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DOSUE-RR Experiment: The First Direct Search for Dark Photon Dark Matter at 1 meV Mass

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Dark photon is one of the candidates for cold dark matter, predicted by specific models of string theories and high-scale inflation models. Dark photons interact with ordinary photons via the coupling constant χ . Owing to this interaction, the dark photons convert into millimeter-wave light at electromagnetic boundaries, such as the surface of a metal plate. The frequency of the conversion photon corresponds to the mass of the dark photon because of energy conservation ($h\nu \simeq mc^2$). For example, a signal at 240 GHz corresponds to the mass of 1 meV.

To detect the conversion light from the dark photon in various frequency bands, we, the DOSUE-RR collaboration, have developed cryogenic millimeter-wave receivers. We have already searched for conversion photons in the 10–26.5 GHz range. Since there is still an unexplored range around $O(100 \text{ GHz})$, we are focusing on the frequency range of 170–260 GHz as the next target.

As a pilot experiment for the high frequency range, we developed a cryogenic receiver equipped with a Superconductor-Insulator-Superconductor (SIS) mixer to achieve low noise (around 150 K). We then searched for dark photons with a mass at 1 meV, corresponding to the frequency range 242.9493–242.9503 GHz. In this workshop, we will present our results of the pilot experiment and future plans to cover the full range of 170–260 GHz.

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