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Modeling Backgrounds in the MAJORANA DEMONSTRATOR

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The MAJORANA DEMONSTRATOR was a neutrinoless double-beta decay ($0\nu\beta\beta$) experiment containing ~44 kg of p-type point contact germanium detectors, of which ~30 kg were enriched to 88% in ^{76}Ge. The DEMONSTRATOR's low background rate and excellent energy resolution of 2.52 keV at the $0\nu\beta\beta$ Q-value allowed it to set a lower limit of 8.3×10^{25} yrs on the $0\nu\beta\beta$ half-life. Through the use of a multi-layer passive shield, radiopure materials, and analysis-based background rejection techniques, the DEMONSTRATOR achieved one of the lowest background rates of all $0\nu\beta\beta$ experiments at the $0\nu\beta\beta$ Q-value, 6.23×10^{-3} cnts/(keV kg yr). However, the observed background rate exhibited significant tension with the assay-based projection of 1.17×10^{-3} cnts/(keV kg yr). Spectral fits and supplementary background studies indicate that this discrepancy primarily arose from an excess of events from the ^{232}Th decay chain, which were non-uniformly distributed between the DEMONSTRATOR's two modules and which did not originate in a near-detector component. This poster presents the results of background model fits, their implications for the next-generation experiment LEGEND-200, and a measurement of the half-life of two-neutrino double-beta decay, incorporating studies of multiple sources of systematic uncertainty.

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Poster prize

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