INTER STELLAR SHOCKED REGION CHEMISTRY CERTAIN REACTIONS BETWEEN INTERSTELLAR MOLECULES AND O AND N ATOMS

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ABSTRACT. The reactions between O and N atoms and certain interstellar molecules (H_2S, NH_3, H_2CO, CH_3OH, C_2H_5OH) are studied using the dynamical flowing afterglow method. It is found that NH and OH radicals are formed which can be used as a diagnostic probe to differentiate between interstellar shocked and heated regions.

1. INTRODUCTION

The propagating shock waves, generated by interstellar winds, expanding HII regions, and supernovae remnants will lead to the rapid collision-induced dissociation of heavy homonuclear molecules like N_2 and O_2 in shocked regions whereas the dissociation occurs slowly in heated region (1). These active dissociated atoms will react with ambient molecules and the resulting chemical species may be used as diagnostic probes to differentiate between interstellar shocked and heated regions.

2. EXPERIMENTAL

We have carried out certain experiments between $O(^1D)$ and $N(^2P)$ atoms and certain interstellar molecules (H_2S, NH_3, H_2CO, CH_3OH, C_2H_5OH). The experimental set up and procedures in detail is described elesewhere(2,3)

3. RESULTS AND DISCUSSION

The wavelengths of observed spectra which are mainly due to NH and OH radicals are presented in Table I. The number densities of excited species were obtained using the method of De Vos (4) and Larrabee (5). The chemical reaction between $O(^1D)$, $N(^2P)$ and the reactants may be written as:

$$O(^1Dg) + R \rightarrow OH(A^2\Sigma^+) + \text{products} \quad - (1)$$

$$N(^2P) + R \rightarrow NH(d^1\Sigma) + \text{products} \quad - (2)$$

where R = H_2S, NH_3, H_2CO, CH_3OH, C_2H_5OH

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The rate coefficients for the above reactions (1), (2) are of the order of 2×10^{-10} cm^3 S^{-1} and 8×10^{-10} cm^3 S^{-1} respectively. From energy considerations it can be shown that $O(^1D)$ and $N(^2P)$ can produce $OH(A^2\Sigma^+)$ and $NH(d^1\Sigma)$ radicals whereas the ground state of $O(^3P)$ and $N(^4S)$ can produce $OH(X^2\pi_i)$ and $NH(^3\Sigma^-)$ radicals only.

From the experiment it is found that NH and OH will be formed other than CN and CO radicals when dissociated N and O atoms react with the reactants like H_2S, NH_3, H_2CO, CH_3OH, C_2H_5OH. Thus the abundances of NH and OH will be enhanced in the shocked region.

The enhancement of the abundances of NH and OH radicals may be used as a diagnostic probe to differentiate between the interstellar shocked and heated regions.

TABLE I. NH and OH band systems of glow

Observed Wavelength	Intensity	Standard Wavelength	Intensity	Transition ($d^1\Sigma \rightarrow c^1\pi$)
NH band system				
2516.0	Ms	2516.3	5	($v'=1$) ($v''=1$)
2557.0	S	2557.3	10	($v'=0$) ($v''=0$)
2683.0	Ms	2683.4	5	($v'=0$) ($v''=1$)
OH band system				
3064.8	Vs	3063.6	10	($v'=0$) ($v''=0$)
3122.4	W	3121.7	-	($v'=1$) ($v''=1$)
3185.7	W	3184.8	-	($v'=2$) ($v''=2$)
3428.8	W	3428.1	-	($v'=0$) ($v''=1$)

Vs, Very strong; S, Strong; Ms Medium Strong; W, Weak.

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