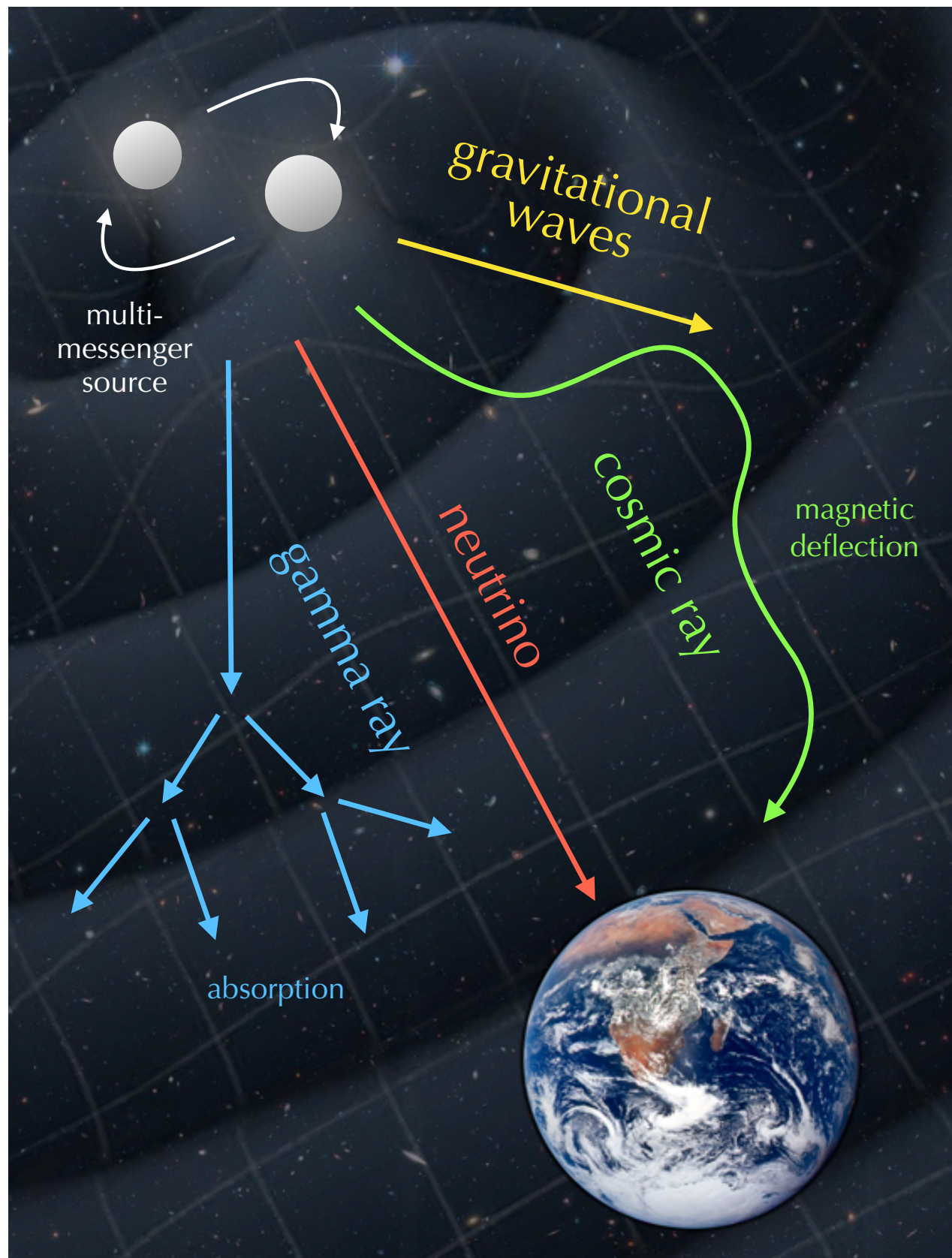
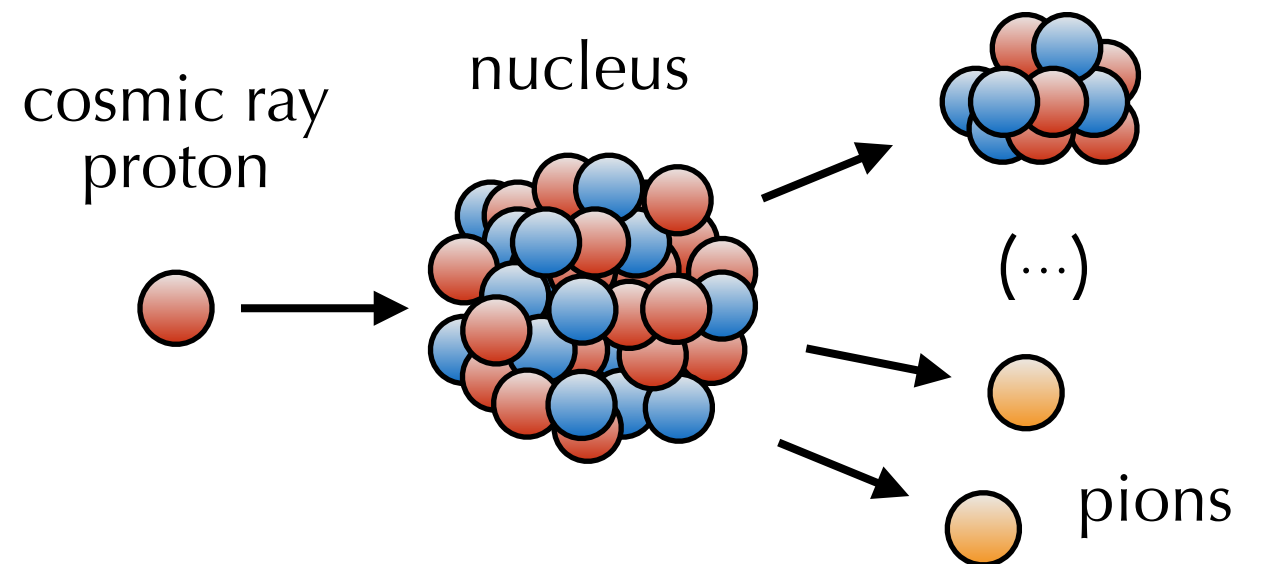


