Two-Photon Excitation of Rb $5S_{1/2}-5D_{5/2}$ Using a Single Laser Operating at 778 nm

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The two-photon spectroscopy is a powerful tool for precision measurements. It has been widely used in determination the Rydberg constant, proton charge radius, fine structure constant and the ratio of proton-to-electron mass. The $5S_{1/2}-5P_{3/2}-5D_{5/2}$ two-photon transition of the rubidium atom has been extensively studied owing to its large transition probability, its better Doppler-free background caused by the small difference between the real energy level and the virtual energy level, and its potential application as a frequency standard due to its relatively narrow natural linewidth and low sensitivity to the external environment.

The one-colour two-photon transition from the $5S_{1/2}$ ground state to the $5D_{5/2}$ excited state is demonstrated in rubidium vapour using a laser operating at 778 nm. The intensity modulation method is employed to improve the signal-to-noise ratio of the two-photon spectrum by two orders of magnitude compared with that for direct measurement. The effects of the vapour temperature, the frequency scanning speed of the laser, the polarization combination of the laser beams, and the laser power on the spectra are investigated in detail. The magnetic dipole hyperfine coupling constant $A$ and quadrupole coupling constant $B$ corresponding to this transition are determined. This research is expected to be beneficial for potential applications in precision measurements and quantum information processing.

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References