

lecture 1. introduction

Rafael Alves Batista

Sorbonne Université

Institut d'Astrophysique de Paris (IAP)

Laboratoire de Physique Nucléaire et de Hautes Énergies (LPNHE)

Advanced Astroparticle Physics

NPAC M2

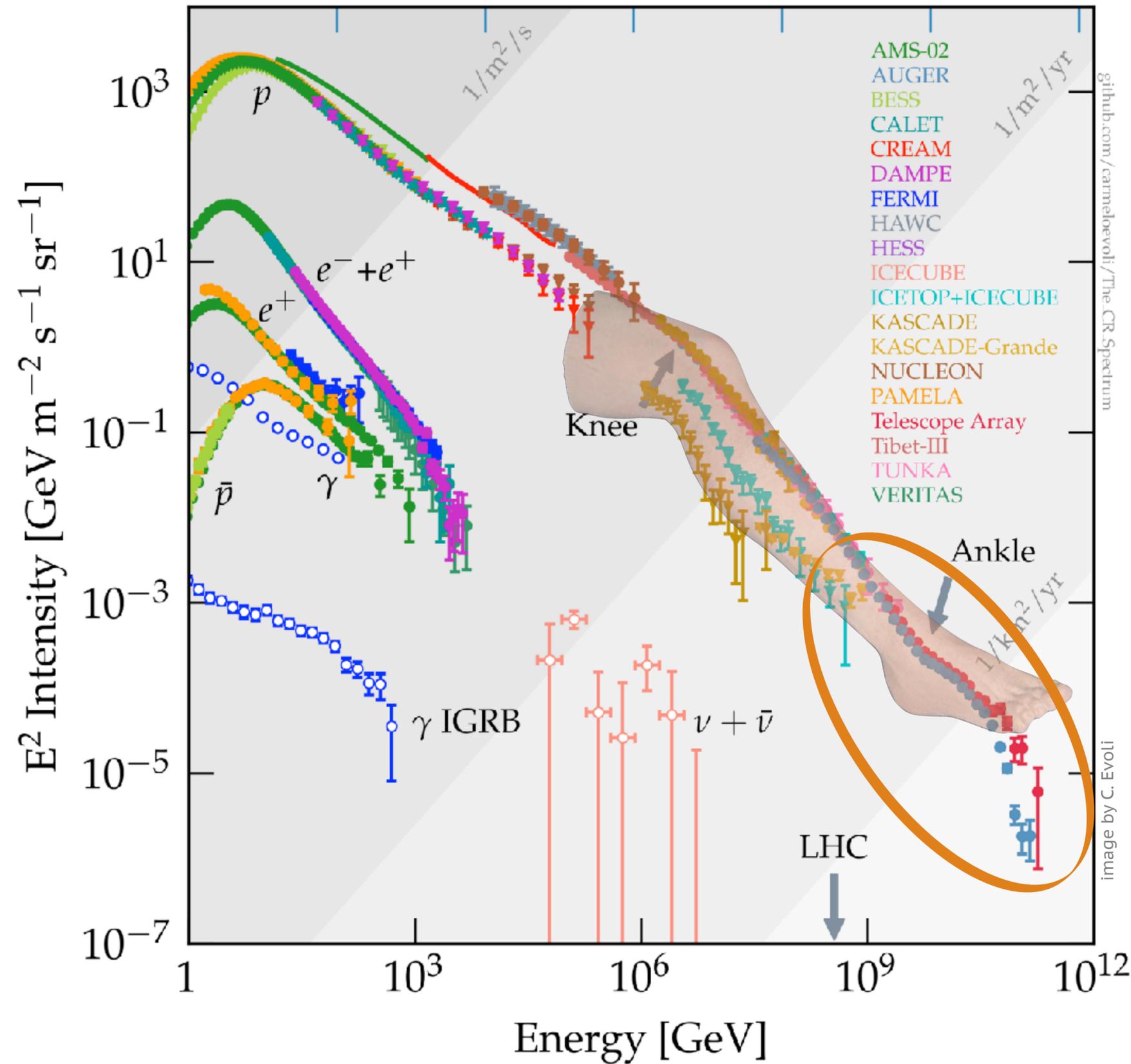
2024-2025

in today's class...

