WAVELENGTH OF THE $4s^2\ {}^1S_0 - 4s4p\ {}^3P_1$ INTERCOMBINATION LINE IN Br VI

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A beam—foil measurement of the wavelength of the Br VI $4s^2\ {}^1S_0 - 4s4p\ {}^3P_1$ intercombination transition has been made which corrects an earlier error. The new value of 946.3(2) A is 6.7 A longer than the previously accepted value, and the excitation energies of all triplet levels in Br VI should correspondingly be adjusted downward by 756 cm^{-1}.

The need for a knowledge of the level schemes and transition wavelengths for highly ionised members of the Zn isoelectronic sequence has been emphasised by the observation of radiation from these systems in tokamak fusion plasmas [1,2]. Correspondingly, the Zn sequence has been the object of recent experimental studies utilising laser-produced plasma [3,4] and beam—foil [5,6] excitation techniques. Theoretical calculations have also been made [7–9] for this sequence. The classification of highly ionised spectra usually proceeds by semiempirical extrapolation [10] utilising measurements of lower ionisation stages so it is important that the data base be precise and free of misclassifications. We have performed a beam—foil study of Br VI that has revealed a misclassification in the previously accepted value [11] of the lowest lying intercombination transition. The purpose of this letter is to correct this misclassification and to revise the en-

ergy levels of the triplet system relative to the ground state so as to provide accurate values for extrapolation to higher charge states.

The experiment was carried out using 2 MeV beams of HBr⁺ from the 5.5 MV van de Graaf accelerator at the University of Arizona. The spectra were obtained using a McPherson 225 1 m normal incidence monochromator with a Bendix 4219 channeltron at the exit slit. The monochromator was refocussed for a light source of fast excited particles. Spectra were recorded in the wavelength interval 480–1280 Å. The lines widths were about 0.7 Å and, using Br lines of known wavelength (including calculated hydrogenic transitions in highly ionised Br) as references, wavelengths could be determined with 0.1–0.2 Å uncertainties.

Our spectra revealed more than 150 spectral lines, the majority of which have not been classified previously. In this letter we shall discuss some results for the Zn-like spectrum of Br VI for which previous data were obtained by Rao and Rao [11] using spark spectroscopy. Those authors reported the energies of the excited singlet term $4s4p\ {}^1P$ and the $4s4p\ {}^3P$, $4s4d\ {}^3D$ and $4p^2\ {}^3P$ terms in the triplet system. The intercombination transition $4s^2\ {}^1S_0 - 4s4p\ {}^3P_1$ was suggested to be at 939.57 Å.

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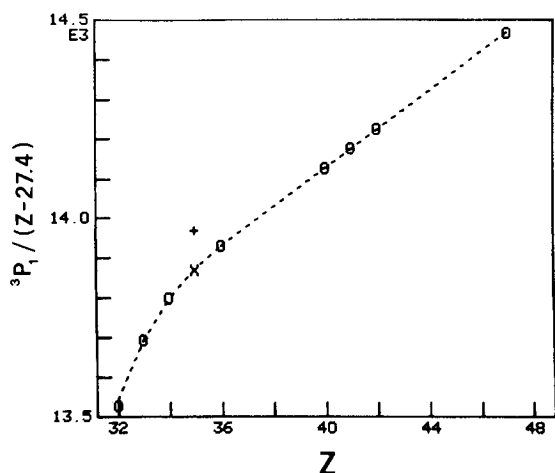
Fig. 1. Isoelectronic plot of the excitation energy of the $4s4p\,^3P_1$ level, charge scaled to $(Z-27.4)$. ○: existing data exclusive of Br VI [3,6,13–15], +: previous Br VI value of Rao and Rao [11] and ✕ : present measurement.

Table 1
Revised energy levels in Br VI.

Term	Energy (cm^{-1})
$4s^2\,^1S_0$	0
$4s4p\,^3P_0$	103 560
$4s4p\,^3P_1$	105 675
$4s4p\,^3P_2$	110 580
$4s4p\,^1P_1$	151 274
$4p^2\,^3P_0$	243 380
$4p^2\,^3P_1$	246 650
$4p^2\,^3P_2$	253 136
$4s4d\,^3D_1$	303 892
$4s4d\,^3D_2$	304 211
$4s4d\,^3D_3$	304 695

However, a systematic study of the effective exchange Slater integral G_1 in the Zn isoelectronic sequence [12] shows that the Br wavelength quoted above is not consistent with the other data for the Zn sequence [3,6,13–15]. This can be seen in fig. 1 where the charge-scaled excitation energy has been plotted as a function of Z. The value of Rao and Rao is well off the systematic trend. A study of the spectrum (fig. 2) shows another line at 946.3 ± 0.2 Å which is

in perfect agreement with the present semiempirical analysis and represent the $4s^2\,^1S_0$–$4s4p\,^3P_1$ transition in Br VI. The other Br VI transitions classified by Rao and Rao [11] were confirmed by our analysis. These facts necessitate a downward adjustment of the excitation energies of the known triplet energies in Br VI by 756 cm^{-1}. The revised energy levels are given in table 1.

A search is also being made for additional excited levels in Br VI, in particular $4s4d\,^1D$ and $4p^2\,^1D$, and the spectral studies will be combined with lifetime measurements. We have also obtained wavelengths for a number of transitions in the Cu-like spectrum of Br VII. These results are in excellent agreement with the beam–foil data of Livingston and Hinterlong [16], thereby also confirming their significant revision of the data of Rao and Rao [11] for the $4p\,^2P$–$4d\,^2D$ multiplet in Br VII.
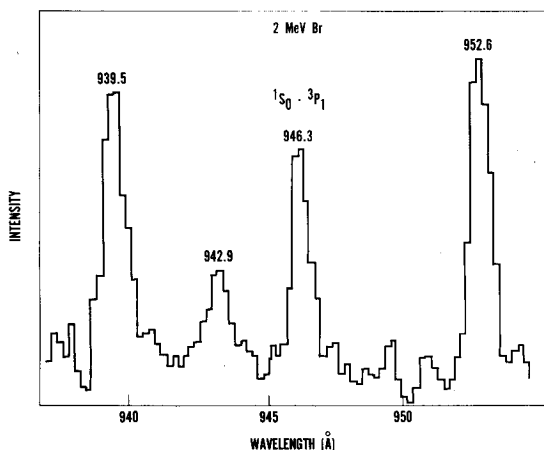

Fig. 2. Beam–foil spectrum of 2 MeV Br in the wavelength region 935–955 Å. The $4s^2\,^1S_0$–$4s4p\,^3P_1$ transition at 946.3 Å is indicated. A classification of the other lines is in progress.

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