Characterization of the cosmogenic background in NaI(Tl)

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The exposure of materials to high energy cosmic ray particles generates small amounts of cosmogenic radioactivity. This cosmogenic background is an important consideration for dark matter direct detection experiments, especially as other sources of background have been well-understood and massively reduced. In NaI(Tl), this background arises from long-lived cosmogenic radioisotopes like ^{3}H and ^{22}Na, which are generated by exposure to cosmic rays above-ground and contribute a background component to the detector once underground measurements begin.

Understanding the production rate of cosmogenic isotopes requires an estimate of the crystal exposure, which is experimentally difficult. This work reports on the activation of NaI(Tl) at the Los Alamos Neutron Science Center (LANSCE) facility in November 2019. The LANSCE neutron beam has a cosmic-ray-like spectrum, and was used to activate NaI(Tl) crystals with the equivalent of approximately half a million years' worth of sea-level cosmic neutron exposure.

I will present the activation rates of short-lived and long-lived isotopes, which were measured using gamma ray spectroscopy of the irradiated crystal, and interpreted with the help of a simulation model which accounted for the light yield nonlinearity. These results will be used to help improve models that predict cosmogenic activation, as well as by dark matter experiments such as SABRE to better plan for and understand experimental cosmogenic backgrounds.