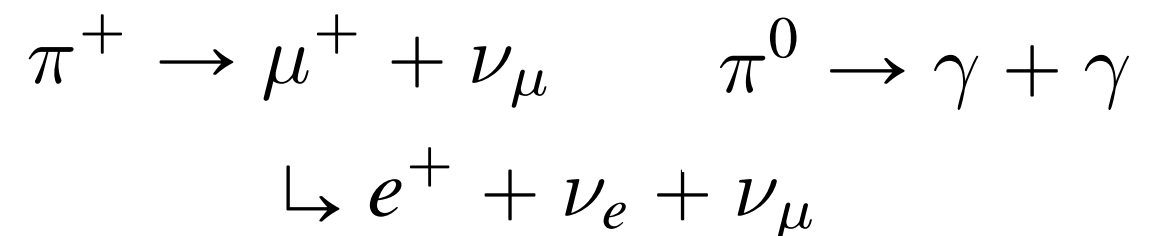
Cosmic Messengers



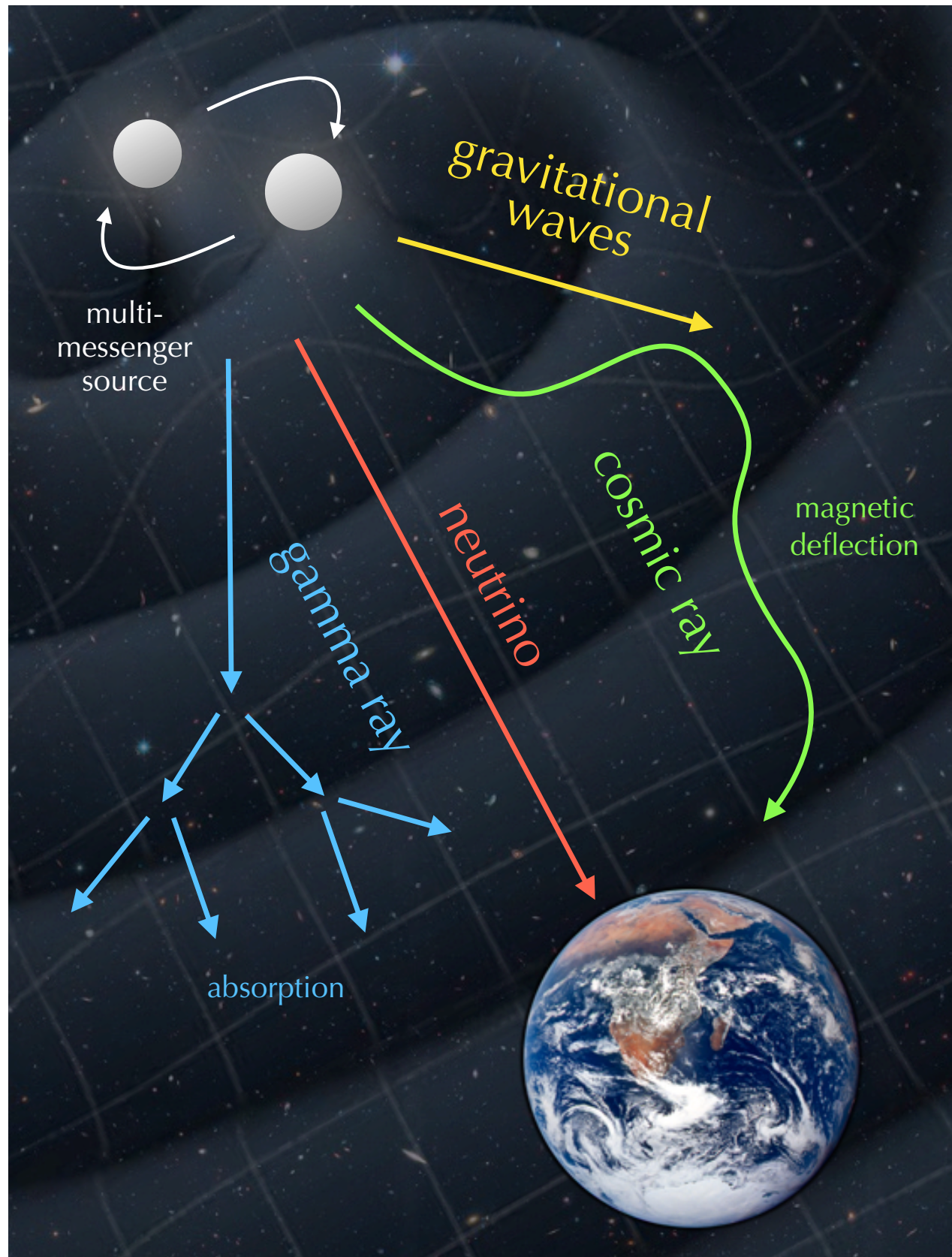
Acceleration of charged nuclei (**cosmic rays**) - especially in the aftermath of cataclysmic events, sometimes visible in **gravitational waves**.



Secondary **neutrinos** and **gamma-rays** from pion decays:



Cosmic Messengers



What are the sources and mechanisms that are responsible for energetic cosmic messengers?

How do energetic messengers probe their environment on astrophysical and cosmic scales?

What are the best strategies for the observation and analysis of multi-messenger data?

What new can we learn about fundamental particle physics and cosmology?

Multi-Messenger Astrophysics

“GZK Neutrinos after the Fermi-LAT Diffuse Photon Flux Measurements”