- ▶ **particle acceleration**
 - ◆ paradigms
 - ◆ Fermi 2nd order
 - ◆ Fermi 1st order
 - ◆ gravitational

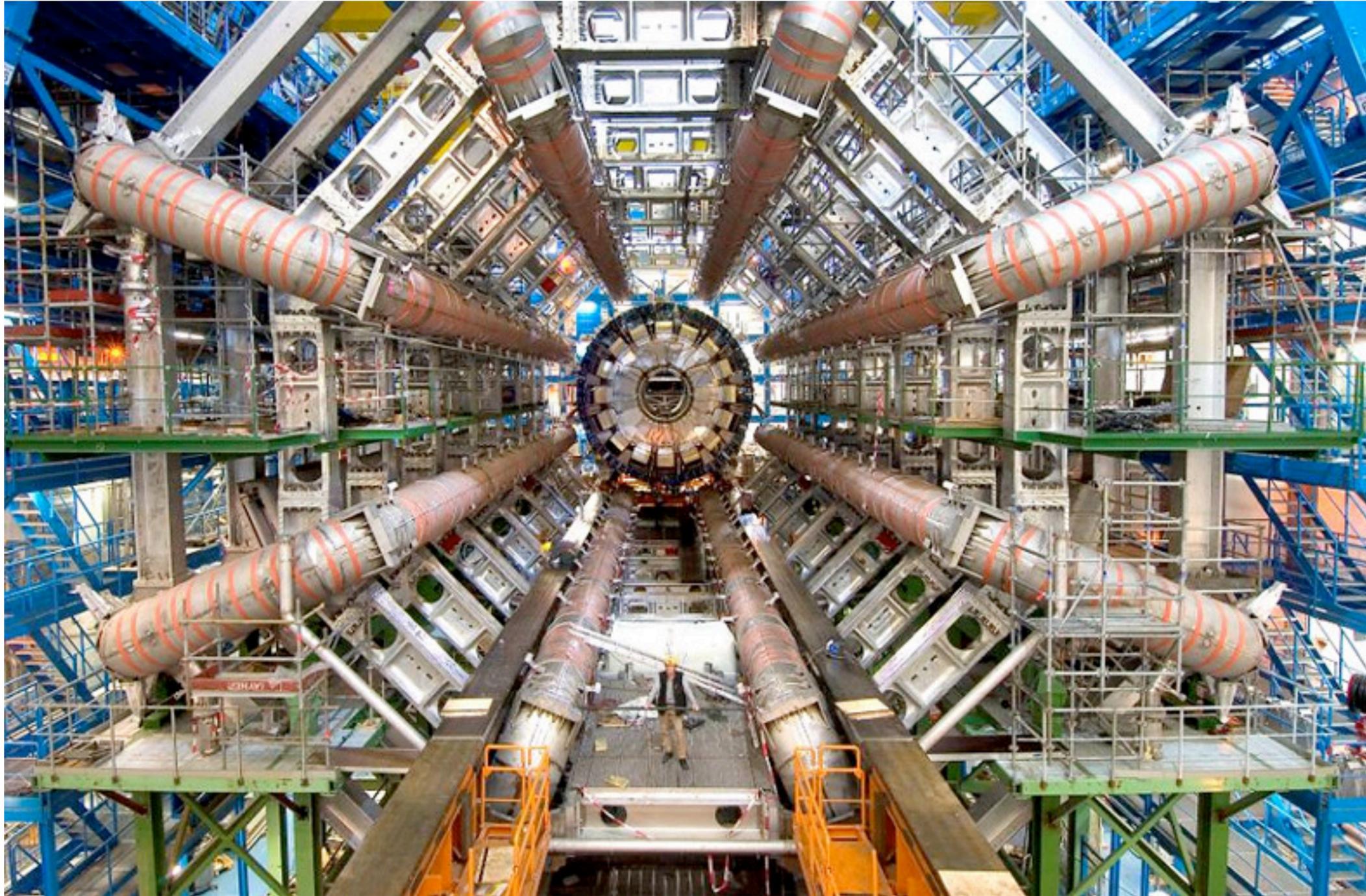
