The molecular ion CH$_2^+$ is of special interest because of its quasilinearity (resulting from a small barrier to linearity, 1089 cm$^{-1}$) and the strong interaction of its ground and first excited states due to the Renner-Teller effect. At linearity the ground state is a doubly degenerate $^2\Pi_u$ state that splits into $^2\tilde{X}$ A$_1$ and $^2\tilde{X}$ B$_1$ states as the molecule bends. Although in the ground state the molecule is a near-prolate asymmetric rotor ($\chi_{\text{HCH}}=140^\circ$), the excited state equilibrium geometry is linear. Both the initial detection of the infrared spectrum of the $v_3$ band$^a$ and a more recent PFI-ZEKE study$^c$ confirm the bent nature of CH$_2^+$ in the ground state. This work presents the first experimental spectroscopic characterization of the $^2\tilde{X}$ B$_1$ state.

Using a Ti:sapphire laser, we have observed four new absorption bands in the near-infrared region (11,000-13,000 cm$^{-1}$). The comparison between spectra recorded in He/CH$_4$ and He/CH$_4$/H$_2$ liquid-nitrogen cooled positive column discharges was used to identify these transitions, the strongest of which had a signal-to-noise ratio of $\sim$100. A least-squares fit of 57 transitions from the $^2\tilde{A}$ (0,3,0)$^1\leftarrow^2\tilde{X}$ (0,0,0)$^0$ band has given preliminary values for the excited state molecular constants $B=7.140(22)$ and $D_N=-0.00034(16)$. The fit of 46 lines from the $^2\tilde{A}$ (0,4,0)$^0\leftarrow^2\tilde{X}$ (0,0,0)$^1$ band resulted in the following excited state constants: $B=6.796(56)$ and $D_N=-0.00170(42)$. Recent ab initio predictions$^d$ of the rovibronic spectra of CH$_2^+$ show good agreement with the observed spectrum ($\Delta\nu_{0-0}=-53$ cm$^{-1}$ for the $^2\tilde{A}$ (0,3,0)$^1\leftarrow^2\tilde{X}$ (0,0,0)$^0$ band and $\Delta\nu_{0-0}=-18$ cm$^{-1}$ for the $^2\tilde{A}$ (0,4,0)$^0\leftarrow^2\tilde{X}$ (0,0,0)$^1$ band). Assignment of the $^2\tilde{A}$ (0,3,0)$^2\leftarrow^2\tilde{X}$ (0,0,0)$^1$ and $^2\tilde{A}$ (0,3,0)$^3\leftarrow^2\tilde{X}$ (0,0,0)$^1$ bands is underway.

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