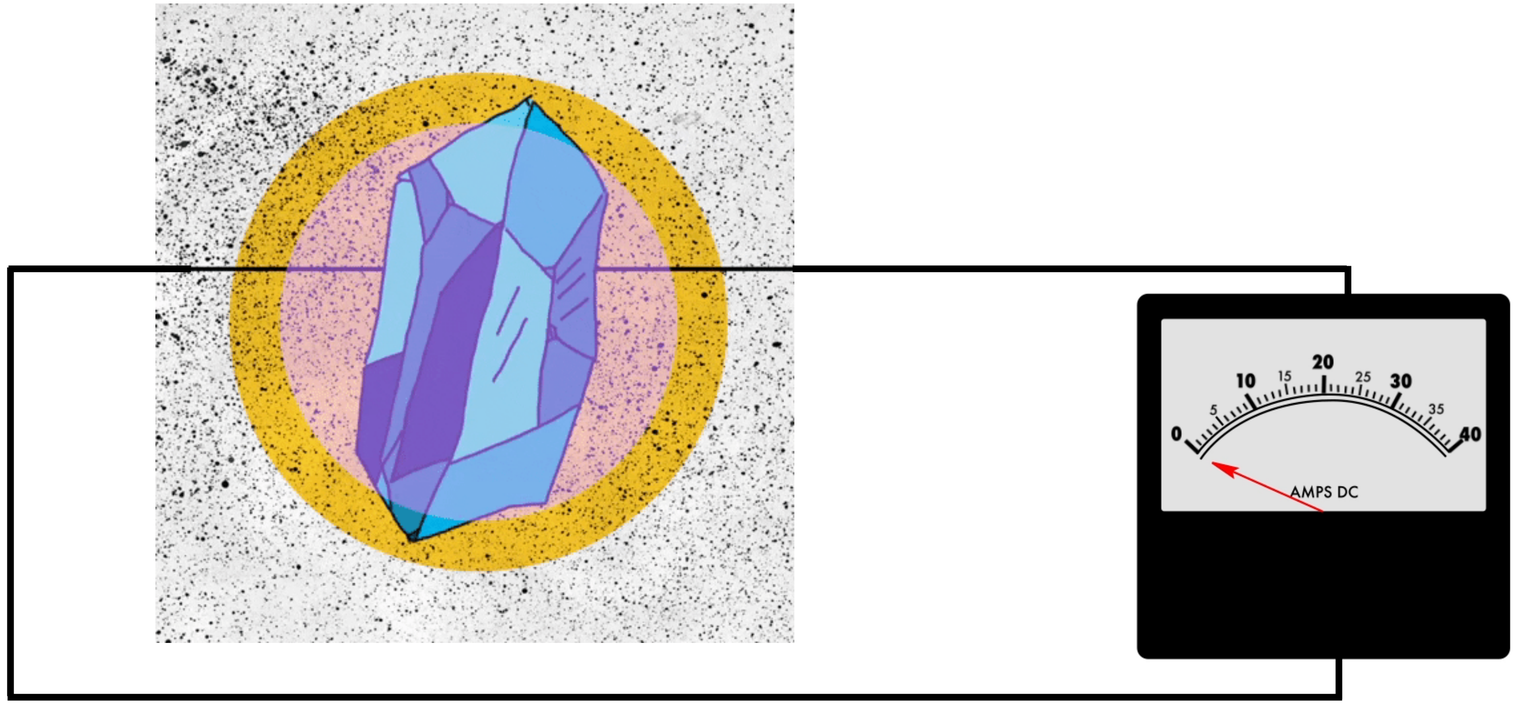
The Piezoaxionic Effect



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Based on arxiv: 2112.11466 with Asimina Arvanitaki and Ken Van Tilburg

The QCD Axion: Motivation

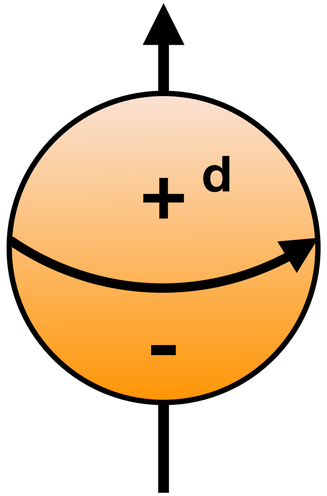
- **Strong CP Problem**

  $$\mathscr{L} \supset \frac{\theta_{QCD}}{32\pi^2} \operatorname{tr} G\tilde{G}$$

