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Spectroscopic study of rotational energy distribution of BH ($A^1\Pi$) and electronic excitation temperature determination

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Abstract. Emission spectra of BH($A^1\Pi$–$X^1\Sigma^+$) system were recorded and studied using a low pressure (3·0 torr) arc in flowing hydrogen and argon + hydrogen mixture. The rotational distributions in the $A^1\Pi$ state determined from the intensities of rotational lines for the 0–0 band of the A–X system conforms to a Maxwellian distribution with effective rotational temperature of 1000 ± 50°K. Intensities of Balmer lines of hydrogen were measured and used to determine electronic excitation temperature which was found to be around 2000°K.

Keywords. Line intensity; Maxwellian distribution; effective rotational temperature; electronic excitation temperature.

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Experimental studies

The emission spectrum of BH($A^1\Pi \rightarrow X^1\Sigma^+$) first observed by Paton and Almy 1931, has been studied mainly from the analysis angle (Lotche-Holtgreven and Van dor Vleugel 1931; Thunburg 1936; Almy and Horsfall 1937 and John *et al* 1967). However, there are no reports on rotational intensities and temperatures. In view of the fact that BH molecule is of astrophysical interest, such measurements are needed. Therefore, we present in this paper relative populations of rotational levels of BH($A^1\pi$) derived from intensity measurements of $A^1\Pi$–$X^1\Sigma^+$ band and also the electronic excitation temperatures derived from Balmer lines.

The BH(A–X) was excited in a low pressure D.C. arc burning in flowing hydrogen/argon + hydrogen gases over boron powder contained in a cup in the lower electrode. The arc was maintained at a pressure of about 3·0 torr. The intensities of rotational lines of the 0–0 band of the A–X system and the Balmer lines (H_β and H_γ) of hydrogen were measured using photographic photometry since it averages out the fluctuations of the arc.

The vibrational and electronic transition probability within a vibrational level remains reasonably constant in a single band. Therefore the populations of the rotational levels is governed by Boltzmann law and the intensity of the rotational line (J', J'') in emission within a band is given by (Hertzberg 1950).

$$I_{J',J''} = Cv^4 S_{J',J''} \exp(-E_{J'}/kT). \tag{1}$$

Here J' and J'' are the rotational quantum numbers of the upper and lower energy