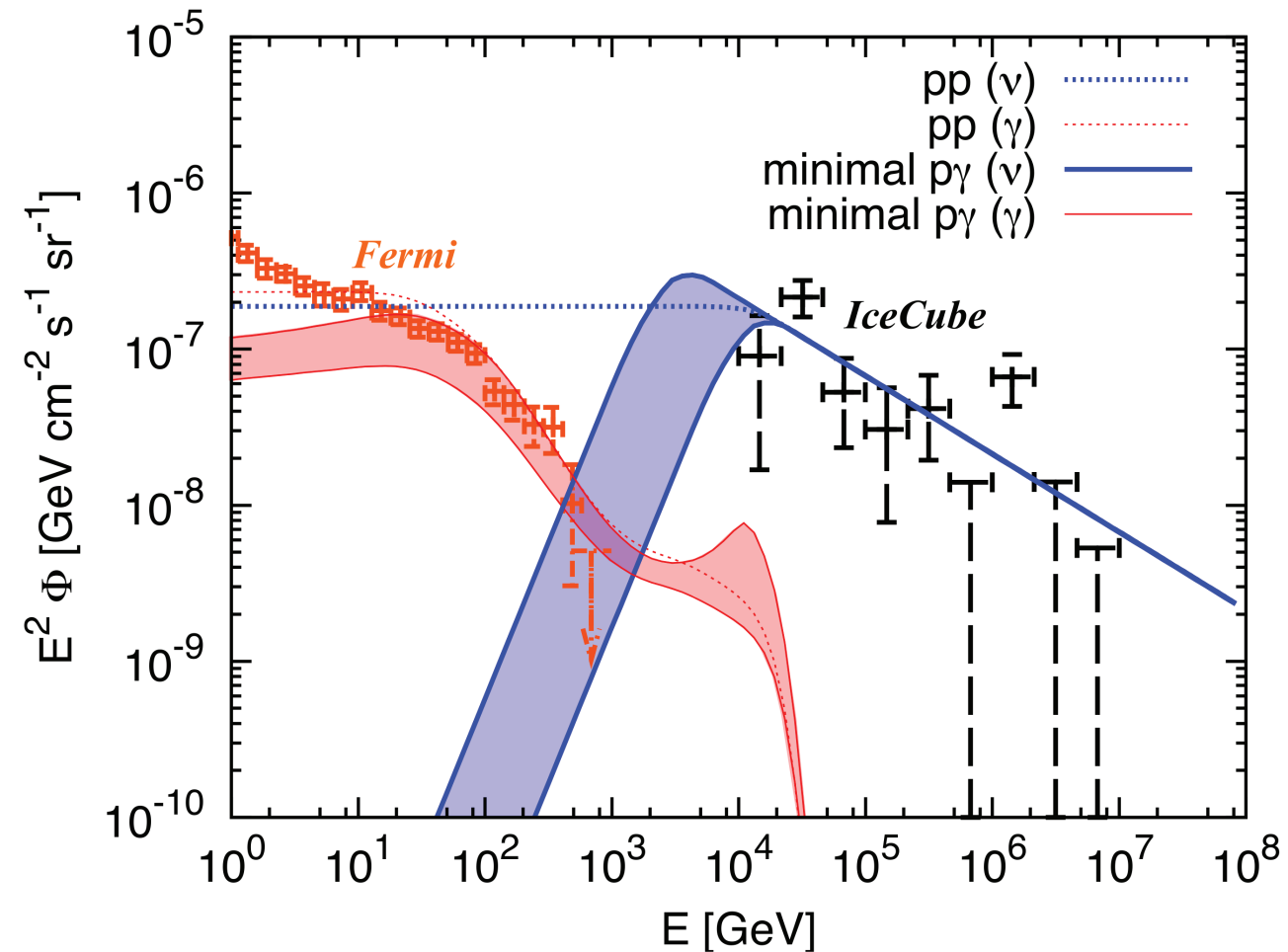
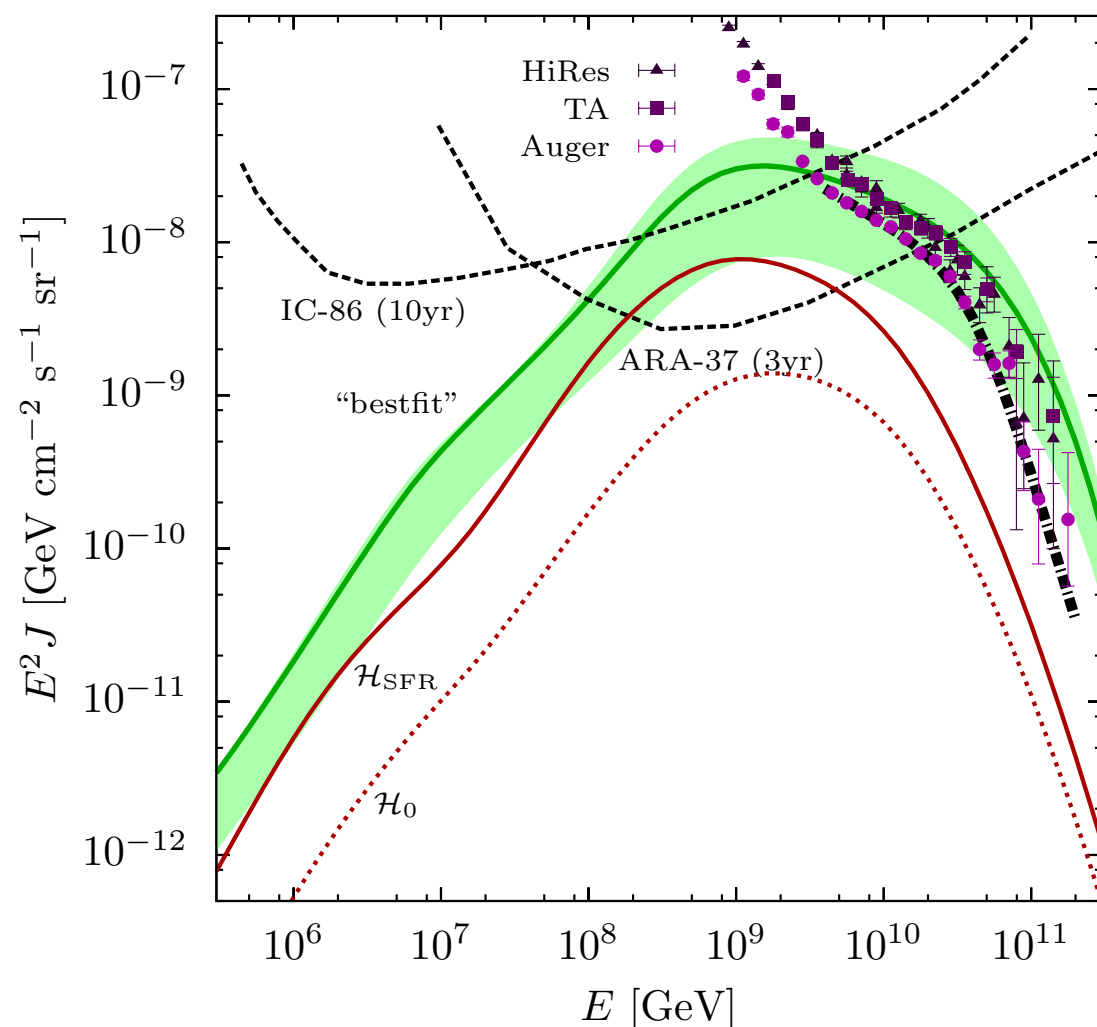
[MA, Anchordoqui, Gonzalez-Garcia, Halzen & Sarkar, **Astropart.Phys.** 34 (2010)]