  Neutron Electric Dipole Moment ~ $e\,fm\,\theta_{QCD}$

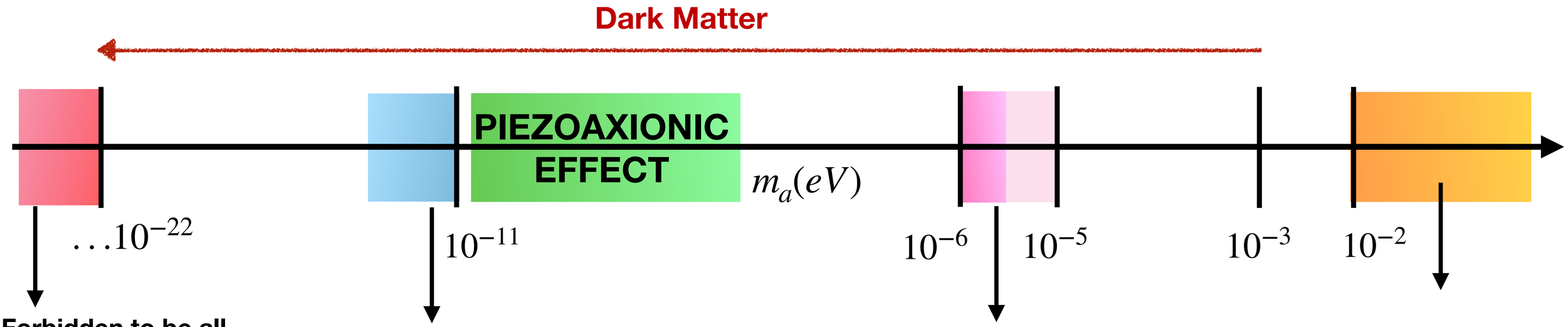
  Experimental bound: $\theta_{QCD} < 10^{-10}$

  Solution: θ_{QCD} is a dynamical field, an axion



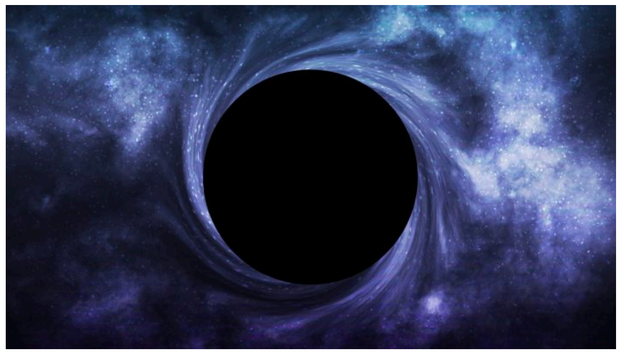
- **Cold Dark matter candidate**
  Can be produced in early universe via “misalignment mechanism”.

