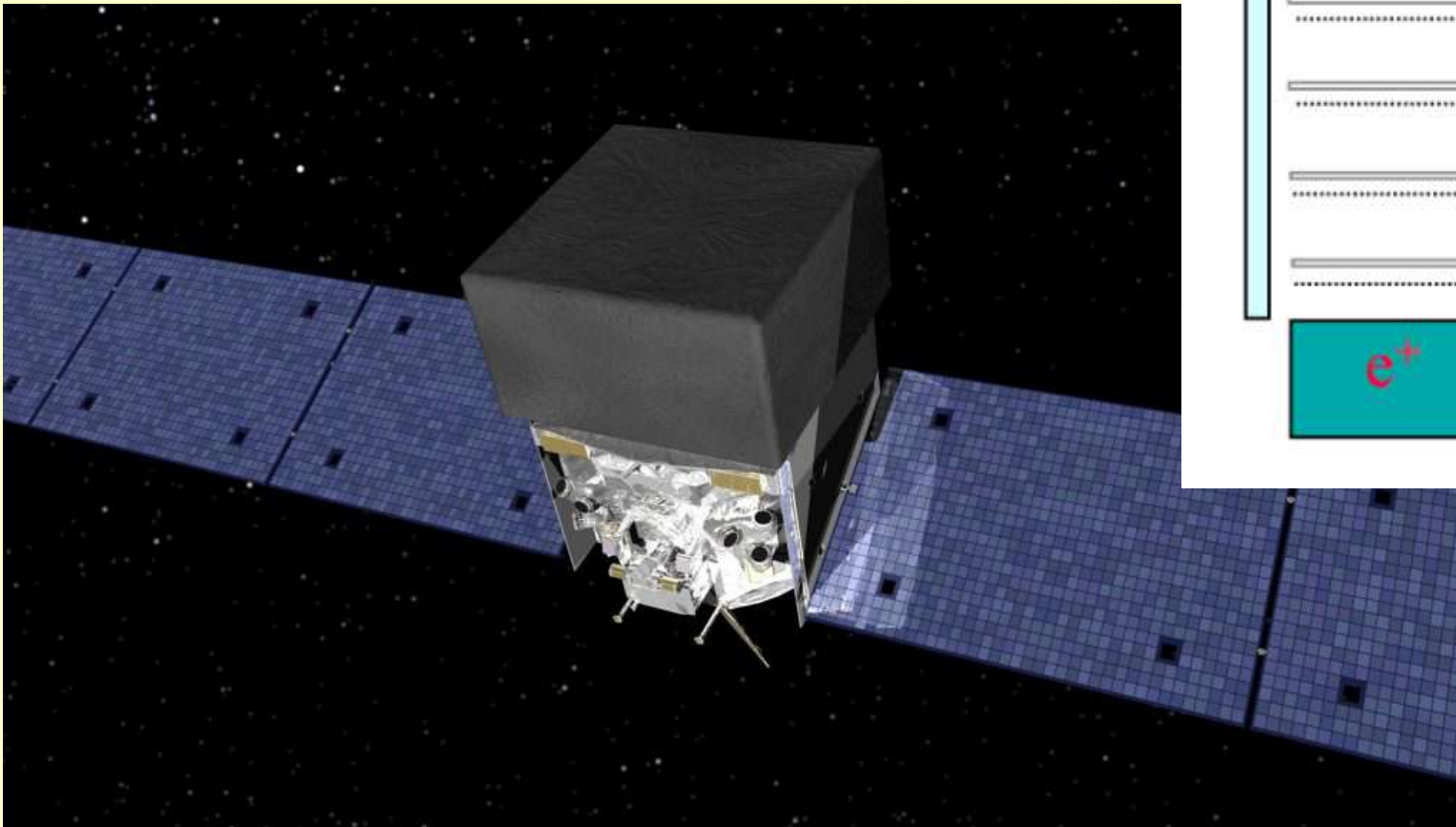


IceCube



Fermi – LAT

- od 20 MeV do 300 GeV
- energijsko razlučivanje $< 15\%$
- kutno razlučivanje $< 0.15^\circ$



