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Hunting Galactic Axion Dark Matter with Gravitationally Lensed Fast Radio Bursts

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Ultralight axion or axionlike particles are one of the most promising candidates for dark matter because they are a well-motivated solution for the theoretical strong CP problem and observational issues on small scales, i.e. the core-cusp problem and the satellite problem. A tiny coupling of axions and photons induces birefringence. We propose the differential birefringence measurements of multiple images of gravitationally lensed fast radio burst (FRB) systems as probes of the Galactic axion dark matter (ADM) background. In addition to general advantages of lensing systems, i.e. alleviating systematics and intrinsic astrophysical dependencies, precise measurements of lensing time delay and polarization angle in gravitationally lensed FRB systems make them a more robust and powerful probe. We show that, with a single lensed FRB system (which may be detected in large numbers in the SKA era), the axion-photon coupling under the ADM background could be constrained to be $g_{a\gamma} < 7.3 \times 10^{-11}\ \mathrm{GeV}^{-1}$ for an axion mass $m_a \sim 10^{-20}\ \mathrm{eV}$. This will be of great significance in achieving synergistic searches of the Galactic ADM with other astrophysical probes and laboratorial experiments.

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