introduction

the all-sky multi-messenger spectrum

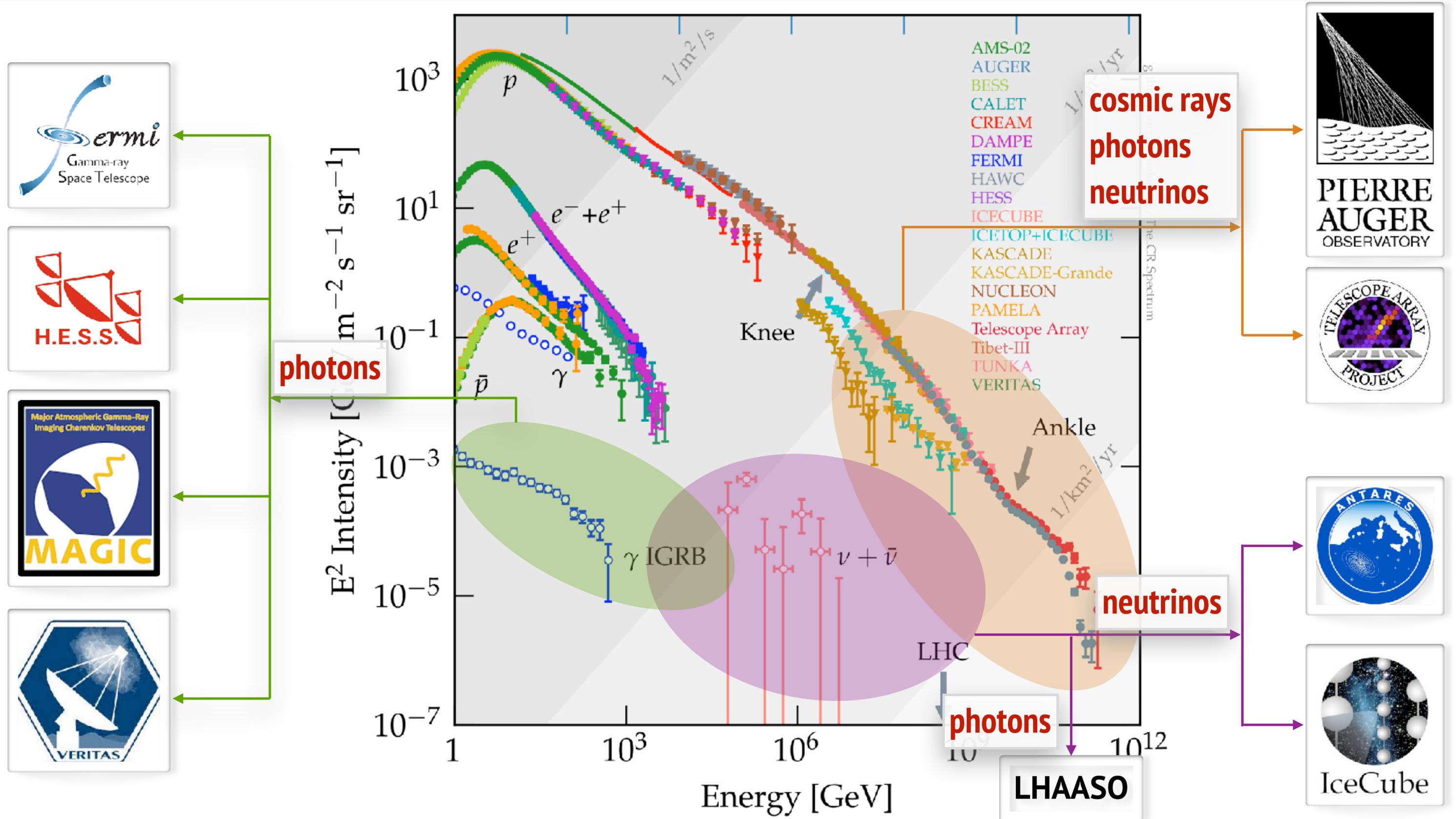


what produces such energetic particles?





