ABSTRACT

This thesis comprises of six chapters, dealing with four different atomic spectra of tellurium atoms: Te II, Te III, Te IV and Te V. Most of the spectra studied here are quite complex. Relativistic Hartree-Fock Multi Configuration Interaction method have been utilized to predict the structure of the ions. About 727 spectral lines have been identified which involves a total of 286 experimental energy levels. Beside that calculated values of 297 energy levels have also been presented in this thesis belonging to Te II - Te V.

The first chapter describes the basic theory of Atomic Spectra. Various approximations used to solve the Schrodinger's wave equation for Hartree-Fock calculations, (H, HF and HFS scheme). Central - field Approximation. R.D. Cowan's approach to solve the complicated integro - differential equations which was developed in the form of a computer code (RNC/RCN2/RCG/RCE) a set of four different programs known as Cowan's code. Description of isoelectronic sequence and their utility in the analysis of atomic spectra has also been discussed.

Chapter II explains the experimental detail of the work concerning the light source used to produce the spectra, spectrograph
used in the process and the experimental recordings of the spectrograms, its calibration procedure and establishment of the wavelength line list, ionization separation of different ions present on the plates are described.

**Chapter III** provides a detail theoretical and experimental interpretation of the structure of singly ionized tellerium: Te II. The configurations $5s^25p^3$ (ground), $5s5p^4$, $5s^25p^26s$, $5p^27s$, $5p^25d$, $5p^26d$ have been investigated completely. Due to strong configuration mixing of $5p^27d$ and $5p^28s$ with the other even parity levels of $5p^26d$ and $5p^27s$ it was necessary to incorporate $5p^27d$ and $5p^28s$ configurations in the least squares fitted calculations for satisfactory interpretation. The reported levels of odd parity configurations $5p^26p$ and $5p^24f$ lie outside the region of our investigation, have been interpreted theoretically. A total of 118 energy levels have been studied of which 30 are newly established. Two hundred and twenty spectral lines have been identified in this spectrum.

**Chapter IV** deals the third spectrum of tellerium (Te III). Analysis has been extended to complete the structure of $5s^25p^2$, $5s5p^3$, $5p5d$, $5p6d$, $5p7d$, $5p6s$, $5p7s$, $5p8s$, and $5p^4$ configurations. The $5p^4$ configuration has been studied first time. Many of the earlier reported levels have been revised.
The earlier reported levels of 5p6p and 5p4f configurations could be only theoretically interpreted as the corresponding transitions lie beyond our region of investigation. Configuration 5s5p25d strongly interacting with 5p6p, 5p4f and 5p4 while 5s5p26s interacting moderately; have also been incorporated in the final calculations. Their levels and corresponding parameters have been included in respective tables. 72 experimental levels have been investigated and one hundred fifty three lines have been classified in this spectrum.

Chapter V, is based on the structural studies of trebly ionized tellurium atoms: Te IV. Multi Configuration Interaction Calculations with suitable scaling (LSF/HFR) of the energy parameters provided very precise predictions. The configurations 5s25p, 5s26p, 5s25d, 5s26d 5s27d, 5s26s, 5s27s, 5s28s, 5s5p2, 5p4, 5s5p5d and 5s5p6s configurations have been analysed completely. 5s24f configuration interacting strongly with 5s5p5d was necessary to incorporate in the final least squares fit. Fifty six levels have been established based on the identification of one hundred ninety spectral lines. The results on 5p4, 5s5p5d, 5s5p6s and 5p26p have already been published [J. Phys. B. (U.K.) 32 2917, (1999)]

Chapter VI is devoted to describe the structure of four times ionized tellurium atoms (Te V). Which is Cd I-like sequence. One
hundred sixty one spectral lines have been classified in this spectrum, covering the configurations $5s^2$ (ground), $5p^2$, $5s5p$, $5s6p$, $5s6s$, $5s7s$, $5s5d$, $5s6d$, $5p6s$ and $5p5d$ completely. To interpret the results more satisfactorily, some additional configurations of both parities were incorporated into the least squares fitted calculations to include the configuration interaction effect. For instance $5s4f$, $5s5f$, $4f5d$, $4p^64d^95s^25p$ and $4p^64d^95s^2(4f+5f)$ in the odd parity system while $5p4f$, $5d^2$ and the core excited configuration $4p^64d^95s5p^2$ were included with the even parity configurations. The theoretical structure of these configurations have also been presented here for future studies.

Ionization Potential (IP) of Te V has been calculated using Edlen’s Polarization Formula. The adopted value is 59.24 eV. These results are also published [Phys. Scr 62 (2000) in press].

Lastly in appendix the tellurium spectra used for analyses are reproduced in the region ~ 365-2080Å. These spectrograms were recorded on a 3-m normal incidence vacuum spectrograph of Antigonish laboratory (Canada), showing first order inverse dispersion of 1.385Å/mm. Prominent impurity lines of aluminium, Oxygen and Carbon, used as standards in calibration of wavelength are marked along with a few lines of Te II, Te III, Te IV and Te V.