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

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A superthermal ultracold (<350 neV) neutron source using a solid Deuterium (D₂) crystal is being developed at the NC State University PULSTAR nuclear reactor. Ultracold neutron production in the solid D₂ crystal requires that the D₂ be in the ortho (total nuclear spin of 0) rotational state, as D₂ 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-D₂ ratio is to use Raman spectroscopy to determine the fraction of rotational states in the D₂. This project focuses on the design, construction, and ultimate use of a double-grating Raman spectrometer to determine the ratio of ortho-D₂ to para-D₂. This system is critical to the optimization of the para-to-ortho-D₂ converter which produces D₂ 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 D₂ (with 30% para-D₂ content).