VIBRATION ROTATION BANDS OF NO IN SUNSPOTS

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Abstract. The equivalent widths of $R_1(26.5)$ lines, belonging to the 1-0, 2-1 and 3-2 vibration-rotation bands of NO near 5.3 μm, have been computed for two different sunspot models at four positions on the disc. The computed equivalent widths in both models suggest a possible presence of these NO bands in the sunspot spectrum.

1. Introduction

The detectable computed equivalent widths of the R_1 (26.5) line of the 1-0 vibration-rotation band of NO (Gaur, 1974) at various position on the disc for the sunspot model of Stellmacher and Wiehr (1970), and the fact that the oscillator strengths associated with the 2-1 and 3-2 bands of NO are twice and thrice that of the 1-0 band, respectively (Penner, 1959), suggest that the 2-1 and 3-2 bands of NO may also be present in the sunspot spectrum. The aim of the present communication is to predict the equivalent widths of the strongest lines of the 2-1 and 3-2 bands of NO for two different sunspot models. The selected sunspot models are those by Henoux (1969) and by Stellmacher and Wiehr (1970). The calculations in these two models were done to assess the effect of the choice of the model on the resulting equivalent widths. Here the results of such an investigation are presented.

2. Equivalent Width Calculations

The method for calculating the equivalent width of a weak NO line belonging to a vibration-rotation band is given earlier (Gaur, 1974). The molecular constants of NO used in the calculations were adopted from Carpenter and Franzova (1965). The calculated wavenumbers of the $R_1(26.5)$ lines of the 1-0, 2-1 and 3-2 bands are 1954.43 cm^{-1}, 1925.16 cm^{-1} and 1896.23 cm^{-1}, respectively.

The equivalent widths of the above lines were computed at four positions on the disc, i.e. at $\cos\theta = 1$, 0.7, 0.5 and 0.3. The resulting equivalent widths $W(\theta)$ in Henoux's (1969) sunspot model and in Stellmacher and Wiehr's (1970) sunspot model are shown in Figure 1.

3. Concluding Remarks

It is obvious from Figure 1 that $R_1(26.5)$ lines, belonging to 1-0, 2-1 and 3-2 vibration-rotation bands of NO, show appreciable equivalent widths in both sunspot models. The equivalent widths of these lines in Henoux's model are larger

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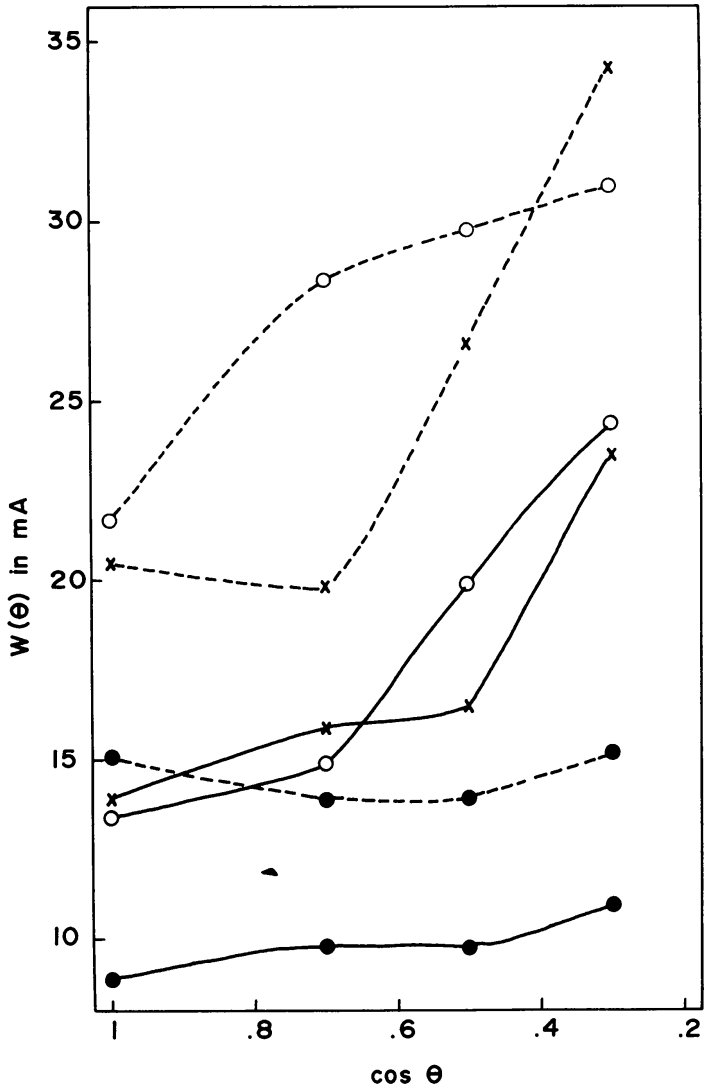

Fig. 1. The center-to-limb variations of $R_1(26.5)$ lines of three bands of NO in two sunspot models. Filled circles, open circles and crosses correspond respectively to 1-0, 2-1 and 3-2 vibration-rotation bands. Solid curves represent the behaviour in Stellmacher and Wiehr's (1970) model while dotted curves that for Henoux's (1969) model.

than the values obtained for Stellmacher and Wiehr's model. The equivalent widths of these lines increase with cos θ for both models.

Though the $R_1(26.5)$ line is the strongest of the band, other lines, with quantum numbers not too much different from 26.5, in the main P and R branches will not be much weaker. So a list of wavenumbers of these vibration-rotation lines with quantum numbers 21.5 to 31.5 is given in Table I to facilitate identification. The asterisked wavenumbers are the observed values adopted from Gillette and Eyester (1939).

In view of these calculations it may be desirable to investigate the sunspot spectrum in the spectral region around 5.3 μm so as to resolve the question of the presence or absence of the 1-0, 2-1 and 3-2 vibration-rotation bands of NO definitively.

TABLE I

Computed and adopted wavenumbers of vibration-rotation band lines of NO orginating from $^2\pi_{1/2}$ level (cf. text)

J	Band Branch	1-0 P_1	1-0 R_1	2-1 P_1	2-1 R_1	3-2 P_1	3-2 R_1
21.5		1796.55*	1942.04*	1769.30	1913.23	1742.09	1884.48
22.5		1792.40	1944.76*	1765.24	1915.69	1738.08	1886.90
23.5		1788.28	1947.03*	1761.16	1918.12	1734.03	1889.29
24.5		1784.13	1949.56*	1757.04	1920.50	1729.94	1891.64
25.5		1779.94	1952.12*	1752.89	1922.85	1725.83	1893.96
26.5		1775.72	1954.43*	1748.70	1925.16	1721.68	1896.23
27.5		1771.46	1956.39	1744.48	1927.43	1717.50	1898.47
28.5		1767.18	1958.66	1740.23	1929.67	1713.28	1900.66
29.5		1762.86	1960.89	1735.95	1931.86	1709.03	1902.82
30.5		1758.51	1963.08	1731.63	1934.01	1704.75	1904.93
31.5		1754.12	1965.25	1727.29	1936.13	1700.44	1907.01

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