Introduction

Spectra are the best tools to study the atomic properties. Numerous properties of the elements have been discovered through the study of the radiation they emit. The emitted radiations are the characteristic spectra of the elements. The study of these spectra is carried out through spectroscopic techniques. Atomic spectral studies are of paramount importance in another way also. If we want to build ion lasers satisfying all requirements of physics industry, we must know with great precision the level structure and transition probabilities of all usable ions. The more extensive and precise knowledge of these details shall be, the better we shall be able to study the lasing actions. This increases the importance of completing our knowledge of the structure of atomic ions in every respect. The analysis of atomic spectra has an old history, and energy structure of the neutral and singly ionized atom is supposed to be well known in most of the cases. The importance of the spectral studies of heavier atomic ions has tremendously increased because of demands from astrophysics, plasma and laser science.

The spectra of various refractory metals are important for developing new energy sources especially by means of tokamak and other controlled fusion devices. In this regard a workshop on “Challenges in Plasma Spectroscopy for Fusion Research Machines” organized by International Atomic Energy Agency (IAEA) very recently (February 20 - 22, 2008) at Birla Auditorium, Jaipur, India. A lot of emphasis was given on the accurate spectroscopic data for the planned International Tokamak Experimental Reactor (ITER) for fusion studies.
It is worthless to mention the importance of any particular element of the periodic table in the era of fast growing technology and its medical and industrial application. Spectroscopic data are of great help in optical hole burning, used to enhance the memory for data storage capacity. On the other hand industries involved in lithography are using spectroscopic data very successfully. Our laboratory has been engaged in providing data at National and International level since last four decades. More than thirty different elements have been studied so far. Fifteen Ph.D. theses have been completed on various elements that includes Y, Zr, Mo, Nb, Ta, Sb, Te, Cs, I etc. I have chosen to study the four different spectra of Iodine viz. I III, I IV, I V and I VI in the vacuum ultraviolet wavelength region and would like to shed some light on its basic properties.

It has been discovered by Courtois in 1811. It is bluish-black lustrous solid, volatilizing at ordinary temperatures into a blue violet gas with an irritating odor. Its atomic weight is 126.9045 (based upon C-12); atomic no. 53; b.p.184.35°C; m. p. 113°C; and density of gas 11.27 g/l; sp. gr for solid is 4.93 (at 20°C), it has twenty three isotopes, only one stable isotope $^{127}$I is found in nature. It occurs sparingly in form of iodides in sea water from which it is assimilated by seaweeds. Iodine exhibits some metal like properties. It dissolves readily in chloroform, carbon tetrachloride or carbon disulfide to form beautiful purple solutions. It is only slightly soluble in water. The artificial radioisotope $^{131}$I, with half life of 8 days, has been used in treating the thyroid gland. Lack of iodine is the cause of goiter the iodides and thyroxin which contains iodine, are used internally in medicine, and a solution of KI and iodine in alcohol is used for external wounds. Potassium iodide finds use in photography.
In earlier days lot of simple spectra like one electron and two electron systems were studied mainly through isoelectronic extrapolations or predictions made by simple calculations. However, the complex atomic systems either could not be studied or found to be erroneous later on and were being revised. In recent past, fast computers capable of handling large data became available and a handful of computer codes that can calculate the structure of complex ions very reliably, the renewed interest of studying complex spectra has risen up. Our laboratory is especially engaged in the study of complex systems. The spectra of iodine ions which I have studied are in fact very complex, making three or four electron systems. We have tried to investigate some of them. The basic procedure and technicalities involved will be discussed at length in the following chapters.

In the first chapter, the basic theory of Atomic Structure and Spectra has been described. Second chapter provides all the experimental details. The remaining four chapters (Ch III – VI) are devoted to describe the detailed energy structure of I III, I IV, I V and I VI respectively. An appendix in the end illustrates the iodine spectrograms used in this work.