(200+ citations)

“Minimal Cosmogenic Neutrinos”

[MA & Halzen, **PRD** 86 (2012)]

(50+ citations)



“Hidden Cosmic-Ray Accelerators as an Origin of TeV-PeV Cosmic Neutrinos”

[Murase, Guetta & MA, **PRL** 116 (2016)]

(100+ citations)

“Testing the Hadronuclear Origin of PeV Neutrinos Observed with IceCube”

[Murase, MA & Lacki, **PRD** 88 (2013)]

(250+ citations)

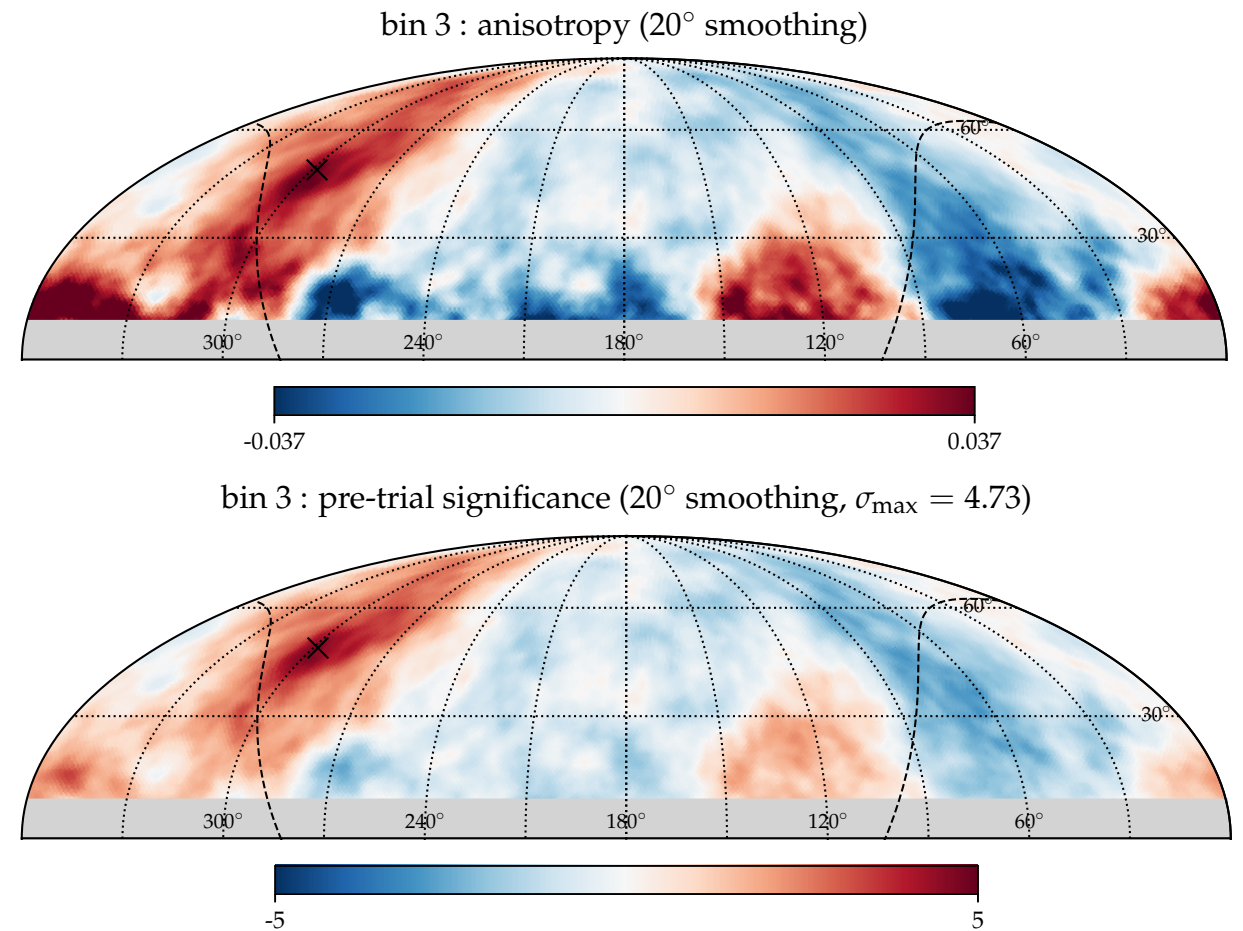
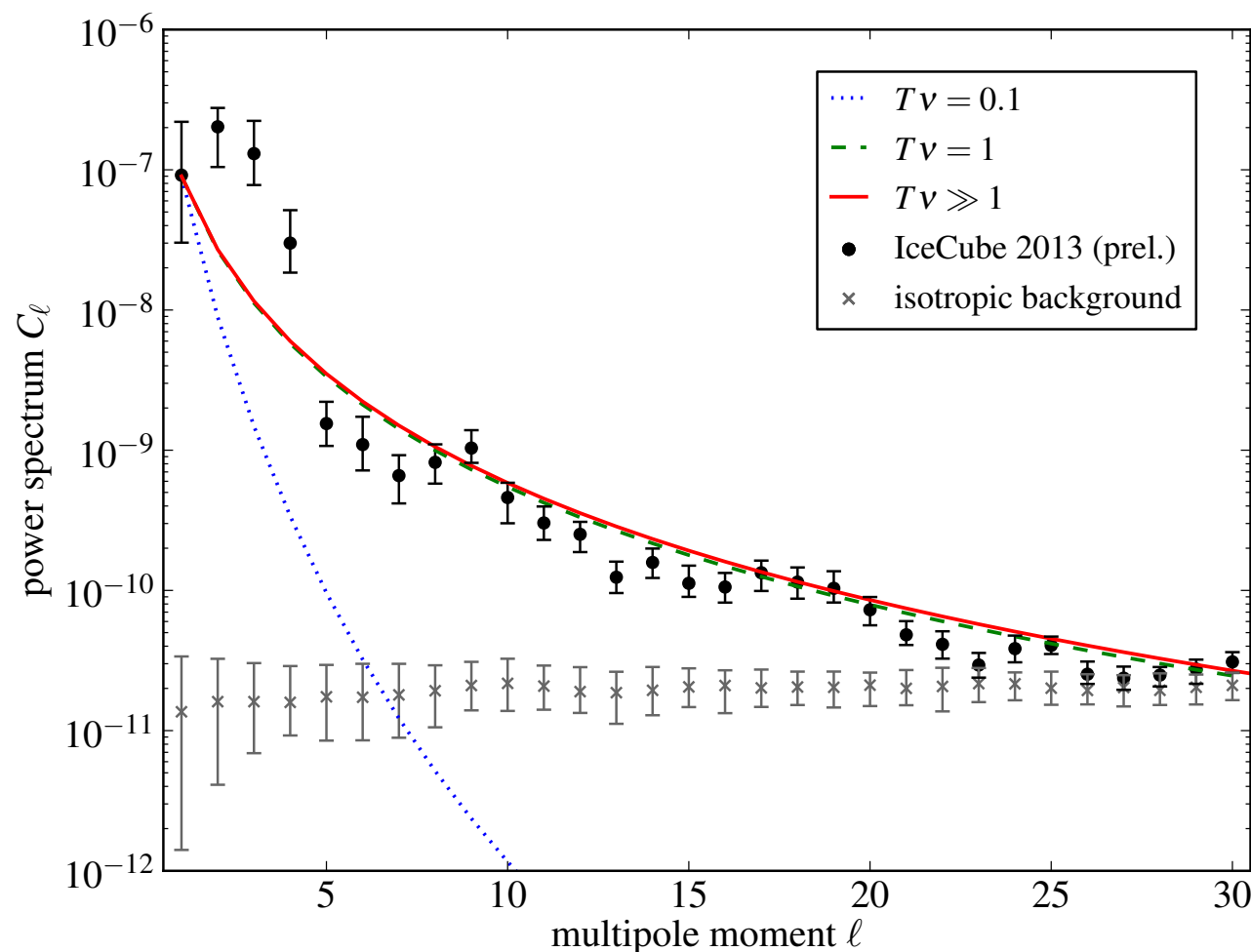
Cosmic Ray Anisotropy

