Physics > Instrumentation and Detectors

Study of infrared scintillations in gaseous and liquid argon - Part II: light yield and possible applications

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We present here a comprehensive study of the light yield of primary and secondary scintillations produced in gaseous and liquid Ar in the near infrared (NIR) and visible region, at cryogenic temperatures. The measurements were performed using Geiger-mode avalanche photodiodes (GAPDs) and pulsed X-ray irradiation. The primary scintillation yield of the fast emission component in gaseous Ar was found to be independent of temperature in the range of 87-160 K; it amounted to 17000+/-3000 photon/MeV in the NIR in the range of 690-1000 nm. In liquid Ar at 87 K, the primary scintillation yield of the fast component was considerably reduced, amounting to 510+/-90 photon/MeV, in the range of 400-1000 nm. Proportional NIR scintillations (electroluminescence) in gaseous Ar were also observed; their amplification parameter at 160 K was measured to be 13 photons per drifting electron per kV. No proportional scintillations were observed in liquid Ar up to the electric fields of 30 kV/cm. The applications of NIR scintillations in dark matter search and coherent neutrino-nucleus scattering experiments and in ion beam radiotherapy are considered.

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