Simulation of Doppler-free Spectra using the Collisional Radiative Model

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Saturated absorption spectroscopy is a tool that can be used to suppress the Doppler broadening of observed atomic and molecular transition lines in order to measure their precise wavelengths. Obtaining a saturated absorption condition by laser excitation is an essential technique for use in saturated absorption spectroscopy. We are introducing the laser excitation process into the collisional-radiative model of hydrogen atoms to uncover how much saturation can be achieved under realistic plasma conditions and laser power density. Results show that the simulated spectra were able to successfully model Lamb dips and peaks utilising this method, with the simulated plasma and laser parameters showing good agreement with the ones used in the experiment. This model has additionally helped to give further insight into how plasma parameters can affect the spectral characteristics of Lamb dips and peaks by noting the dependence of the simulated spectral saturation on these parameters.

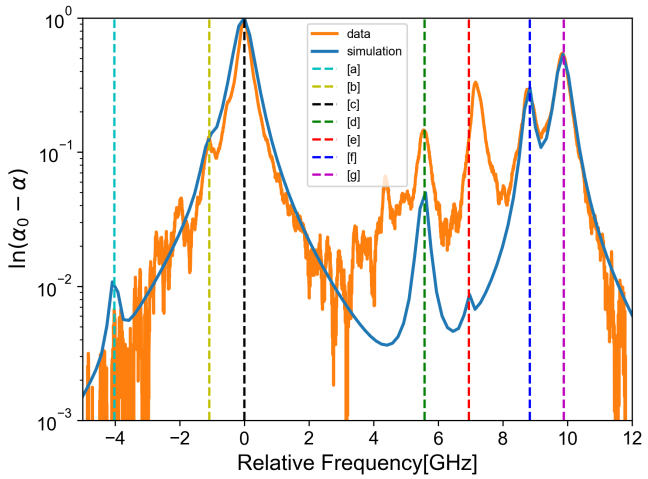

Fig. 1: Log plot of direct comparison between experimentally obtained Doppler-free Lamb peak spectra [data] with simulated model Lamb peak spectra [simulation], showcasing the 7 fine structure hydrogen Balmer-α transition lines [a-g].