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Intensity variation of OH Meinel Bands in the Nightglow

Jahangir Payamara

Department of Physics, Shahed University, Tehran- IRAN

Abstract:

OH nightglow measurements from Firuzkuh mountain (52°34′, 45°34′) at height of 3000m(30 km away from Tehran), were carried out for studying the mesosphere emission and its behavior, and the results obtained are reported. From OH (9,3) band , the intensities of entire OH Meinel band system (0.384μ-4.47 μ) has been evaluated. On the basis of ozone-hydrogen mechanism leading to the emission of OH Meinel bands in the nightglow, the estimated total OH band intensities are utilized to calculate ozone concentration prevailing at night time over Mt. Firuzkuh .

Keyword: Nightglow, Mesosphere, OH Meinel band.

INTRODUCTION

OH vibration-rotation bands constitute most conspicuous emission in the nightglow spectrum. These bands have been observed in the nightglow spectrum extending from 5000A to IR region. The OH (9,3) band emission were carried out. Fig.1 shows a twin channel photoelectric photometer [1] was utilized for carrying out these observations. The observations were carried out during years 2004-2005. Table 1 shows the numbers of nights.

The interference filter pass bands employed in making these observations of emission and background intensities are shown in fig.2. OH (9,3) band extends from 6236A to 6417A. A programmable stepper motor drive sets the time sequence of measurement. A photomultiplier tube (S-20) detects emission intensity in a digital mode. Photometer was calibrated using C14 radioactive phosphor [1].

Fig.1: Experimental agreement

Table1: Nights of observation

Month	Total number of nights	Total number of long night
Dec.2004	11	9
Jan.2005	8	3
Mar.2005	10	6
Apr2005	5	3
May 2005	6	3
Total	**40**	**24**

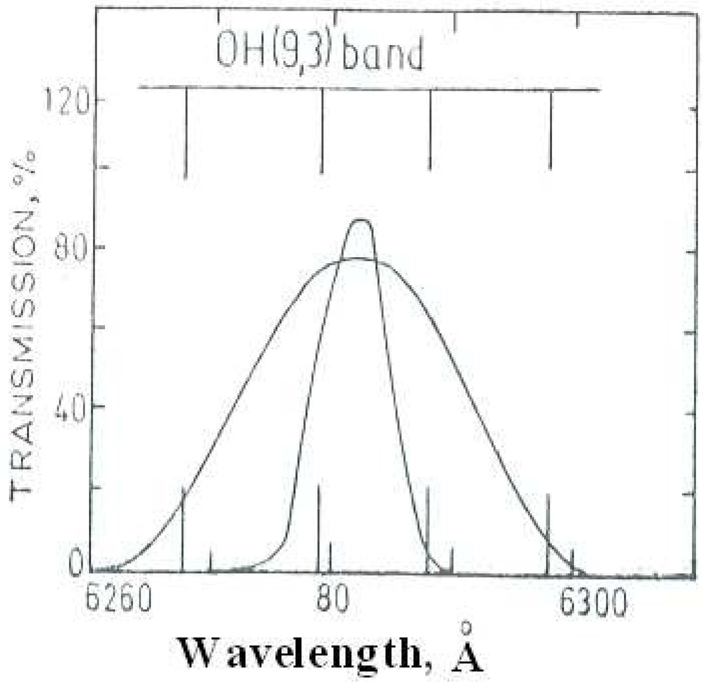

Fig.2 Pass bands of interference filter.

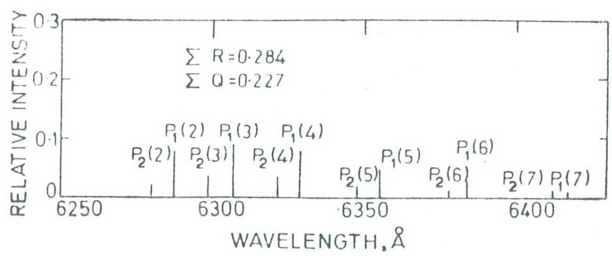

Fig.3 Relative intensities of rotational lines.

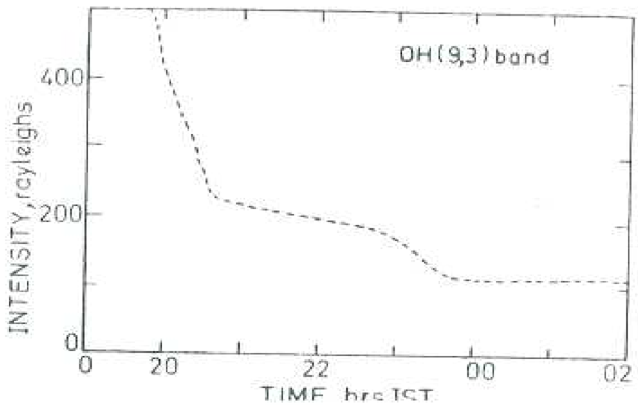

Fig.4 curve showing mean nocturnal intensity

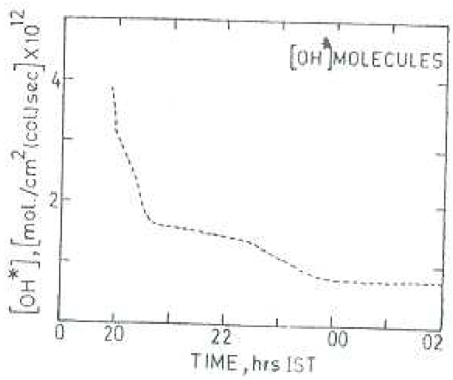

Fig.5 Curve showing nocturnal varation.

