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Electron Trap as a Dark-Photon Detector

Dark photon dark matter in the milli-eV mass range is notoriously difficult to detect, being too high in frequency for high-Q cavity resonators yet below the energy threshold of single-photon detectors. I will present a new method that overcomes this difficulty, based on recent work (arXiv:2208.06519) with Peter Graham and Gerald Gabrielse et al. We propose to use trapped electrons as high-Q resonators to detect dark photon dark matter. Initially cooled to its cyclotron ground state, the trapped electron's first excited state can be resonantly driven if the cyclotron frequency matches the dark photon mass. A proof-of-principle measurement demonstrates that the method is background free over a 7.4-day search, setting a limit on dark photon dark matter at 148 GHz (0.6 meV), which is around 75 times better than previous constraints. Dark photon dark matter in the 0.1–1 meV mass range (20–200 GHz) could likely be detected at a similar sensitivity in an apparatus designed for dark photon detection.

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