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A Way of Axion Detection with Mass 10^(−4)eV ~ 10^(−3)eV using Cylinder with Low Electric Conductivity

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A dark matter axion with mass ma induces an oscillating electric field in a cylindrical sample placed under a magnetic field B parallel to the cylinder axis. When the cylinder is made of a highly conductive material, the induced oscillating current primarily dissipates the axion energy at the surface. In contrast, if the cylinder is composed of a material with low conductivity, e.g. σ = 10^(−3)eV, the axion energy is dissipated mainly inside the bulk of the cylinder. Within the QCD axion model, the dissipated power P is estimated as P ≅2.8×10^(-28)W g^2 (L/100cm) (10^(−4)eV/ma)(B/10T)^2
(ρa/0.3GeV cm^(−3))(yx^2/(ϵ^2 +y^2)), with parameters y ≡ σ/ma = 10, x ≡ maR ≅ 10, axion mass ma, radius R = 2cm, length L = 100cm, electric permittivity ϵ = 10 and axion energy density ρa. For the coupling constants, we take g(KSVZ) = −0.96 and g(DFSZ) = 0.37. Using an LC circuit tuned to a quality factor Q = 10^6, the signal-to-noise ratio is given by P(Q sqrt(δω tob/2π)/Pt ≅ 10 g^2(ma/10^(−4)eV)^(−3/2) (T/100mK)^(−1)sqrt(tob/60s), where Pt is the thermal noise power at temperature T = 100mK and bandwidth δω = 10^(−6)ma. By choosing appropriate values of conductivity and cylinder radius for example, σ/ma = 10 and ma R ≥ 10, the detection of dark matter axions is feasible in the mass range ma = 10^(−4)eV ~ 10^(−3)eV

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