Cosmogenic activation of TeO2 in the neutrinoless double-beta decay experiment CUORE

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The Cryogenic Underground Observatory for Rare Events (CUORE) is an experiment that will search for the neutrinoless double-beta $(0\nu\beta\beta)$ decay of 130Te. The CUORE detector, currently being constructed underground at the Gran Sasso National Laboratory in Italy, is an array of 988 high-resolution, low-background cryogenic bolometers. Each bolometer is comprised of a thermal sensor and a TeO2 crystal that serves as both a source and a detector of $0\nu\beta\beta$ decay. The $0\nu\beta\beta$ decay signature for 130Te is a peak at the Q-value 2528 keV. Observation of $0\nu\beta\beta$ decay requires that the background rate at the peak be ultra-low; CUORE is aiming for a rate less than 0.01 counts/keV/kg/y. Background-source identification and characterization are therefore extremely important.

One source of background that is poorly characterized is activation of the TeO2 crystals by sea-level cosmicray neutrons. This process, known as cosmogenic activation, produces long-lived radioisotopes that can obscure the $0\nu\beta\beta$ decay peak. Existing cross-section data is insufficient to estimate this background; therefore an additional cross-section measurement has been performed in which a TeO2 target is irradiated with a neutron spectrum similar to that of cosmic-ray neutrons at sea-level. The cross-sections obtained have been combined with Monte Carlo simulations of the CUORE detector to estimate the cosmogenic activation background that will be present in CUORE.

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