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The PISA Photosensor for Multi-Ton Rare Event Detectors

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The search for dark matter is one of the highest priorities in contemporary modern particle physics roadmaps. Direct detection experiments employing noble liquid detectors are currently limited by the radioactivity from the detector materials, mostly from the specially radio-clean photomultiplier tubes (PMTs), contributing to the background at ˜ 80% level. Large area avalanche photodiodes and SiPMs have limited gain or too small active areas to be alternatives to PMTs. We propose a simple concept, the Photon Induced Scintillation Amplifier (PISA), as an innovative high-gain photon-multiplier with imaging capability. Instead of a multi-element stack of micropattern electron multipliers, in the PISA a true photon-multiplier is conceived. The secondary scintillation produced in the charge avalanches that take place inside the holes of the micropattern electron multiplier will be read out by suitable photosensors, like SiPMs. The PISA will be cost effective and allow for area coverage above 80%, maximizing the photon detection efficiency. The SiPMs can be distributed in a 2D array with a pitch suitable for the imaging capability. The PISA concept offers an attractive alternative to PMTs and other photon-detector concepts for dark matter direct detection and other high-energy physics experiments.

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