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Searching for dark photons using a multilayer dielectric haloscope

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We have overwhelming evidence that 85% of the matter content in the Universe is composed of dark matter (DM), some new kind of beyond-the-Standard-Model particle that has yet to be detected. Probing the nature of DM is recognised as one of the most pressing scientific pursuits worldwide.

Since DM candidates span about 45 orders of magnitude in mass, from ultra-light bosons to massive primordial black holes, discovery can come from anywhere. While WIMPs become less motivated, with large experiments ruling out the traditionally favoured parameter space, dark photons (DP) are receiving increasing attention among the alternative DM models. The DP arises naturally in extensions of the Standard Model by theorising the existence of an extra U(1) symmetry coupled to the U(1) gauge group of electromagnetism via kinetic mixing.

I am one of the few developers of a new type of detector to search for DPs called "dielectric haloscope,"having built one of the only two in operation anywhere in the world. Dielectric haloscopes consist of thin dielectric layers with alternating high and low refractive indices and can convert DP into SM photons, thus making them detectable. I have developed and run a SiO_2/Si_3N_4 dielectric haloscope coupled with a single-photon avalanche diode operated in Geiger-mode. As no excess of events was observed in the data, the method of maximum log-likelihood was used to set exclusion limits at 90% confidence level on the kinetic mixing coupling constant between dark photons and ordinary photons. This prototype experiment, baptised MuDHI (Multilayer Dielectric Haloscope Investigation), has been designed, developed and run at the Astroparticle Laboratory of New York University Abu Dhabi, which marks the first time a dark matter experiment has been operated in the Middle East.

Collaboration

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