Study of Laguerre Gaussian Beam Induced Azimuthal Doppler Shift using Saturation Absorption Spectroscopy.

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Laguerre Gaussian (LG) light modes (with a 'doughnut shaped') spatial profile, possess orbital angular momentum along its propagation axis [Phys. Rev. A **45,** 8185 (1992)]. We present a simple technique to measure the rotational frequency shift induced by LG field using saturation absorption spectroscopy of atomic Rubidium. The rotational frequency shift is related to the topological charge index (l) of the beam and to study its influence, we use co-propagating and counter-propagating pump and probe beams with two geometries: (a) $l_{p\text{ump}} = l_{\text{probe}} = +1$ and (b) $l_{p\text{ump}} = +1$ and $l_{\text{probe}} = -1$. The LG beam was produced using computer generated holograms. ["departments.colgate.edu/physics/research/optics/oamgp/homemadedos.htm"].

The hyperfine lines of Rb were significantly broader (~ 7 MHz) for geometry (b) when counter-propagating beams were used and for geometry (a) when co-propagating beams were used. The additional contribution to the line width is attributed to the Azimuthal Doppler shift induced by the LG beam in addition to the translation Doppler shift. The Azimuthal Doppler shift calculated for a two-level atom using the Liouville equation agrees well with our experimental estimate.