

First Scan Search for Dark Photon Dark Matter with a Tunable Superconducting Radio-Frequency Cavity

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Dark photons have emerged as promising candidates for dark matter, and their search is a top priority in particle physics, astrophysics, and cosmology. We report the first use of a tunable niobium superconducting radio-frequency cavity for a scan search of dark photon dark matter with innovative data analysis techniques. We mechanically adjusted the resonant frequency of a cavity submerged in liquid helium at a temperature of 2 K, and scanned the dark photon mass over a frequency range of 1.37 MHz centered at 1.3 GHz. Our study leveraged the superconducting radio-frequency cavity's remarkably high quality factors of approximately 1010, resulting in the most stringent constraints to date on a substantial portion of the exclusion parameter space on the kinetic mixing coefficient ϵ between dark photons and electromagnetic photons, yielding a value of $\epsilon < 2.2 \times 10^{-16}$.

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