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Dark Matter Searches on a Photonic Chip

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Dark matter (DM) with masses of order an electronvolt or below can have a non-zero coupling to electromagnetism. In these models, the ambient DM behaves as a new classical source in Maxwell's equations, which can excite potentially detectable electromagnetic (EM) fields in the laboratory. We describe a new proposal for using integrated photonics to search for such DM candidates with masses in the 0.1 eV - few eV range. This approach offers a wide range of wavelength-scale devices like resonators and waveguides that can enable a novel and exciting experimental program. In particular, we show how refractive index-modulated resonators, such as grooved or periodically-poled microrings, or patterned slabs, support EM modes with efficient coupling to DM. When excited by the DM, these modes are read out by coupling the resonators to a waveguide that terminates on a micron-scale-sized single photon detector, such as a single pixel of an ultra-quiet charge-coupled device or a superconducting nanowire. We then estimate the sensitivity of this experimental concept in the context of axion-like particle and dark photon models of DM, showing that the scaling and confinement advantages of nanophotonics may enable exploration of new DM parameter space.

Mini Symposia (Invited Talks Only)

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