HIGH-RESOLUTION NEAR-INFRARED SPECTROSCOPY OF THE SECOND NEGATIVE SYSTEM OF O$_2^+$

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The second negative system ($A^2 \Pi_u - X^2 \Pi_g$) of O$_2^+$ has been spectroscopically studied for over 70 years$^a$ due to the significant role it plays in the chemistry of the upper atmosphere. More recently, the (2,18), (4,20), (6,20),$^b$ (3,18), (3,19), and (4,19)$^c$ bands were observed in the near infrared. While scanning for N$_2^+$ lines in a pure helium discharge containing N$_2$ as an impurity (<8 ppm) for another experiment,$^d$ we serendipitously found two new bands of O$_2^+$, (2,19) and (5,21). The O$_2^+$ ions were produced in a liquid-nitrogen-cooled positive-column plasma containing 1 Torr of He, where most likely the dominant source of oxygen in the plasma is a small leak in the vacuum system. The spectra were obtained with a Ti:sapphire laser (11,000-13,000 cm$^{-1}$) using velocity modulation, phase modulation with heterodyne detection, noise subtraction, and optical multi-passing. A detailed analysis of the newly observed bands will be presented.

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