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Prospects of S2 analysis in single-phase liquid xenon TPCs

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Proportional scintillation in liquid is a possible alternative scheme for charge-to-light signal conversion in future large-size liquid xenon TPCs. Based on detailed simulations we explore the implications on charge signal (S2) analysis arising from this fast scintillation process. The peaked signals allow precise reconstruction of the individual electrons and thus a quantized measure of the S2 strength. Counting the number of electrons significantly improves the S2 resolution for small signals, relevant for low-energy ER studies and sub-GeV WIMP searches. The direct measurement of the electron arrival times improves S2-only reconstruction of the event depth and allows for powerful discrimination between single site and multiple site interactions. We discuss these prospects in the context of a future multi-ton liquid xenon experiment such as DARWIN, assuming a single-phase design with minimal change compared to state-of-the-art dual-phase detectors.

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