Search for dark photons using CRESST-II data

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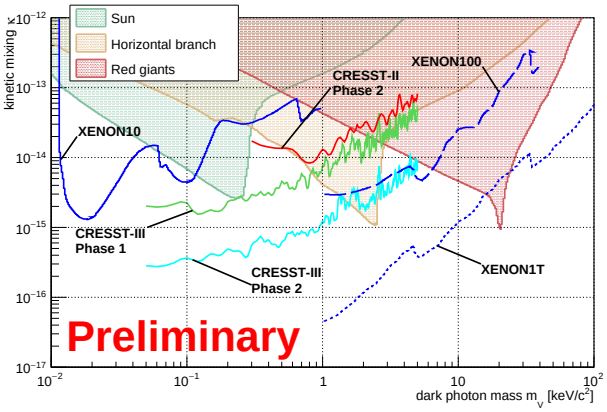
Hints for the existence of cold dark matter can be found on several different length and energy scales [1]. Although its fraction of the energy density of the universe is known precisely [2], the nature and origin of dark matter remains unclear.

The direct dark matter search CRESST-II [3] is optimized for observation of dark matter particles interacting with nuclei inside calcium tungstate ($CaWO_4$) based detectors. The simultaneous measurement of the heat signal and the scintillation light generated by a particle interacting with the $CaWO_4$ crystals allows an efficient rejection of dominant electron-recoil backgrounds (e.g., betas, gammas).

However, there are also many models predicting dark-matter particles interacting mainly with electrons. One of these models deals with so-called dark photons, i.e., long-lived vector states with masses from $\mathcal{O}$(eV) to $\mathcal{O}$(100 keV) [4, 5]. Dark photons interact with standard-model particles via a kinetic mixing κ to standard-model photons. Thus, for dark photons interacting with electrons the efficient background rejection of CRESST detectors can not be applied. Due to the low velocities of dark photons, the expected signal is a peak at the energy corresponding to the dark-photon mass.



To search for dark photons we performed a peak search on the data obtained by the detector module with the best energy threshold of ~ 0.3 keV. We fitted an empirical background model including known x-ray lines and a potential dark-photon signal to the data. The preliminary result of this peak search is depicted in the figure on the left together with previous limits from anomalous energy loss in the sun, horizontal branch stars, and red giant stars, as well as constraints based on XENON10 and XENON100 data[5]. In addition, projections for CRESST-III and XENON1T are shown. Using data from CRESST-II Phase 2 we further constrain the kinetic mixing κ for dark-photon masses between 0.3 and 0.5 keV.

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[4] M.Pospelov, et al., Phys. Rev. D **78**, 115012 (2008), arXiv:0807.3279 (2008)
[5] H. An, et al., Phys. Lett. B **747**, 331 (2015), arXiv:1412.8378 (2015)