Spectroscopic study of C_2 in vacuum ultraviolet region

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The dicarbon radical, C_2, has been widely observed in various energetic environments, like flames, carbon stars, interstellar medium, comets and so on. Spectroscopic studies of C_2 and identifications of the corresponding electronic transitions can be dated back to 19th century [1]. Most of the previous studies have been limited to relatively low energy region (below the first dissociation limit of C_2), spectroscopic investigations of C_2 in vacuum ultraviolet have been rare [2]. In this study, we produced C_2 radicals using a discharge valve, and then photoionized them using a tunable high-resolution vacuum ultraviolet laser radiation source generated by the four-wave mixing technique. We identified various vibronic transitions of C_2 in vacuum ultraviolet region, including those from $a^3\Pi_u$ to $g^3\Delta_g$ and $f^3\Sigma_g^-$ states as identified previously by Herzberg et al. [2]. The vibronic transition from $a^3\Pi_u$ to $1^3\Sigma_g^+$ is identified for the first time, as shown in Figure 1. The rather astrophysically important $F\ ^1\Pi_u$ state was not observed here, which may be due to its fast predissociation process. Instead, our study shows that the position of the absorption band $g^3\Delta_g(v'=2)\leftarrow a^3\Pi_u(v''=0)$ exactly overlaps with that of $F^1\Pi_u(v'=0)\leftarrow X^1\Sigma_g^+(v'=0)$. Possible astrophysical impacts of these findings will be discussed.

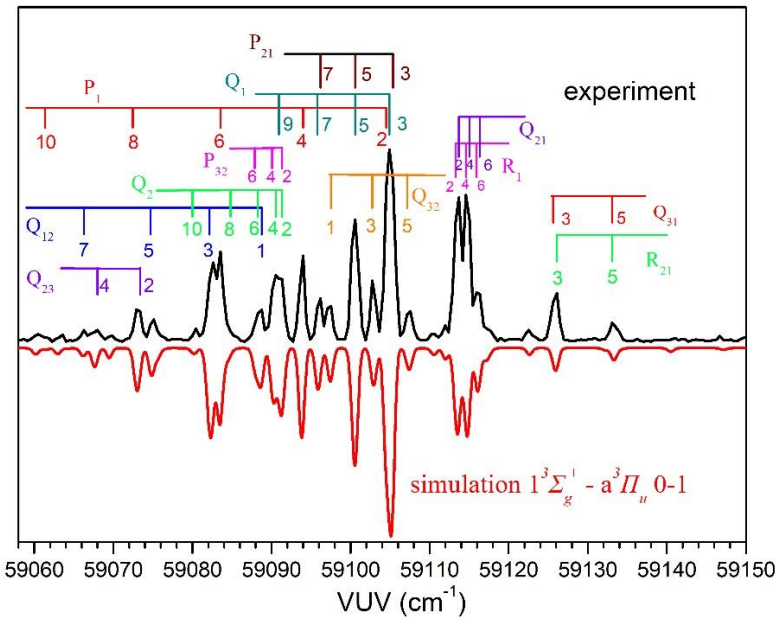

Figure 1: The (1VUV+1UV) photoionization spectrum (top black curve) and its Pgopher simulated one (bottom red curve) of C_2 for the transition $1^3\Sigma_g^+(v'=0)\leftarrow a^3\Pi_u(v''=1)$

[1] T. W. Schmidt, *Acc. Chem. Res.* 54, 481-489 (2021).
[2] G. Herzberg et al., *Can. J. Phys.* 47, 2735 (1969).