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Electric Fields and their Effects in the LUX-ZEPLIN Experiment

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Dual-phase noble liquid time projection chambers (TPCs) are at the forefront of direct dark matter detection experiments. Their functionality hinges on a meticulously designed homogeneous electric field structure defined by electrodes, material properties, and the relative permittivities of gas and liquid. These fields impact recombination processes within the target liquid (e.g xenon) and influence the drift path of ionisation electrons (S2 signal). This, in turn, affects both position reconstruction (combined with S1 signal) and the crucial discrimination between background-like electronic recoils and signal-like nuclear recoils. Furthermore, high voltage elements in these TPCs exhibit occasional anomalous electron or photon emission, a phenomenon attributed to field emission but lacking a deeper understanding. This talk delves into the multifaceted role of electric fields within the LUX-ZEPLIN (LZ) TPC. By employing data-driven and simulation techniques, we aim to illuminate charge transport mechanisms, energy-position reconstruction, and potential sources of this anomalous emission. This improved understanding will be crucial for designing and optimising future generations of dark matter detectors beyond LZ.

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