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The effect of contamination on the S1 triplet component in DarkSide-50 dark matter experiment

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The DarkSide-50 (DS-50) experiment aims at the direct detection of the Weakly-Interacting Massive Particles (WIMP). Studies have been conducted in both high-mass (>10 GeV/c2) and low-mass (<10 GeV/c2) ranges for WIMPs in DS-50. It is a dual-phase liquid argon time projection chamber (LAr TPC) where Dark Matter (DM), which constitutes five-sixth of all matter in the universe, is expected to interact with the argon nucleus resulting in nuclear recoils.
In the DS-50 low-mass search, the analysis on the low-energy background observed an excess amount of signals around a few extracted ionized electrons, referred to as Spurious Electrons (SEs), during a period when the inline gas purifier was bypassed for a few days. The cause of these SEs, hence, may be related to the impurities in the LAr. A faster reduction in the SE rate was observed once the getter was re-installed, implying a rapid removal of impurities in the gas phase. It has been observed in the literature that the presence of contamination in LAr can quench the scintillation signal (S1) in LAr. One of the primary suspects for these contaminants is nitrogen since it is highly volatile compared to the other impurities in TPC. To investigate the presence of the suspected nitrogen in LAr, the suppression of the observed lifetime of the scintillation signal has been examined using real data from DS-50. The scintillation photons are emitted from two excimer states: the long-lived triplet state (˜1.5 µs) and short-lived singlet state (˜6 ns). The impurities with concentrations at the order of ppm can lead to a reduction in the observed lifetime of the triplet component. This impurity-analysis would help understand the SE process, consequently improving the sensitivity of low-mass DM searches in future experiments.

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