“Deciphering the Dipole Anisotropy of Galactic Cosmic Rays”

[MA, **PRL** 117 (2016)]

“Anomalous Anisotropies of Cosmic Rays from Turbulent Magnetic Fields”

[MA, **PRL** 112 (2014)]



“Large- and Medium-Scale Anisotropies in the Arrival Directions of Cosmic Rays observed with KASCADE-Grande”

[MA, **ApJL** 886 (2019)]

“Searching for All-Scale Anisotropies in the Arrival Directions of CRs above the Ankle”

[MA, **ApJ** 863 (2018)]

Probe of Particle Physics

“Probing the Galactic Origin of the IceCube Excess with Gamma-Rays”

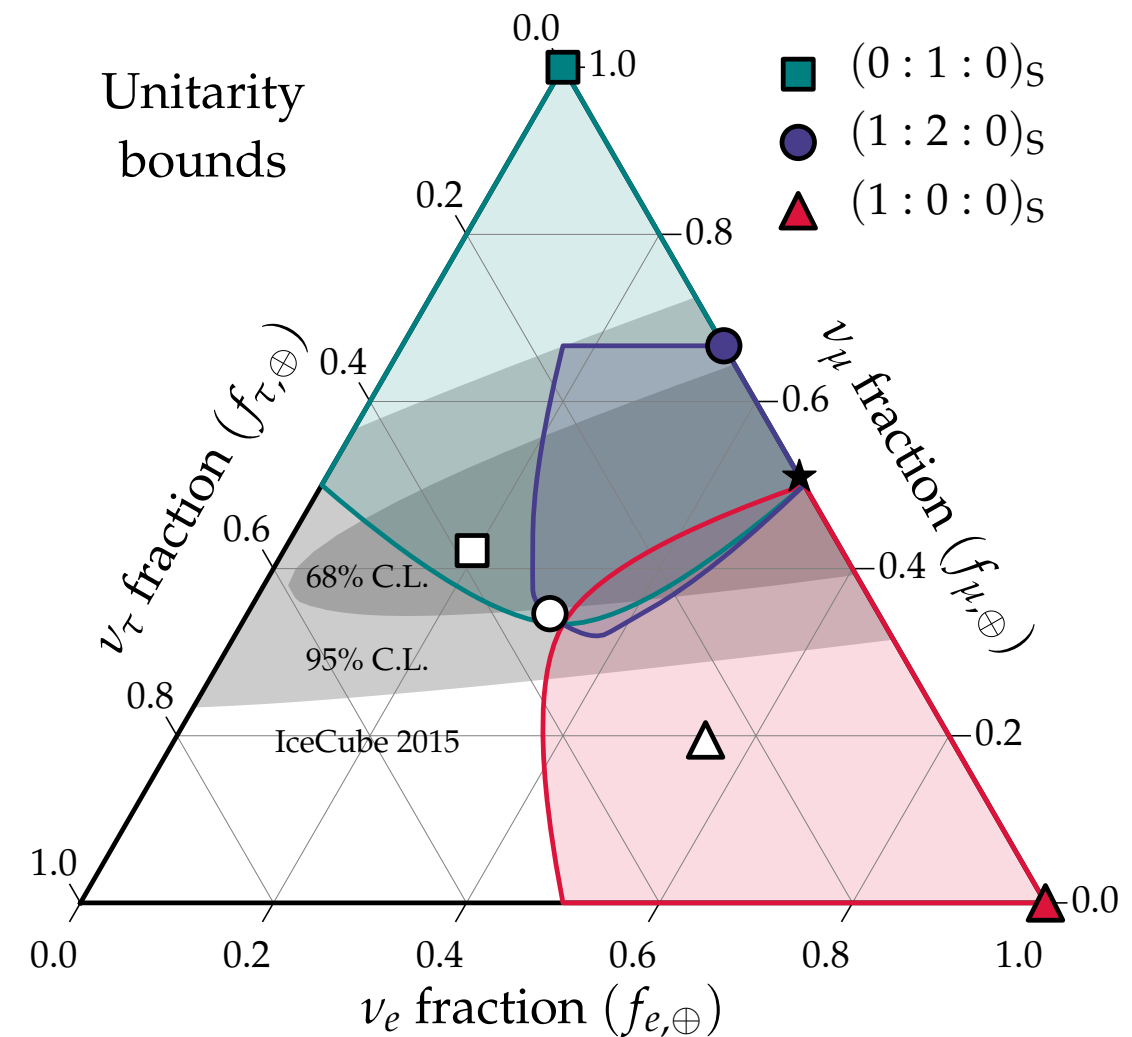
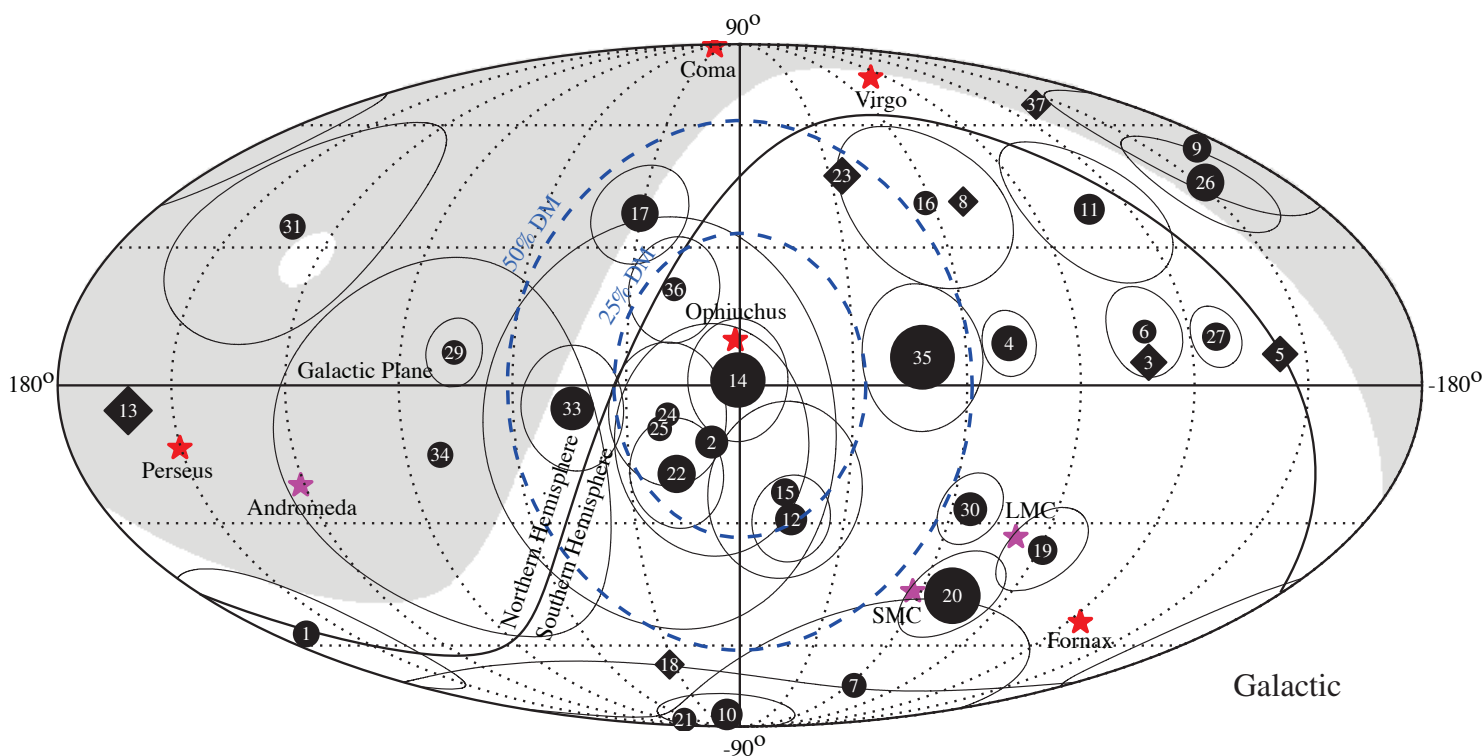
[MA & Murase, **PRD** 90 (2013)]

