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High Resolution Photo-absorption studies of Ytterbium in the Wavelength range 1200-2000 Å

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ABSTRACT.

The absorption spectrum of ytterbium in the wavelength range 1200-2000 Å has been recorded in the first order of a 3m spectrograph equipped with a 6000 line mm-1 holographic grating, using synchrotron radiation as the background source of continuum. More than 150 new levels of YbI are reported which are interpreted as the inner-shell transitions, $4f^{14}6s^{2\ 6}$ $4f^{13}(^2F_{7/2,5/2})$ nd, ng and the doubly excited transitions, $4f^{14}6s^{2\ 6}\ 4f^{14}5d(^2D_{3/2,5/2})$np,nf and $4f^{14}6s^{2\ 6}\ 4f^{14}6p(^2P_{1/2,3/2})$ns, nd. All the observed levels lie well above the first ionization threshold and are arranged into Rydberg series converging onto six limits.

INTRODUCTION.

The ytterbium atom belongs to an extended homologous sequence [1] for which the relative energies of the ns and nd states come close together as a result of orbital collapse. Although Yb is the only memberof the sequence with a closed 4f subshell, which in turn implies that the coupling between 4f and the valence excitation channel is not great.Interestingly, this occurs despite the fact that, in Yb, the first ionization limit, the doubly excited spectrum and the first inner shell spectrum lie remarkably close in energy so that the doubly excited spectrum is very prominent, and actually overlaps in energy with the 4f excitation spectrum. In the present paper, we provide new data on single excitations from the 4f subshell and on double excitations for Yb.

Experimental Details.

We performed our experiments at higher dispersion and resolution than were available to previous investigators [2]. An absorption column approximately one meter long was achieved by vaporizing.metallic ytterbium in a resistively heated furnace of inner diameter 3 cm and wall thickness 1 mm. The furnace was operated at temperatures in the range 600-800 °c, which correspond to vapour pressures of about 0.1 and 1 Torr respectively.

Low resolution data were also recorded using a 1m monochromater equipped with a 1200 line mm^{-1} ruled grating operating in conjunction with a hot wire detector system and synchrotron emitted by the DORIS II storage ring at the DESY facility. In particular, the wavelength region 1700-2000 Å is more interesting when observed at low resolution: the broad autoionizing lines exhibit clearer lineshapes in the low resolution spectra. High resolution spectra were recorded on Kodak SWR plates with exposure times ranging from 5 to 10 minutes. The plates were measured on an Abbe comparator with an absolute accuracy of 0.003 Å for sharp lines.