Near-Infrared Scintillation of Liquid Argon

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Background and Motivation

The scintillation of liquid argon in the vacuum ultraviolet (VUV) spectrum is well understood and used in a variety of experiments; however, this light is hard and expensive to detect, but recent research suggests that pure liquid argon may also scintillate in the near infrared (NIR) range. If that is the case, difficulties like wavelength shifters and Rayleigh scattering would no longer be problematic in large-scale liquid argon scintillation detectors. Previous groups have confirmed NIR scintillation in gaseous argon and have seen NIR absorption bands in all argon states [1]. The goal of this experiment is to test and eventually quantify the process of NIR scintillation in pure liquid argon.

The Experiment

- LEDs with peak output at 850 nm were used to understand the PMT.
- Americium-241, a 5.4 MeV α-source, immersed in liquid argon (source on), excited and/or ionized the atoms so they could scintillate.
- Light with wavelength < 715 nm was filtered out.
- The number of times the photomultiplier tube (PMT) detected light over an interval of 10 seconds was counted.
- A computer recorded these counts over a period of several hours.
- The source was raised out of the liquid (source off) and the test was repeated.
- Because of the geometry of this setup, the acceptance of the PMT was approximately 0.6%.

Preliminary Results

- Compared distributions of source on and source off (above).
- Ran a Kolmogorov-Smirnov test on the two data sets.
- Null hypothesis: The two sets come from the same physical process.
- Dashed curve: source off
- Solid curve: source on
- D = 0.564 with P = 0.00, thus ruling out the null hypothesis.
- There are indications of a light signal which must be better understood. We also need to determine the source of the noise seen in the histogram above.

Future Work

The next step is to quantify and obtain a rough estimate of the amount of NIR light being emitted by the scintillating liquid argon. The ultimate goal is to use photodetectors with higher NIR sensitivity and improve the setup geometry to increase the acceptance.

References


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