Experimental Searches for Axions

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Abstract

Satisfying the Strong CP Problem as well as proposed to make up a large percentage of the currently-unknown dark matter, axions are hypothetical particles with no spin, no charge, and mass of 10^{-6} to 10^{-3} eV. With these properties, they interact very little with the fields and ordinary matter, making them extremely hard to detect. Currently, the designs of mechanisms to produce and detect axions are based on the axion-photon interaction—that when placed in a strong magnetic field, axions decouple into two photons (one may be imaginary).

The Axion Dark Matter Experiment (ADMX) group at LLNL has conceived and built a model that would allow the detection of axions indirectly through the decoupling into the photons, using heterojunction field-effect transistor (HFET) first as the amplifier to listen to axion-photon conversion, and is in progress to upgrade to superconducting quantum interference device (SQUID).

In pure laboratory experiments, two concepts have been developed to create axions: photon regeneration and changes in polarization state of light in a magnetic field. In photon regeneration, a laser beam is shone through a magnetic field, effectively converting some into axions, which would traverse through the wall (since it interacts very little with matter), then be converted back to photons by a second magnetic field. The second method is to detect changes in polarizations light as photons travel through a magnetic field, since photons polarized perpendicularly to the magnetic field do not get affected, while those polarized parallel to the field would have some photons coupled to axions, creating a difference in the angle of polarization between the initial and the final polarizations.

Keywords: ADMX, axion, charge-parity violation, dark matter, heterojunction field-effect transistor (HFET), photon regeneration, superconducting quantum interference device (SQUID)

References

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