Introduction to astroparticle physics

Part 2, Exercises 6

May 30, 2025

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1 Astronomy with protons

What is the minimum energy of a proton ($E_{\min}$) coming from a source located at $d = 2$ kpc from the Earth we can detect as "pointing" to the source? The mean strength of the magnetic field in the Milky Way is $B = 1$ µG. Assume that the magnetic field is uniform and the proton travels through it perpendicular to the field lines.

2 Crypton flux

Cryptons are superheavy particles hypothesized within string theories. They were proposed as possible dark-matter particles. They could also be responsible for the high-energy cosmic-ray events observed beyond the Greisen–Zatsepin–Kuzmin cutoff. They are supposed to have a sufficiently long lifetime to still exist. Determine the flux of cryptons if they were responsible for the 11 cosmic-ray events with energies $\geq 10^{20}$ eV observed with the AGASA experiment. The AGASA extensive air shower experiment was situated at an altitude of approximately 900 m, covering an area of around 100 km^2 and was operational for 14 years. The cross section of the interaction crypton-atmospheric nucleon is about 10^{-8} pb.

AGASA experiment: http://www-akeno.icrr.u-tokyo.ac.jp/AGASA/

AGASA events $\geq 10^{20}$ eV : http://www-akeno.icrr.u-tokyo.ac.jp/AGASA/results.html#highest/

3 The Glashow resonance

Show that the neutrino energy of the Glashow resonance process is 6.3 PeV.