Dielectric Haloscope Simulation And The Quest For Dark Matter Axions

Xiaoyue Li[1], Olaf Reimann[1], Chang Lee[1], Derek Strom[1]

[1]Max-Planck-Institut für Physik, München, Germany

Abstract

The nature of dark matter remains one of the most pressing puzzles in physics. The MAgnetized Disc and Mirror Axion eXperiment (MADMAX) is a dielectric haloscope dedicated to the search for QCD axion dark matter in the mass range of 40 - 400 µeV. The design of the experiment consists of a metal mirror and 80 dielectric discs of 1 mm in thickness and ~1 m in diameter placed inside a 9 T dipole magnet; the microwave signal generated by the axion-to-photon conversion is detected by an antenna and RF receiver. This study focuses on a scaled-down setup with 3 sapphire discs of 96 mm in diameter place inside a metal waveguide. The COMSOL Multiphysics® RF Module is used to simulate the electromagnetic response as well as the axion-induced signal. Most notably the external current density is used to account for the modified Maxwell equations in the existence of axion-photon coupling. Moreover, the 2D Axisymmetry configuration has been used to greatly speed up the calculation. The results from the simulation study will be compared with lab measurements to further our understanding of the dielectric haloscope.