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Diffuser Ball Light Simulations: An Analysis of Geometry, Optical Properties and Isotropy

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The nEXO experiment seeks to investigate the Majorana nature of the neutrino via observation of neutrinoless double beta decay. The existence of this hypothesized process would confirm the neutrino to be its own antiparticle, giving way to physics beyond the Standard Model. To be able to observe the signal from this process, it is crucial to shield the 5000 kilograms of target xenon-136 employed in the experiment from various backgrounds. We thus make use of a large tank of ultrapure water for neutron moderation, which additionally acts as a Cherenkov detector to veto the passage of muons. The latter function is achieved by lining the inner surfaces of the tank with photomultiplier tubes (PMTs). These light detectors are calibrated with laser sources, optical fibers, as well as diffuser balls which emit light isotropically, ensuring optimal light distribution to PMTs. To verify the isotropy of the instrument, we put together light simulations of the diffuser ball using a Monte Carlo based ray tracing package. We will discuss the careful construction of the simulation geometry and the selection of optical parameters for its various components. This simulation will then allow us to analyze the impact of certain optical parameters on the diffuser ball's isotropy. In particular, by varying the reflectivity of its metal surfaces we can potentially observe variations in the light emission profile. This would allow us to assess the necessity of an absorptive coating on certain reflective components of the diffuser ball to maintain an isotropic emission. In the future, simulation results will be analyzed to help us quantify the light attenuation through the diffuser ball. This, combined with the loss through the optical fiber, will give us insight into the laser power required to achieve the desired light intensity emitted outside of the instrument.

What area of study best describes your talk?

Physics

If you answered 'Other', please provide the study area.

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