ASEN-6265. Fundamentals of Spectroscopy for Optical Remote Sensing
Homework #12 (Doppler-Free Laser Spectroscopy)

1. To summarize the approaches for sub-Doppler spectroscopy -- how to achieve high spectral resolution, please briefly describe the principles of how the following methods achieve Doppler-free spectroscopy. You may draw the experimental setup or spectral figure to help your understanding and explanation.

(1) Saturation absorption spectroscopy,
(2) Polarization spectroscopy,
(3) Multiphoton spectroscopy,
(4) Molecular beam, and
(5) Laser cooling/trapping.

2. (*Optional problem for Doppler-free spectroscopy*)
(1) A collimated sodium beam is crossed by the focused beam (focal area A = 0.2 x 0.01 cm^2) of a single-mode cw dye laser, tuned to hyperfine component (F'=1 → F" = 2) of the D_2 transition $3^2S_{1/2}$ → $3^2P_{3/2}$ of Na. Calculate the saturation intensity I_S if the mean velocity of sodium atoms is v = 5 x 10^4 cm/s. The lifetime τ_K of the upper level is τ_K = 16 ns and the residual Doppler width can be neglected.
(2) How large is I_S in a sodium cell at $P_{Na} = 10^{-6}$ mbar with P_{Ar} = 10 mbar additional argon pressure? The pressure broadening is 25 MHz/mbar for Na-Ar collisions.

HW #12 is due on Thursday, April 27th, 2017 in class.