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Identifying axion conversion in compact star magnetospheres with radio-wave polarization signatures

Axion is well-motivated in physics. It solves the strong CP problem in fundamental physics and the dark matter problem in astronomy. Its interaction with electromagnetic field has been expected but never detected experimentally. Such particles may convert to radio waves in the environment with strong magnetic field. Inspired by the idea, various research groups have been working on theoretical modeling and radio data analysis to search for the signature of radio signal generated by the axion conversion in the magnetosphere of compact stars, where the surface magnetic field as strong as 1e13 to 1e14 G is expected. In this work we calculate the observational properties of the axion-induced radio signals (AIRSs) in the neutron star magnetosphere, where both the total intensity and polarization properties of radio emission are derived. Based on the ray tracing method, assuming 100% linear polarization of radio wave generated in each conversion, we compute the polarization emission profile concerning different viewing angles. We note that plasma and general relativistic effects are important for the polarization properties of AIRS. Our work suggests that AIRS can be identified by the narrow bandwidth and distinct polarization features.

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