Near-Infrared Emission of Highly Excited CO - A More Sensitive Method to Probe the Inter Stellar Matter??

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Carbon monoxide is one of the major constituents of the stellar and interstellar media. The near infrared emission of CO due to the ground-state vibrational transitions at 4.67 and 2.3 μm are used as markers to study the evolution and ages of several stars [1]. The vacuum ultraviolet (VUV) features of CO have been observed with *IUE* followed by *HST* using *GHRS*-Spectrograph [2]. On the other hand, the spectroscopic features of CO in the near infrared region (NIR) between 0.9 and 2 μm involving the electronically excited states have not yet been explored in astrophysical observations.

There are four triplet electronic states of CO that lie energetically close to each other like nested ladders between the ground-state ($X^1\Sigma^+$) and the first optically allowed excited singlet state ($A^1\Pi$). These triplet states with increasing energy are: $a^3\Pi$, $a'^3\Sigma^+$, $d^3\Delta$ and $e^3\Sigma^-$, respectively. The a-state is a metastable state with a lifetime of several ms; 94 ms in the gas-phase, 90 ms in Ne, and 7.2 ms in Ar matrices [3]. Hence, the transitions involving the a-state and the other three upper states, covering the wavelength region between the UV and the NIR, should be of importance for astrophysical studies of CO-abundant objects.

In our experimental work, we have observed that the band-maxima of the NIR emissions of CO are highly sensitive to the environment in which CO exists. Due to the fact that the above-mentioned triplet states are associated with opposite dipole moments of CO, these states shift energetically in opposite directions with increasing polarizability of the medium.

Based on the large shifts observed in the positions of these NIR emission bands, we proposed a few years ago [4], that a combination of astrophysical observations and laboratory experiments in the NIR region on CO would be a highly sensitive method to probe stellar and interstellar objects containing CO and exposed to VUV radiation. Further details of the photophysical processes will be presented.

References:

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