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hedla@tecnico.ulisboa.pt

Coherent emission from QED cascades in pulsar polar caps

F. Cruz[1,2,†], T. Grismayer[1], A. Y. Chen[3], A. Spitkovsky[4], L. O. Silva[1]

[1] *GoLP/Instituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico, Universidade de Lisboa, 1049-001 Lisboa, Portugal*
[2] *Inductiva Research Labs*
[3] *JILA, University of Colorado Boulder, 440 UCB, Boulder, CO 80309, USA*
[4] *Department of Astrophysical Sciences, Princeton University, Princeton, NJ 08544, USA*

[†] fabio.cruz@tecnico.ulisboa.pt

Pulsar magnetospheres are thought to be filled with electron-positron plasma generated in pair cascades. The driving mechanism of these cascades is the emission of gamma-ray photons and their conversion into pairs via Quantum Electrodynamics (QED) processes [1, 2]. In this work, we present 2D particle-in-cell simulations of pair cascades in pulsar polar caps with realistic magnetic field geometry that include the relevant QED processes from first principles. Our results show that, due to variation of magnetic field curvature across the polar cap, pair production bursts self-consistently develop an inclination with respect to the local magnetic field that favors the generation of coherent electromagnetic modes [3] with properties consistent with pulsar radio emission [4]. We show that this emission is peaked along the magnetic axis and close to the polar cap edge and may thus offer an explanation for the core and conal components of pulsar radio emission.

References

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