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Laser optogalvanic spectroscopy of argon in the wavelength region 605–740 nm

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Abstract. Two-photon optogalvanic transitions in Ar glow discharge with Nd : YAG laser pumped dye laser excitation in the frequency range 13520–16520 cm^{-1} has been studied using linear and circular polarization. The intensities of two-photon optogalvanic transitions are very sensitive to changes in the incident laser power which is not the case with one-photon transitions. Intensity ratio for circular and linear polarized light for two photon transitions $6s'[1/2]^\circ 1 \leftarrow 4s[3/2]^\circ 2$, $6s'[1/2]^\circ 0 \leftarrow 4s[3/2]^\circ 2$, and $5d[1/2]^\circ 0 \leftarrow 4s[3/2]^\circ 2, 5d[1/2]^\circ 1 \leftarrow 4s[3/2]^\circ 2$ are quite different from the other two-photon transitions. This has been explained as due to near one photon resonance of $4p'[3/2]1$ level for the first pair and $4p'[1/2]1$ for the second pair of transitions. The ratio of optogalvanic intensity for circular to linear polarized light has been theoretically estimated and compared with the observed results.

Keywords. Optogalvanic spectrum; two-photon transitions; laser spectroscopy.

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1. Introduction

Optogalvanic spectroscopy of glow discharges is based on the detection of small changes in the plasma-impedance, with high signal to noise ratio. This change of impedance is caused by resonant absorption of monochromatic radiation from the tunable laser, by atomic or molecular species in the plasma. Hollow cathode discharges have been found particularly suitable for such studies on the excited electronic states and rare gas filled commercial hollow cathode lamps have also been used for the wavelength calibration of dye lasers [1–3]. Extensive studies of neon optogalvanic spectra have led to a great deal of information on its one-photon and two-photon transitions [2, 3]. In contrast, there are no reports on the two-photon optogalvanic transitions in argon in spite of several studies of its one-photon optogalvanic spectra [4–7]. There are also no systematic investigations of the extreme red end of the Ar optogalvanic spectrum apart from identification of about ten one-photon lines spread over the 695–795 nm region [4]. We report here, for the first time, two-photon optogalvanic transitions in Ar with Nd : YAG laser pumped dye laser excitation in the wavelength transitions region 605–740 nm (16520–13520 cm^{-1}). The one-photon excited optogalvanic transitions in this region are also included, many of them for the first time, in view of their importance as calibration standards.