SPS Problem of the Week 9/19/2020-9/26/2020

Finally a physics problem! (0 Math!)

Problem 1. *Improvising Spectroscopy*

The basic principle of *Absorption Spectroscopy* is quite simple: You have a glass chamber with a cloud of your favourite atoms, and you shoot a laser through it into a photodetector. By sweeping the frequency of the laser through a range, you can see that if at a certain frequency the intensity of the light recieved by the photodetector decreases, there must have been absorption of the light at that frequency by the atoms.

However, there is an issue, since these atoms are at finite temperature, the *dip* in intensity is broadened by the *Doppler Effect* as follows:

Suppose a 'hot' atom is moving towards the laser which is at a frequency f slightly lower than the absorption frequency f_0, then the light appears to be of a slightly higher frequency than f to the atom, and thus has a higher probability of being absorbed than f would if the atom was not moving, thus where we were supposed to see little to no absorption, since some of the atoms are moving towards the light, we see some absorption. A similar effect happens when the frequency is slightly higher than f_0, in which case atoms moving away from the laser have a higher chance of absorbing it.

Now your task is as follows: Devise a method with which you can make the true absorption frequency f_0 more 'pronounced' or more 'visible' in the graph of frequency vs photodetector absorption.

Note: You are to use the fact that the absorption of light by the atoms increases with the intensity of the incident laser at f_0 untill a 'saturation intensity' after which the atoms absorb a constant amount of light even if the intensity of the source is increased.

Hint: Consider adding a strong counterpropogating laser beam to the main laser which goes through the cloud of atoms.