Title:

Cherenkov Radiation from Quantum Vacuum around Pulsars

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Abstract:

Cherenkov radiation from the quantum vacuum (CRQV) is predicted by quantum electrodynamics (QED) when ultra-relativistic particles travel through a polarized vacuum in the presence of strong electromagnetic fields. While classical radiative processes, such as synchrotron, curvature, and inverse Compton scattering, remain important across various astrophysical environments, ultra-strong magnetic fields, as found in pulsars, can create unique conditions where CRQV can emerge as a significant contributor to high-energy emissions. We present preliminary estimates based on the unipolar model of pulsars, which indicate that CRQV becomes increasingly significant in the X-ray band for higher magnetic fields (in pulsars with surface magnetic field close to or greater than $B_c = 4.41 \times 10^{13}$ Gauss) and in the gamma ray band for lower magnetic fields (in millisecond pulsars that have a relatively lower surface magnetic field, around $B \approx 10^8$ Gauss). This study highlights the relevance of CRQV in understanding the high-energy emissions of neutron stars, ranging from magnetars to millisecond pulsars.