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An Analysis of the $B^3\Pi_2$– $X^3\Delta_2$ (0, 0) Band System of the TiO Molecule in Laboratory and Sunspot Spectra(Article)

Sriramachandran, P., Priyadharshini, D., Ashraf Shiddeeqaa, N., Shanmugavel, R.

Physics Research Centre, VHNSN College, Virudhunagar, Tamilnadu 626001, India

Abstract

The $B^3\Pi_2$– $X^3\Delta_2$ (0, 0) band system of the titanium monoxide (TiO) molecule was excited in a DC copper arc with a constant deviation spectrometer. The resulting spectrum has been analyzed using image J software. Relative intensity measurements of the P- and R-branch molecular lines of the (0, 0) band with rotational quantum (J) numbering have been obtained. The measured intensity of rotational molecular lines and the J numbering were used to estimate the excitation rotational temperature of the source emitting the spectrum of TiO molecules. Also the presence of TiO spectral lines of the $B^3\Pi_2$– $X^3\Delta_2$ (0, 0) band in the wavenumber region of 14 500 to 16 000 cm^{-1} has been confirmed in the umbral spectrum, from the atlases recorded at the National Solar Observatory using the Fourier transform spectrometer (FTS) of the McMath-Pierce Solar Telescope on Kitt Peak. The combined laboratory and sunspot spectral line measurements have been used to obtain the improved molecular structure parameters for the electronic states $B^3\Pi_2$ and $X^3\Delta_2$ of the TiO molecule. Using equivalent width measurements of well resolved and identified lines in the sunspot spectrum with known rotational quantum number, the effective rotational temperature was found to be 2555 ± 780 K. This proves the presence of TiO molecules in sunspot and other higher temperature astrophysical sources. © 2020, Springer Nature B.V.

Author keywords

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Sriramachandran, P.; Physics Research Centre, VHNSN College, Virudhunagar, Tamilnadu, India;

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