New energy levels of the La atom discovered by combination of optogalvanic and laser-induced fluoresence spectroscopy

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We report on new energy levels of the Lanthanum atom (La I). The spectrum of La has gained new interest since La lines are visible in the spectra of several stars and La provides insight in the star formation process. Atomic data including hyperfine constants are necessary to identify lines in highly resolved star spectra.

When investigating the spectrum of a La low pressure plasma, generated in a hollow cathode discharge, it turned out that a huge number of La lines could not be classified as transitions between known energy levels [1]. Thus we are searching for up to now unknown levels.

It turned out that our discharge is quite sensitive to optogalvanic (OG) detection [2]. In order to that we tune our laser light source unitl we find an optogalvanic signal and record the hyperfine (hf) structure of the excited transition. Then we set the laser to the highest hf component and look for laser-induced fluorescences lines which show a signal of opposite phase compared to the OG signal. This means, when the laser light is exciting a transition, the lower level population is reduced and the decay of the lower level to known deep lying levels shows a decrease in intensity. In this way the lower level of the driven transition is identified, and the energy of the upper new level can be calculated. With this method, we found 8 new levels in the energy range 38000 to 43000 cm^{-1} when we scanned our laser wavelength between 660 and 657 nm. Altogether, more than 30 new levels are presented.

References:

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