QCD Axion Parameter Space

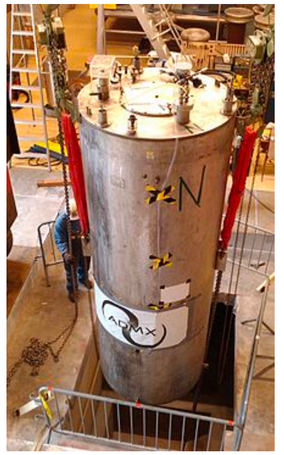


Forbidden to be all of DM as λ no longer fits in dwarf galaxies

Black Hole Superradiance



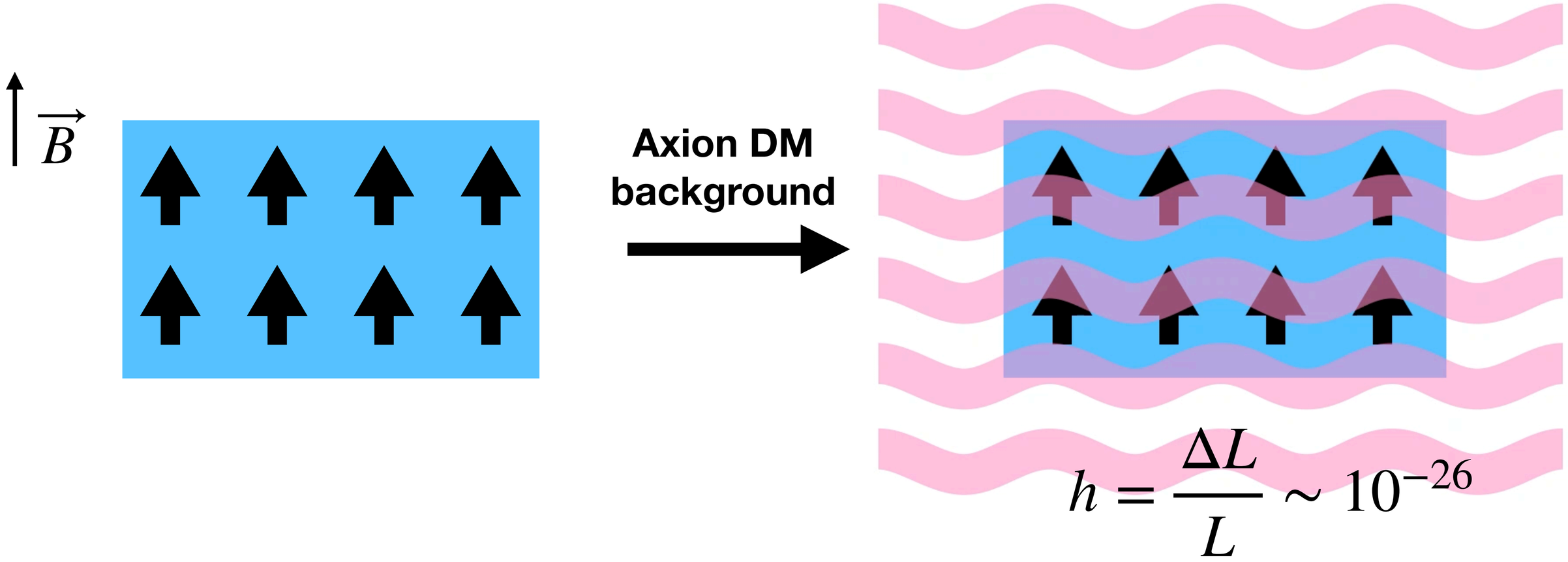
Microwave Cavity Experiments (ADMX)