the all-sky multi-messenger spectrum



the Milky Way with different messengers

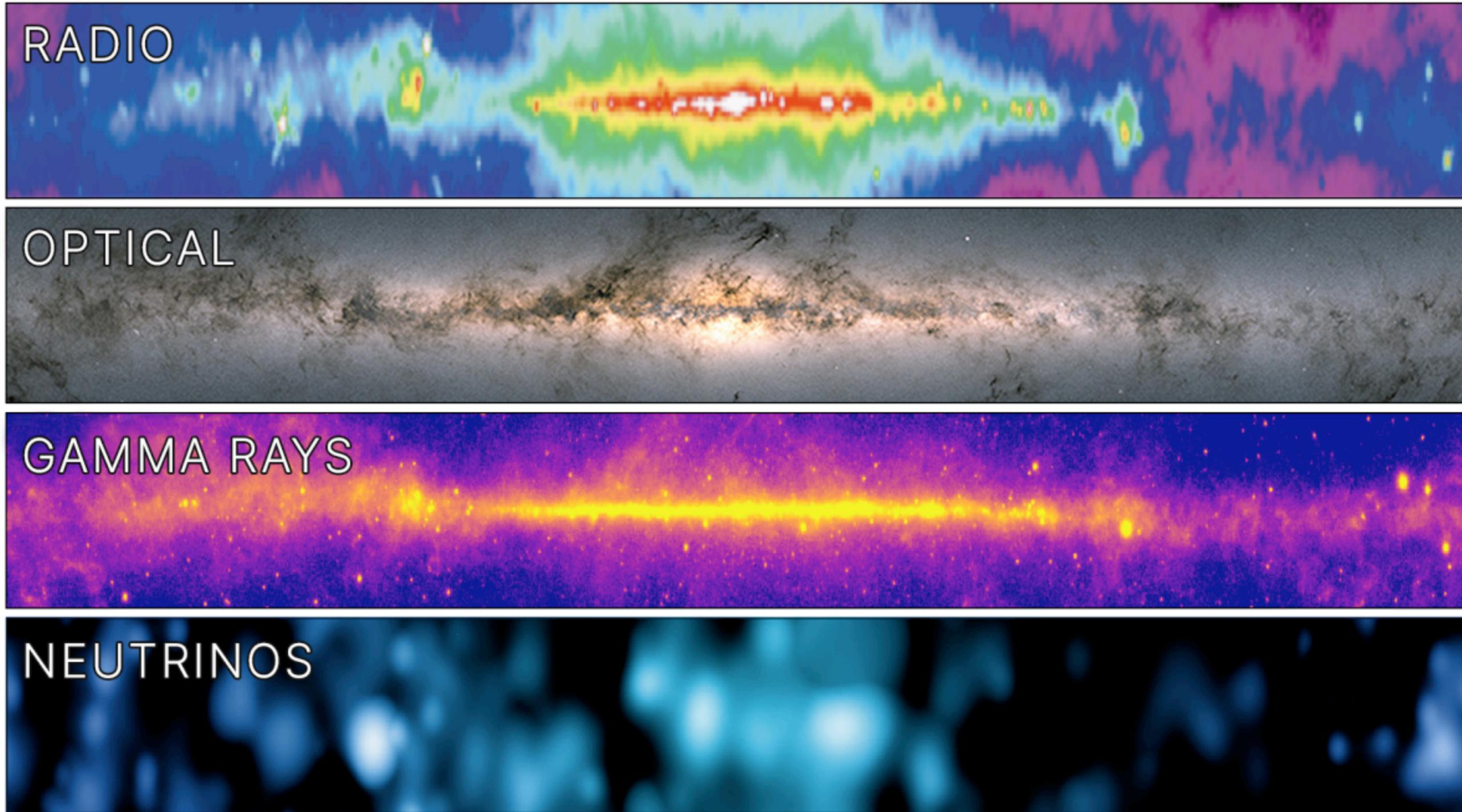
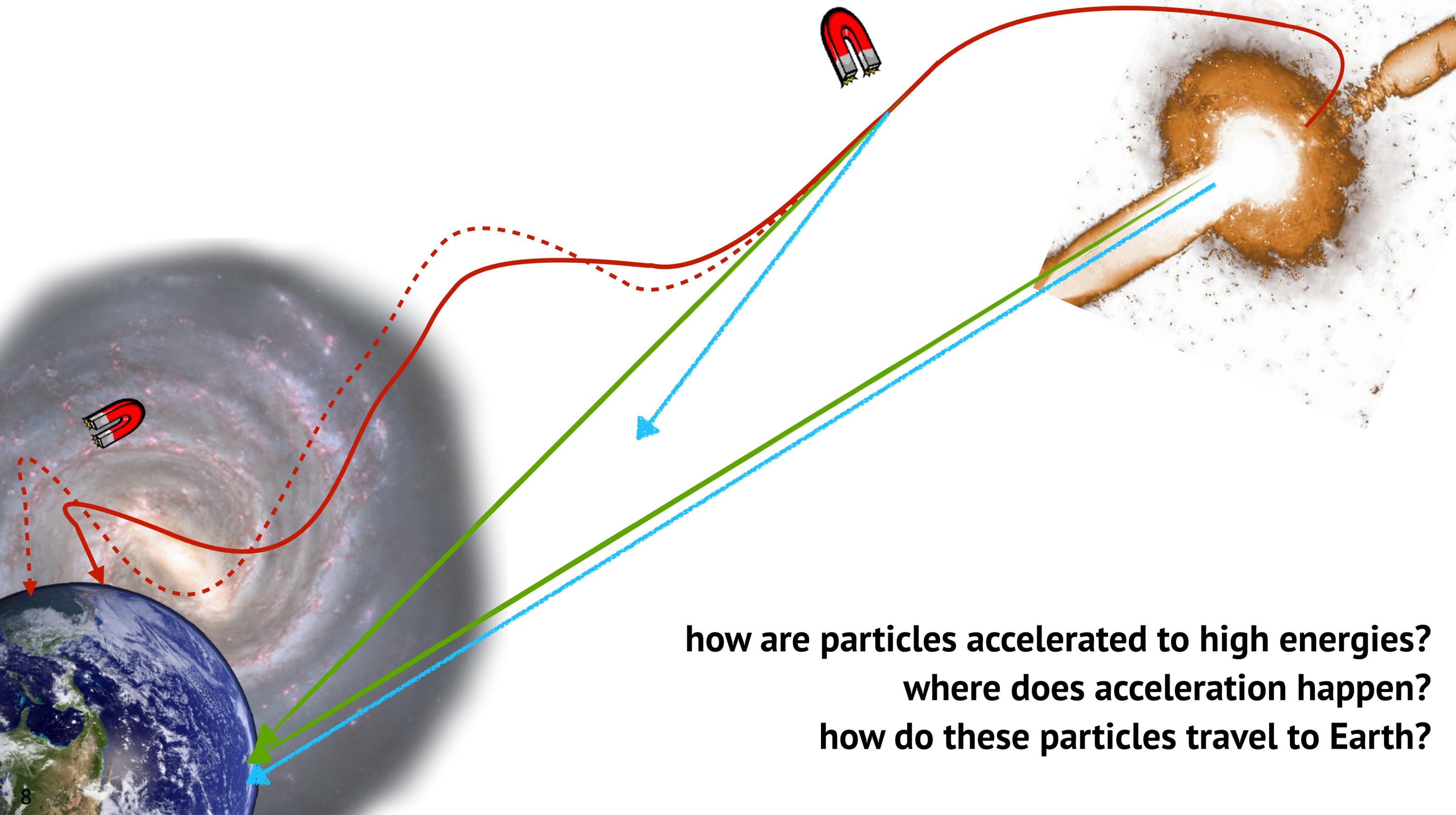