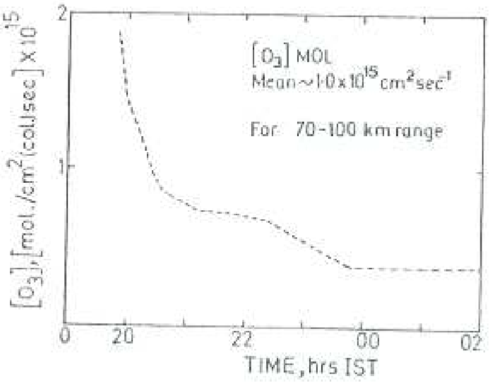

Fig.6 Curve showing nocturnal varation.

RESULTS AND DISCUSSION

Table 1 summarizes the nights of observation whose data are included in this paper. Fig.3 shows the normalized intensities of individual lines belonging to different branches of the OH (9,3) band [2]. While estimating the intensity of the OH (9,3) band , we have assumed that the photochemical theory can explain the intensity variation of OH bands with time . This means that the intensity changes in OH(9,3) band will be in proportion to the normalized intensities of individual lines belonging to different branches of OH (9,3) band. Very few workers have reported seasonal intensity variation of OH band [3,4]. There is no agreement in seasonal intensity variation pattern of OH bands reported by these workers [3-4]. Fig.4 shows nocturnal intensity variation of the OH (9,3) band, published reports show there are six types of intensity variation curves [5], but our data show only one type of nocturnal zenith intensity variation. This may be due to low brightness phase of seasonal intensity variation. In the above estimation OH molecules are assumed to be in the 8th and 9th level initially from which they cascade to lower levels [6]. Using 4.8 (Photons/molecule) as the value of the ratio [7], we have obtained the total number of excited OH molecules for every observation. Fig.5 shows these results. The above calculated OH(9,3) band intensities have been utilized to determine rate of formation of OH molecules, from the estimated OH(9,3) band intensities, corresponding intensities of total OH band system have been determined. For this, reported mean intensities of the OH(9,3) band and the total OH band system have been utilized [6]. Many workers [8-9] have theoretically calculated the rate of formation of vibrationally excited OH* molecules (* indicates that OH molecule band is in an excited state) as a function of altitude for various times , seasons a latitudes [8-9].

OH is formed by O with H_2, H_2O, H_2O_2, in the mesosphere, O has electronic configuration levels of 3p,1_D. The excited OH* molecules are formed through reaction,

$$H + O_3 \xrightarrow{K} OH^*(\nu \leq 9) + O_2 + 3.34(in\ ev) \quad (1)$$

and are quenched through the reactions.

$$OH^* + N_2 \xrightarrow{S_1} OH + N_2 \quad (2)$$

and

$$OH^* + O_2 \xrightarrow{S_2} OH + O_2 \quad (3)$$

The available reaction energy in Eq(1) is just above the excitation energy of the 9th vibrational level.

The equilibrium concentration [10] of OH* molecules can be written as

$$OH^* = \frac{K[O_3][H]}{1+(S_1[N_2]+S_2[O_2])}$$

Where, k=2.6x 10^{-11} Cm ^{3} Sec^{-1}, the rate coefficient of the reaction in Eq.(2),

S=3.6x $10^{-15}\,Cm^3\,Sec^{-1}$, the quenching coefficient of the reaction in Eq.(2), S_2 =1.0x 10^{-14} Cm^3 Sec^{-1} , the quenching coefficient of the reaction in Eq.(3) It is logical to use the observed emission intensities of OH band to infer ozone concentration in the mesosphere. N_2 and O_2 concentration have been obtained from CIRA 1985 model atmosphere [10-11]. Fig.6 shows our calculation which is in agreement with theoretically obtained results for 15 degree of latitude [9].

CONCLUSION

For studying such a complex pattern of emission processes from the observed OH (9,3) band in the nightglow can be used to determine the intensity of total OH Meinel band. It is found that the total OH Meinel band intensity in nightglow is 5 Mega rayleighs. This implies a column reaction rate of $10^{12}\,Cm^2$ Sec $^{-1}$.On the basis of ozone hydrogen mechanism the observed OH Meinel band intensities can be used to determine mesospheric ozone concentration prevailing in the night time mesosphere.

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