Infrared emission lines of Mg II in B stars

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1. Introduction

Recently, Chang et. al. (1992) and Carlsson, Rutten and Shchukina (1992) (CRS) demonstrated the non-LTE formation mechanism behind the 12 μm Mg I emission lines ($6g-7h, 6h-7i$) observed in the solar spectrum (Murcray et. al., 1981). CRS stress the generality of this mechanism showing that it is a natural consequence of the recombination flow from the large Mg II reservoir through the Rydberg levels of Mg I. We have noted the close parallel between Mg I in the solar atmosphere and Mg II in the atmospheres of B stars (where Mg III plays the role of the reservoir) and investigated the operation of this mechanism in high-ℓ infrared transitions of Mg II. We have employed a 58 level Mg II atom including all energy levels through $n = 25$ and a total of 491 linearized radiative transitions. The coupled equations of radiative transfer and statistical equilibrium were solved with the MULTI code in its local operator form (Carlsson, 1992).

2. Results

Figures 1(a) and 1(b) show the $5g-6h$ and $6h-7i$ transitions of Mg II near their maximum strengths in $T_{\rm eff}$. The emission results from a population divergence $b_l < b_u$ which causes the monochromatic source function to rise with height. This also leads to strong limb brightening of the emergent intensity as shown in Figure 1(c) for $5g-6h$. This sensitivity to the variation of viewing angle over the surface, coupled with a strong pressure dependence, suggests that non-spherical disk integrations should be investigated. We have incorporated the effect of rapid uniform rotation in the Roche approximation following Collins (1963). An example is shown for $5g-6h$ in Figure 1(d) for the case of critical rotation, $\omega_f = 1.0$. The non-spherical profile is noticeably weaker than the best fit spherical profile computed with the same M and L but $R = R_{\rm p}$. The main difference is that for a star seen nearly pole on, the average value of μ over the surface will increase with ω_f. For a spherical model, $<\mu>= {}^2/_3$ while for $\omega_f = 1.0$, $<\mu>= 0.746$ due to the absence of viewing angles $\mu < 0.5$.

L. A. Balona et al. (eds.), Pulsation, Rotation and Mass Loss in Early-Type Stars, 414–415.

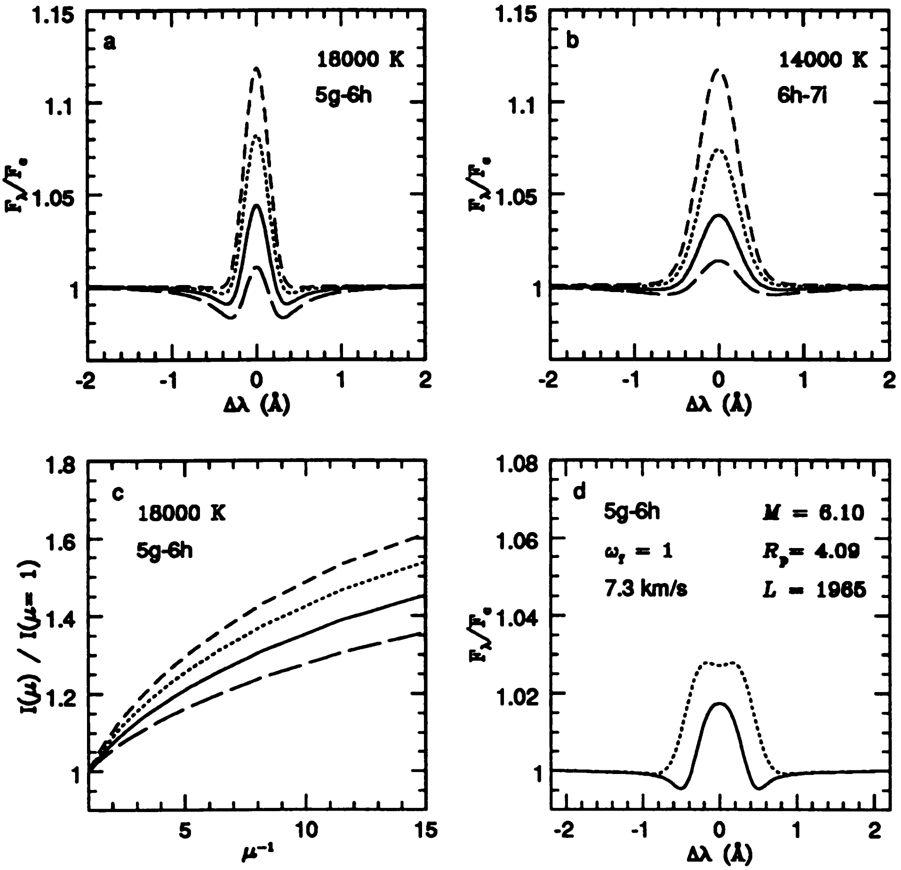

Fig. 1. (a) Relative flux for the transition $5g-6h$ ($1.86\ \mu$m). The $T_{\rm eff}$ is indicated and the model gravities are identified by $\log(g) = 4.5$ (long dash), 4.0 (solid), 3.5 (dotted), and 3.0 (short dash). (b) same for $6h - 7i$ ($3.09\ \mu$m). (c) Line center limb brightening of $5g - 6h$. (d) Non-spherical profile (solid) compared to the best fit spherical profile (dotted). Model parameters are given in solar units; $R_{\rm p}$ refers to the polar radius and both $R_{\rm p}$ and L were assumed unaffected by rotation. The $v \sin i$ of the spherical profile is also given.

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