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The KDK project: measuring the decay of 40K

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Potassium-40 (40K) is a background in many rare-event searches, including the DAMA/LIBRA experiment whch claims to have detected the elusive dark matter which may make up most of the matter in the universe. The electron capture of 40K to 40Ar releases ˜3 keV X-rays and Auger electrons that fall into DAMA's region of interest. In most cases, the decay is to an excited state of 40Ar and is accompanied by the emission of a 1.46 MeV gamma ray that can be used to tag and reject some of the X-rays and electrons. However, the decay can also go directly to the ground state of 40Ar, leaving no means to tag the low-energy contribution to the background. The branching ratio of the direct decay is predicted to be small, but has never been measured, as pointed out by Pradler, Singh and Yavin (PLB 720 2013). This decay would also be the only known example of a unique third forbidden nuclear decay.

In the KDK (40K decay) project, we propose to measure this branching ratio, using a 40K source, a small inner detector to trigger on X-rays, and a large, efficient outer tagger to look for the 1.46 MeV gammas distinguishing between electron capture modes. We present the experiment, which will use the large MTAS (Modular Total Absorption Spectrometer) tagger located at Oak Ridge National Laboratories. It detects gamma rays with high efficiency (total absorption efficiency around 99% at 1.46 MeV). We will also discuss options for X-ray detection, which include novel potassium-based scintillators with very high light yield, and will conclude with the expected sensitivity and status of the project.

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