The Twisted Anyon Cavity Resonator as a Potential Dark Matter Detector and Sensing Device

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The minimum axion mass detectable by existing photonic dark matter searches is set by the detector's frequency and hence size, which places the lower limit around 10^{-7}eV [1], leaving the ultra-light dark matter (ULDM) parameter space relatively unexplored. In this work, a new class of electromagnetic resonator is described; the Anyon Cavity Resonator (see Fig. 1), which has the potential to couple to ULDM axions. This is possible due to the existence of a single electromagnetic mode with non-zero helicity, which is generated in vacuo through a pure photonic magneto-electric coupling of a transverse electric (TE) and transverse magnetic (TM) mode [2]. The resonator is based on twisted hollow structures that possess mirror-asymmetry. The origin of these high helicity modes is demonstrated using finite element simulation. It is predicted that these cavities will have the capability to search for dark matter down to 10^{-24} eV with a minimum coupling strength of $10^{-15.8}$ GeV^{-1} [2]; covering a completely unexplored region of parameter space. Further, the generation of a topologically protected Berry phase is successfully measured in Möbius cavities, which are formed by bending the aforementioned twisted hollow structures around on themselves to form a ring.

Fig.1. 3D printed twisted triangular waveguide

References

[1] CA Thomson et al., Phys. Rev. Lett., **126** (8), 081803, 2021.
[2] JF Bourhill et al., arXiv:2208.01640, 2022.