(100+ citations)

“Testing the Dark Matter Scenario for PeV Neutrinos Observed in IceCube”

[Murase, Laha, Ando & MA, **PRL** 115 (2015)]

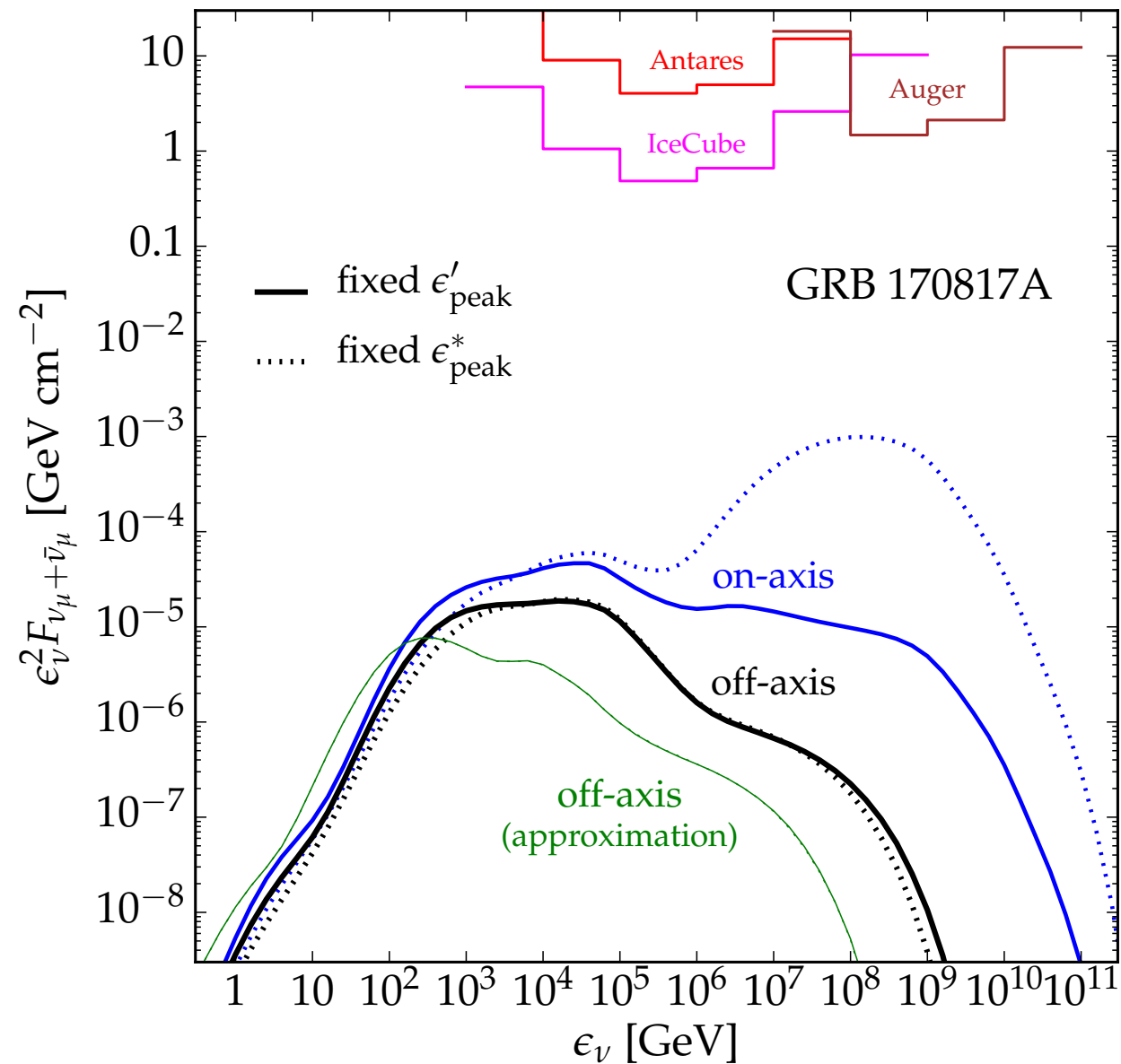
(100+ citations)