image by IceCube Collaboration

what is this course about?



**how are particles accelerated to high energies?
where does acceleration happen?
how do these particles travel to Earth?**

▶ references

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- ◆ G. Sigl. "Astroparticle Physics: theory and phenomenology". Springer, 2017.
- ◆ A. Shalchi. "Nonlinear Cosmic Ray Diffusion Theories". Springer, 2009.
- ◆ G. Fleishman and I. Toptygin. "Cosmic Electrodynamics". Springer, 2013.
- ◆ T. Gaisser et al. "Cosmic Rays and Particle Physics". Cambridge Uni. Press, 2016.

particle acceleration

▶ top-down models

- ◆ cosmic strings
- ◆ topological defects
- ◆ super-heavy dark matter
- ◆ Z-bursts
- ◆ other exotic mechanisms

▶ bottom-up models

- ◆ electromagnetic acceleration
- ◆ gravitational acceleration

Fermi 2nd order: stochastic shock acceleration

PHYSICAL REVIEW

VOLUME 75, NUMBER 8

APRIL 15, 1949

On the Origin of the Cosmic Radiation

ENRICO FERMI

Institute for Nuclear Studies, University of Chicago, Chicago, Illinois

(Received January 3, 1949)

A theory of the origin of cosmic radiation is proposed according to which cosmic rays are originated and accelerated primarily in the interstellar space of the galaxy by collisions against moving magnetic fields. One of the features of the theory is that it yields naturally an inverse power law for the spectral distribution of the cosmic rays. The chief difficulty is that it fails to explain in a straightforward way the heavy nuclei observed in the primary radiation.