Raman Spectroscopy as a way to determine Ortho to Para Ratio of Deuterium

PATRICK WONG, ALBERT YOUNG, GUILHEM RIBEILL, VIJYA MEHTA, NCSU — A superthermal ultracold (<350 neV) neutron source using a solid Deuterium ($\text{D}_2$) crystal is being developed at the NC State University PULSTAR nuclear reactor. Ultracold neutron production in the solid $\text{D}_2$ crystal requires that the $\text{D}_2$ be in the ortho (total nuclear spin of 0) rotational state, as $\text{D}_2$ in the para (spin 1) rotational state interacts with ultracold neutrons by transferring energy to the neutrons. A novel method to determine the ortho/para-$\text{D}_2$ ratio is to use Raman spectroscopy to determine the fraction of rotational states in the $\text{D}_2$. This project focuses on the design, construction, and ultimate use of a double-grating Raman spectrometer to determine the ratio of ortho-$\text{D}_2$ to para-$\text{D}_2$. This system is critical to the optimization of the para-to-ortho-$\text{D}_2$ converter which produces $\text{D}_2$ for the ultracold neutron source. I will present details on the Raman spectrometer’s construction and performance, as well as Raman spectra obtained for air and regular $\text{D}_2$ (with 30% para-$\text{D}_2$ content).

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