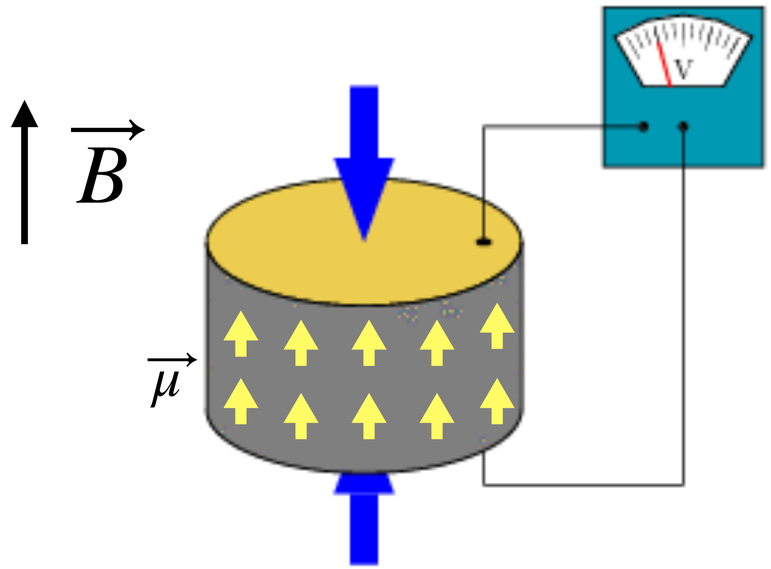
Astrophysical Constraints

Piezoaxionic effect - a preview

$$\mathscr{L} \supset \frac{\alpha_s}{8\pi}\frac{a}{f_a}G\tilde{G}$$

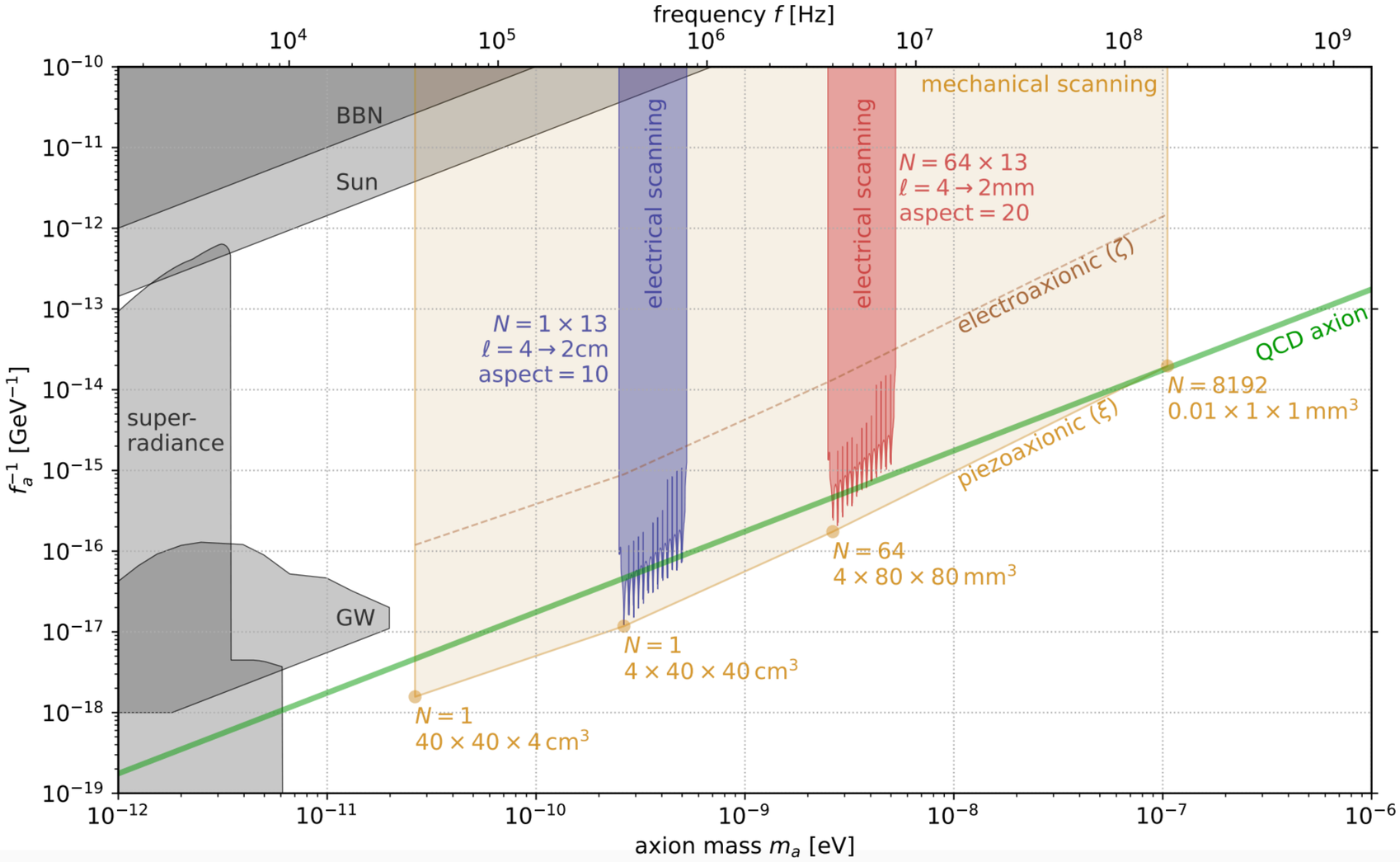


Prposed Experimental Setup



1. Find a piezoelectric material with low mechanical noise
2. Align nuclear spins using a magnetic field
3. Cool to $\sim 1\,mK$ to reduce thermal noise
4. Control backgrounds (mainly magnetic)
5. Oscillating voltage across piezo generates a tiny current, measured using a SQUID.

Idealized Forecast



$$m_a \sim 6 \times 10^{-11} eV \left(\frac{10^{17} GeV}{f_a} \right)$$