On the effective temperature of AlC molecular lines in sunspot umbral spectra

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R. Sindhan, P. Sriramachandran, R. Shanmugavel & S. Ramaswamy

Abstract

In the present work, a significant rotational lines of the $B^4\Sigma^- - X^4\Sigma^-$ $(0, 0)$ band system of the AlC molecule were identified in high resolution FTS sunspot umbral spectra in the region from 22,450 to 22,600 cm^{-1}. Among the well-resolved identified lines, the rotational temperatures have been estimated to be 4018 K for photosphere and 3722 K for a hot umbra. Hence, the estimated effective rotational temperatures provide evidence for the possible presence of the AlC molecule in a sunspot umbra. The radiative transition parameters for $A^4\Pi^- - X^4\Sigma^-$ and $B^4\Sigma^- - X^4\Sigma^-$ systems of the AlC molecule have been estimated for experimentally known vibrational levels using the Rydberg–Klein–Rees (RKR) potential. The Franck-Condon (FC) factor of $B^4\Sigma^- - X^4\Sigma^-$ $(0, 0)$ band system is most intense ($q_{v'v''} = 0.741$). For the $B^4\Sigma^-$ state, the radiative lifetime of $v' = 0$ level is found as 103.93 ns. The effective vibrational temperature of the $A^4\Pi^- - X^4\Sigma^-$ and $B^4\Sigma^- - X^4\Sigma^-$ band systems of the AlC molecule is 3981 K and 2706 K, respectively. Therefore, the effective vibrational temperature and radiative transition parameters help us to ascertain the possible presence of the AlC molecule in the solar atmosphere.