MAGIC

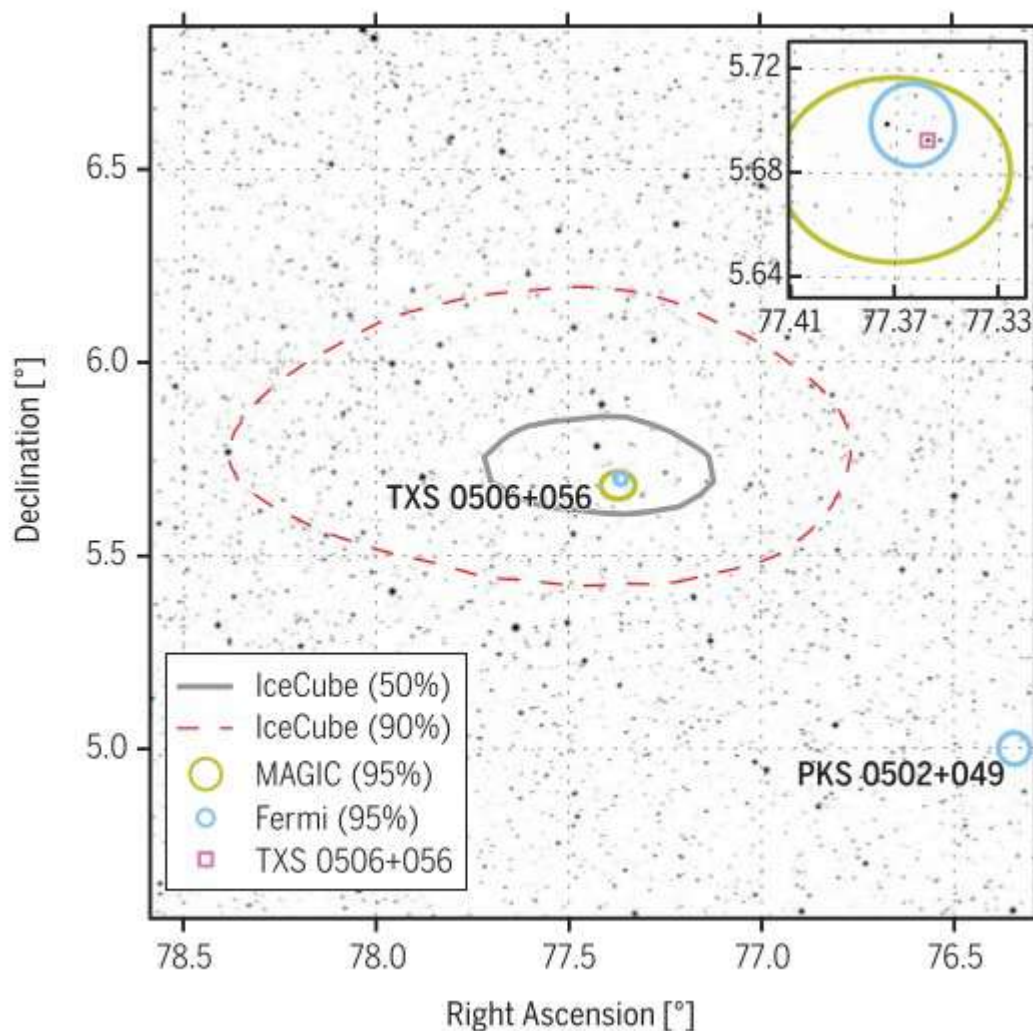


- dva Čerenkovljeva teleskopa
- ORM @ La Palma
- 2200 m n.v.
- oko 170 ljudi iz 10 zemalja

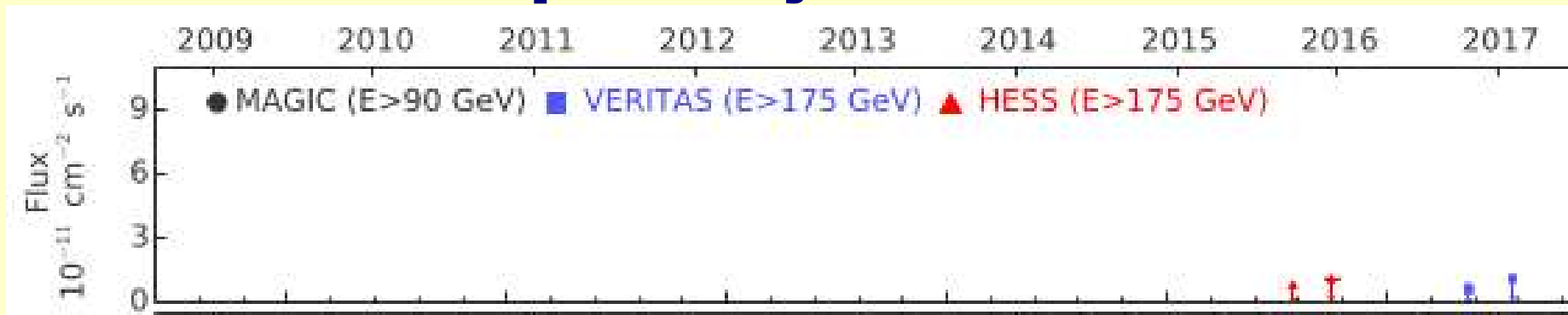
- 17 m, 240 m²
- **od 50 GeV do 50 TeV**
- energijsko razlučivanje < 20%
- kutno razlučivanje < 0.1 °

