Relic Axion Search via RF Cavity

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Axions

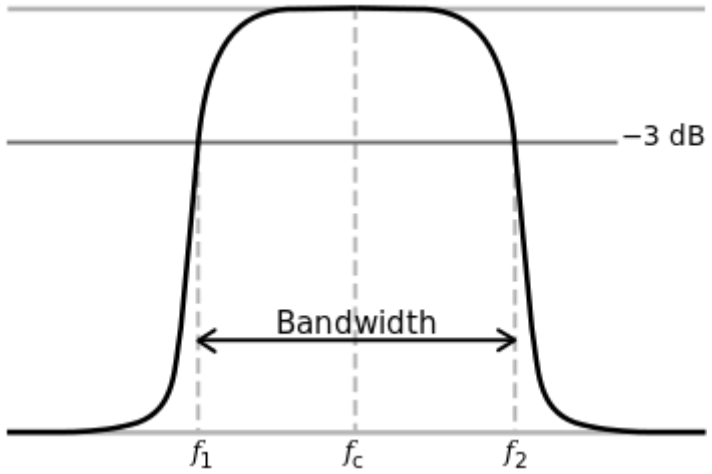
- Axions and Axion Like Particles (ALPs) are proposed Dark Matter (DM) candidates
- Expect mass of 1-100 μeV
- Relic vs. Solar Axions

Methodology

- Based on the coupling of ALPs to two photons:
  - $-\frac{1}{4} g_{a\gamma\gamma} \phi_{ALP} F^{\mu\nu} \tilde{F}_{\mu\nu} = g_{a\gamma\gamma} \phi_{ALP} \mathbf{E} \cdot \mathbf{B}$
- In the presence of strong magnetic fields, axions can produce two photons
- Detect these photons with a microwave cavity

Microwave Cavity

- Resonant Frequency determined by the dimensions of the cavity
- Precision of frequency peak based on quality (Q) factor of the material
  - Not unusual to have very large Q's ~10^4



Cavities Cont.

- Photons with the resonant frequency of the cavity will be excited
- Can measure the power output from the cavity via antenna

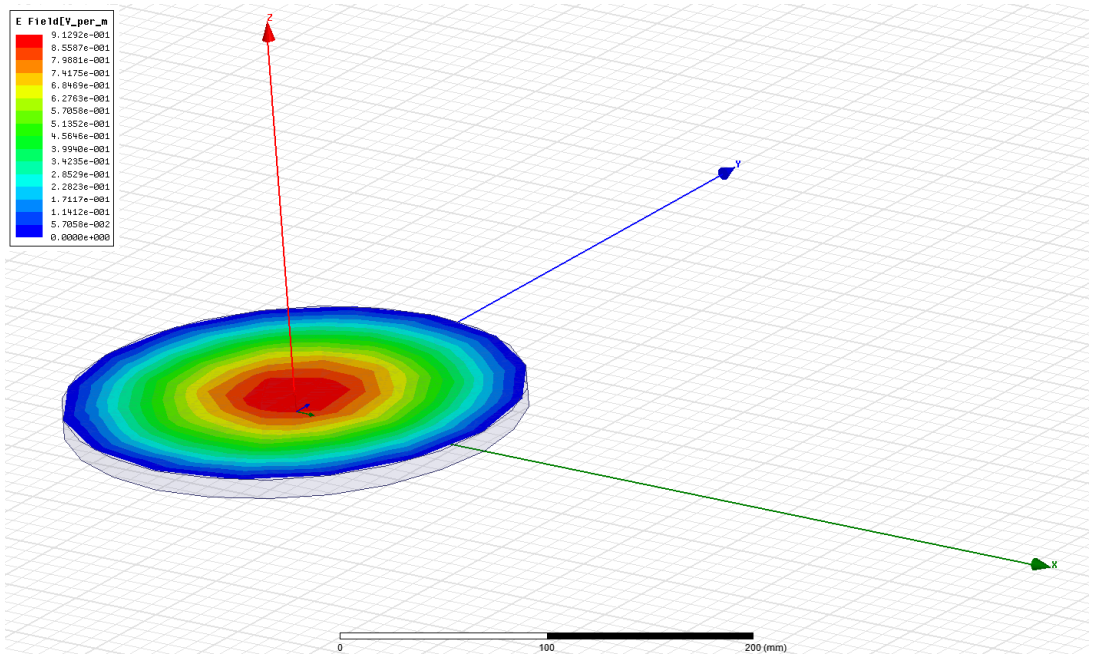
Problems

- 1-100 μeV corresponds to a frequency range of .2-20 GHz
- Simple cylindrical cavity for this range has a range of radii 500-5mm
- Too small cavities have too low sensitivity, too large can’t be placed into apparatus

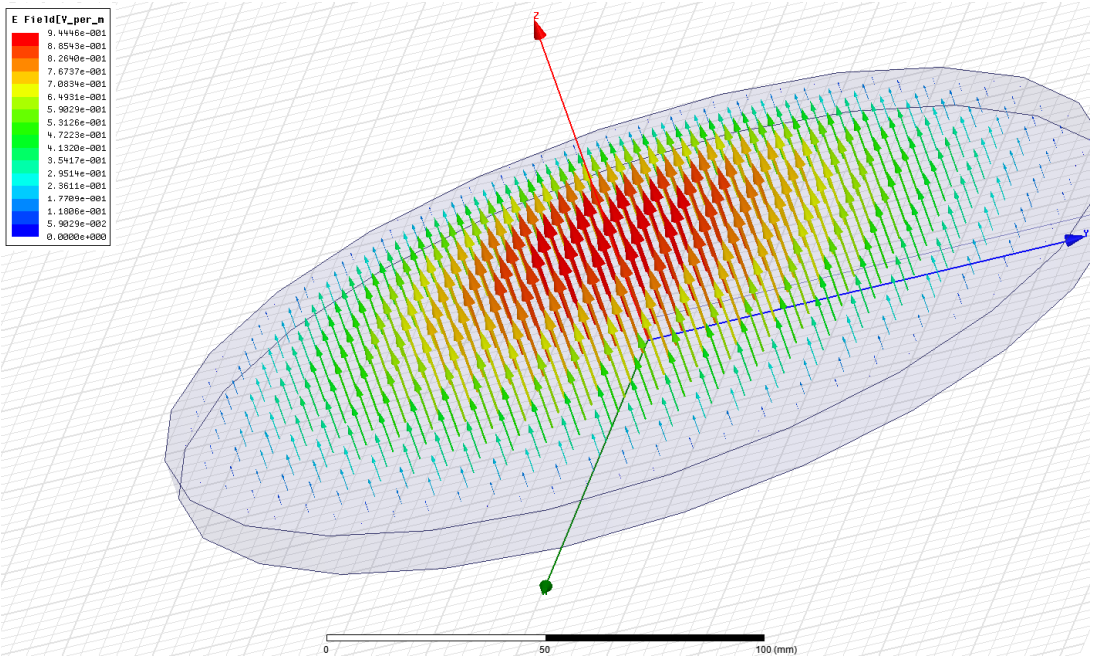
My Work

- Using HFSS, an EM wave solver, simulate fields for various geometries
- Try to maximize coupling sensitivity at the target frequencies
- Couple resonators together or use higher mode frequencies
  - Zeroes of the Besel function

E-field magnitude



E-field vector



E-field as a function of distance from the center of the cylinder