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Modeling Impurity Concentrations in Liquid Argon Detectors

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We present a mathematical model for describing the dynamics of impurity distribution in liquid argon detectors. This model considers the full dynamic components with significant influence on the purity performance of a liquid argon detector, including sources, sinks, and transport of impurities within and between the gas and liquid phases of a liquid argon detector. This model was applied on a detector with about 20 liter liquid argon working volume, which was equipped with a purification system only circulating and cleaning argon in itself gas phase, to extract the Henry's coefficient of various impurities. Through fitting the time dependence of impurity concentration in liquid argon with the model, the Henry's coefficient for oxygen is extracted to be 0.91 ± 0.03, which is in good agreement with previous measurements. The Henry's coefficient for water, which is previously unknown, can be determined by the similar method. The preliminary result for Henry's coefficient for water is presented. We further consider a large liquid argon detector with baffes installed in the gas phase with large coverage on the liquid surface to improve the purity performance. The advantages of this configuration in limiting impurity concentrations in the liquid argon are illustrated through this model.

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