opažanja: IceCube

- 22. rujna 2017. detektiran neutrino s energijom od 290 TeV



opažanja: MAGIC

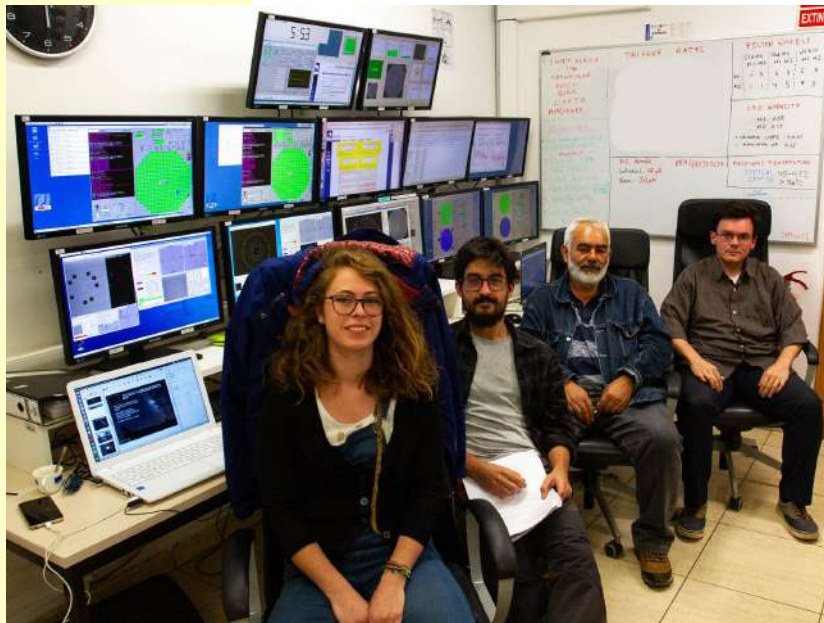
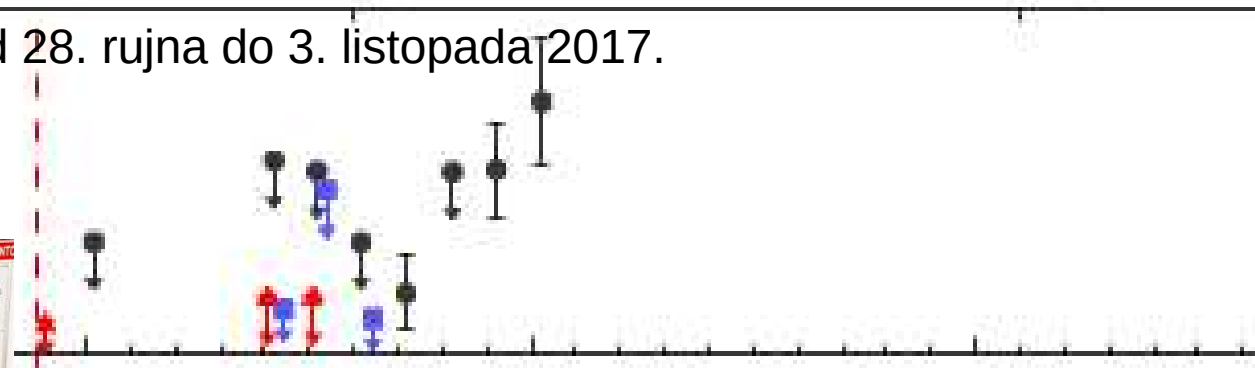


15 September, 2017

1 October, 2017

15 October, 2017

od 28. rujna do 3. listopada 2017.



zašto je ovo otkriće važno