“Unitarity Bounds of Astrophysical Neutrinos”

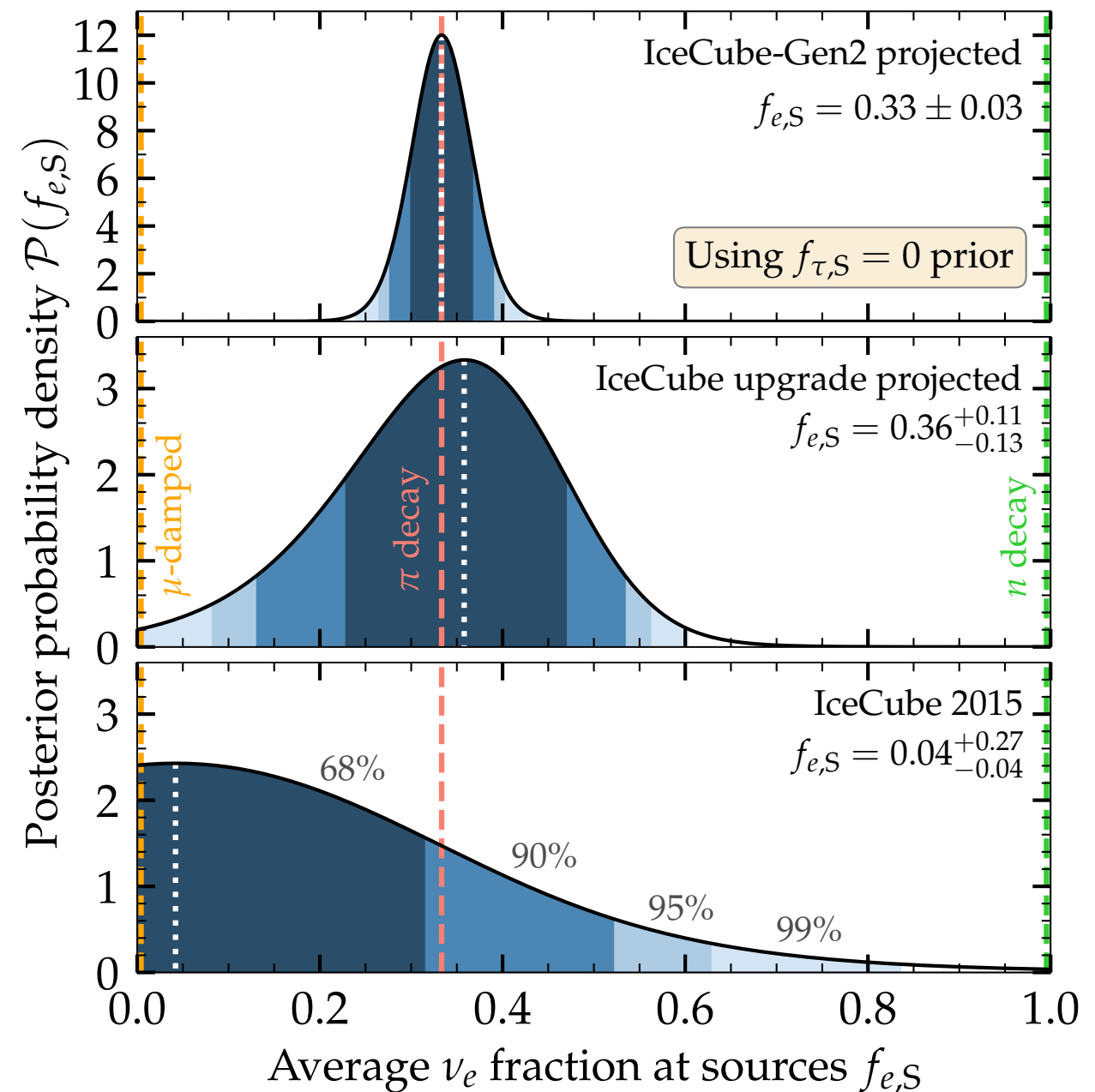
[MA, Bustamante & Mu, **PRD** 98 (2018)]

