Review: Cosmic Gamma Rays Around 70 MeV. DIRACs

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1. Introduction

Gamma rays in the ~70 MeV energy range occupy a unique position in astrophysics. This regime sits at the threshold where particle-physics processes such as neutral pion π^0 decay imprint a distinct signature, and where both Galactic and extragalactic cosmic-ray interactions manifest in the diffuse gamma-ray background. Understanding emission in this range is essential for probing the origin and propagation of cosmic rays, the environments of energetic astrophysical sources, and the large-scale structure of the high-energy Universe.

2. Observational Foundations & Theoretical Context

2.1 EGRET and the Compton Gamma Ray Observatory

The **Energetic Gamma Ray Experiment Telescope (EGRET)**, aboard NASA's Compton Gamma Ray Observatory (1991–2000), provided the first high-resolution, all-sky surveys in the **30 MeV–30 GeV** range, directly covering the 70 MeV band. EGRET detected hundreds of discrete sources, as well as a pervasive **diffuse Galactic emission** component. Analysis revealed a strong correlation of the low-energy gamma-ray sky with interstellar gas density, supporting the idea of cosmic-ray interactions as the dominant emission mechanism in this regime.

2.2 Neutral Pion Decay and the 70 MeV "Bump"

One of the most robust signatures in the ~70 MeV range is the **π^0-decay feature**. When cosmic-ray protons collide with interstellar matter, they produce neutral pions, which promptly decay into two gamma photons. This decay produces a spectral "bump" peaking near **70 MeV** in the photon energy distribution. Detecting this bump in Galactic and extragalactic sources provides **direct evidence of hadronic cosmic-ray interactions**. Theoretical work predicts this signature should be visible in regions with high cosmic-ray densities—such as supernova remnants, molecular clouds, and starburst galaxies. Observations of this feature have been cited as strong support for the **supernova origin of cosmic rays**. It decaying after $\sim 10^{-16}\ s$ into gamma rays.

2.3 Diffuse Gamma-Ray Background

The **cosmic gamma-ray background** in the MeV–GeV regime is a blend of Galactic foreground emission and truly extragalactic sources. The Galactic component arises mainly from π^0 decay, inverse Compton scattering of cosmic-ray electrons, and bremsstrahlung. Extragalactic emission may come from unresolved blazars, star-forming galaxies, and other active galaxies. In the 70 MeV band, the balance between π^0 decay and leptonic processes remains a focus of modeling work.

2.4 Future Missions and Instrumentation

Current instruments such as **Fermi-LAT** are optimized for >100 MeV energies and have relatively modest sensitivity near 70 MeV. Future MeV–GeV missions—**e-ASTROGAM**, **AMEGO**, and related designs—aim to bridge the "MeV gap" with improved angular resolution and sensitivity between **0.2 MeV and several hundred MeV**. These instruments could map the π^0-decay bump across the Milky Way, resolve faint point sources, and measure extragalactic backgrounds with unprecedented precision.

3. Universe-Created Particles DIRAC 70 MeV [1]

S. D. Hunter, *et al.* discuss a peak at 67.5 MeV: *Below about 100 MeV, gamma rays produced via electron bremsstrahlung are the dominant component of the observed spectrum, whereas, above about 100 MeV, the gamma-rays from π^0 decay, which form the broad "pion bump" centered at 67.5 MeV, are the dominant component of the spectrum. The "pion bump ", clearly visible in this spectrum, is the only spectral feature in the diffuse gamma ray emission in the EGRET energy range* [2].

70 MeV peak in EGRET data was discussed by Golubkov and Khlopov [3]. They explained this peak by the decay of π^0-mesons, produced in nuclear reactions. B. Wolfe, *et al.* said that gamma rays at 70 MeV are notably detectable by GLAST and EGRET [4]. R. Yamazaki, *et al.* attribute the 70 MeV peak in the emission spectrum from an old supernova remnant (SNR) to π^0-decay [5], [6].

Note that whenever the 70 MeV peak appears in gamma-ray spectra, it is always attributed to pion decay. We claim that π^0 (135 MeV) decay produces a 67.5 MeV peak, while DIRAC self-annihilation is responsible for 70 MeV peak. To find out the source of the observed broad peak about 70 MeV, we suggest utilization of exponentially cutoff power-law for analysis of experimental data for gamma-ray energies < 70 MeV. A better fit of experimental data will be evidence of DIRACs self-annihilation.

We stress that in frames of World-Universe Cosmology, DIRACs are responsible for Magnetism [7].

4. Conclusions

The 70 MeV gamma-ray regime is a **diagnostic sweet spot** for high-energy astrophysics, especially for identifying hadronic processes in cosmic-ray interactions. EGRET provided the first detailed measurements in this energy range, confirming the presence of diffuse emission and setting the stage for modern theoretical frameworks. The neutral pion decay bump—centered near 70 MeV—is a key target for both observational and theoretical studies, offering a direct probe of cosmic-ray acceleration and distribution in the Universe. The next generation of MeV–GeV missions promises to resolve long-standing questions about the relative roles of hadronic and leptonic processes, and to deepen our understanding of the astrophysical environments that produce the most energetic particles in nature.

This short review highlights the principal role of DIRACs in various astrophysical phenomena. In my view, the self-annihilation of DIRACs offers a far more probable explanation than existing models. I first conceived of DIRAC particles in 2013, primarily to account for the 70 MeV "bump" [8].

References

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