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Searching for axion dark matter with tuneable plasma haloscopes

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We propose a new strategy to search for dark matter axions using tunable cryogenic plasmas. Unlike current experiments, which repair the mismatch between axion and photon masses via breaking translational invariance (cavity and dielectric haloscopes), a plasma haloscope enables resonant conversion by matching the axion mass to a plasma frequency. A key advantage is that the plasma frequency is unrelated to the physical size of the device, allowing large conversion volumes. We identify wire metamaterials as a promising candidate plasma, wherein the plasma frequency can be tuned by varying the interwire spacing. For realistic experimental sizes we estimate competitive sensitivity for axion masses $35 - 400\,\mu$eV.

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