



Revised and extended analysis of the fourth spectrum of indium: In IV

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ABSTRACT

The spectrum of triply ionized indium (In IV) has been investigated in the wavelength region 245–4443 Å. The In^{3+} is a Pd-like ion with the ground configuration $4p^6 4d^{10}$. All levels of the low lying excited configurations $4d^9 5p$, $4d^9 ns$ ($n=5-7$), $4d^9 5d$ and $4d^8 5s^2$ have been reported earlier, while for the higher configurations $4d^9 np$ ($n=6,7$) and $4d^9 nf$ ($n=4-11$), only the $J=1$ levels radiatively decaying to the ground level have been reported. The present work extends the analysis to include the $4d^9 6p$, $4d^9 6d$, $4d^9 4f$ and $4d^9 5f$ configurations. A total 116 levels have been established, 56 of them being new. All the previously reported levels have been confirmed except $4d^9 7s \ ^3D_1$, $4d^9 7p \ ^3P_1$, $4d^9 6f \ ^3P_1$ and $4d^8 5s^2 \ ^3P_1$. The experimental data for the present work was recorded on a 3-m normal incidence spectrograph of St. Francis Xavier University, Antigonish (Canada), as well as on the 10.7 m normal and grazing incidence spectrographs of the National institute of Standards and Technology, Gaithersburg (USA). In both laboratories, a triggered spark source was used. The wavelengths above 2000 Å were supplemented from Bhatia's thesis where an electrodeless discharge source was used. Theoretical predictions were made using Cowan's Hartree–Fock-relativistic atomic codes with superposition of configurations. Least squares fitted (LSF) parametric calculations were used to interpret the energy levels. For vacuum ultraviolet wavelength region our wavelength accuracy is ± 0.005 Å. We estimate the ionization potential of In IV to be $450,921.7 \pm 86.0 \text{ cm}^{-1}$ ($55.9072 \pm 0.0106 \text{ eV}$).

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1. Introduction

Atomic structure of Indium and its ions attracted much interest from spectroscopists, partly because indium-based compounds have numerous industrial applications. The spectrum of triply ionized indium (In IV) has been investigated here which is a member of the Palladium isoelectronic sequence. It has the ground configuration $4d^{10} \ ^1S_0$ and excited configurations are $4d^9 np$ ($n \geq 5$), $4d^9 ns$ ($n \geq 5$), $4d^9 nd$ ($n \geq 5$), $4d^9 nf$ ($n \geq 4$) and further excited configurations are $4d^8 5s^2$, $4d^8 5s 5p$, $4d^8 5p^2$ etc. The first work on In

IV was carried out by Gibbs and White [1], followed by Kruger and Shoupp [2] and Nodwell [3]. Their work is already compiled in Atomic Energy Levels [4] and at NIST atomic spectra database [5]. Bhatia et al. [6] revised and extended the earlier work by including $4d^9 5p$, $4d^9 ns$ ($n=5-7$), $4d^9 nd$ ($n=5, 6$) and $4d^8 5s^2$. Recently, van Kleef and Joshi [7] confirmed $4d^9 5s$ and $4d^9 5p$ levels of Bhatia and revised all the levels of $4d^9 6s$, $4d^9 5d$ and $4d^8 5s^2$ configurations. They did not study $4d^9 6d$ and $4d^9 7s$ configurations; therefore, these levels remained yet to be verified. Secondly, a few more $J=1$ levels of $4d^9 nf$ ($n=4-9$) and $4d^9 np$ ($n=6,7$) were reported by Churilov et al. [8] using triggered spark source while Kilbane et al. [9] extended $J=1$ levels up to $4d^9 11f$ using dual laser plasma technique. The present study has been undertaken considering the importance of indium ions for astrophysical interest [10] and to

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