Probe of Astrophysics

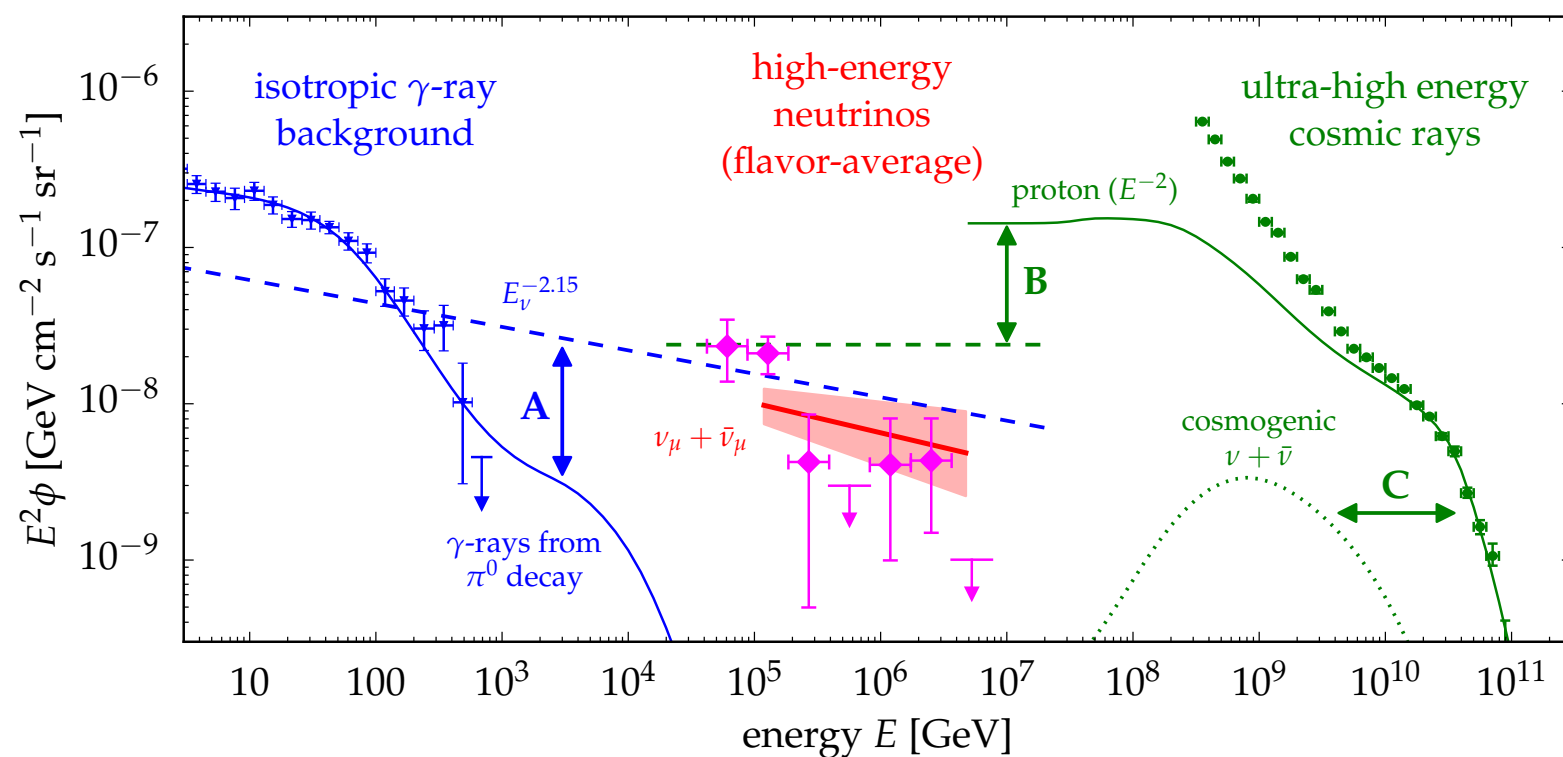
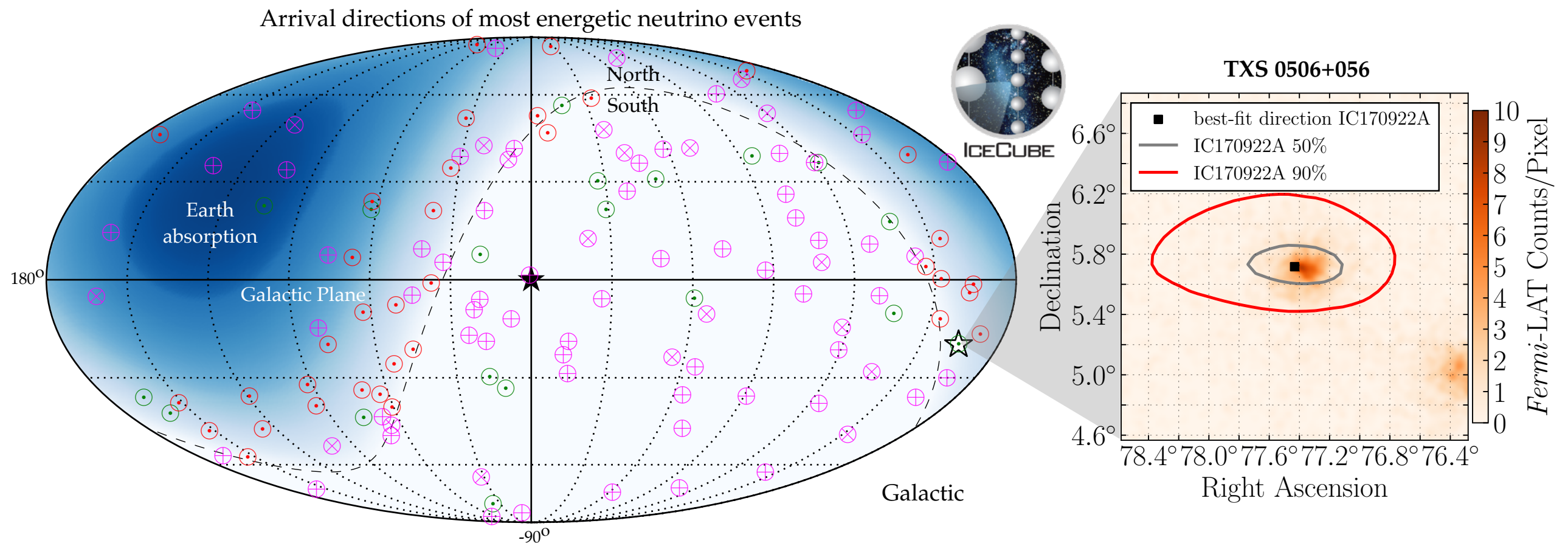


“Neutrino Fluence from Gamma-Ray Bursts: Off-Axis View of Structured Jets”
 [MA & Halser, **MNRAS** 490 (2019)]

“Inferring the flavor of high-energy astrophysical neutrinos at their sources”
 [Bustamante & MA, **PRL** 122 (2019)]



Ongoing Research



What is the origin of high-energy neutrino emission?

How can we use multi-messenger information to decipher the sources?

Are there more sources like TXS 0506+056 - the first high-energy neutrino source?

Beyond IceCube

Astro2020 Science White Paper

Astrophysics Uniquely Enabled by Observations of High-Energy Cosmic Neutrinos

Thematic Area: Multi-Messenger Astronomy and Astrophysics

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March 2019

Astro2020 Science White Paper

Fundamental Physics with High-Energy Cosmic Neutrinos

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March 2019

[arXiv:1903.04334]

Ackermann, MA, Anchordoqui, Bustamante *et al.*

[arXiv:1903.04333]