Alpha Virginis: line-profile variations and orbital elements

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Alpha Virginis is a binary system whose proximity and brightness allow detailed investigations of the internal structure and evolution of stars undergoing time-variable tidal interactions. Previous studies have led to the conclusion that the internal structure of Spica's primary star may be more centrally condensed than predicted by theoretical models of single stars, raising the possibility that the interactions could lead to effects that are currently neglected in structure and evolution calculations. The key parameters in confirming this result are the values of the orbital eccentricity e, the apsidal period U, and the primary star's radius, R1. We analyze the impact that line profile variability has on the derivation of its orbital elements and R1. We use high SNR observations obtained in 2000, 2008, and 2013 to derive the orbital elements from fits to the radial velocity curves. We produce synthetic line profiles using an ab initio tidal interaction model. Results: The variations in the line profiles can be understood in terms of the tidal flows, whose large-scale structure is relatively fixed in the rotating binary system reference frame. Fits to the radial velocity curves yield e=0.108+/-0.014. However, the analogous RV curves from theoretical line profiles indicate that the distortion in the lines causes the fitted value of e to depend on the argument of periastron; i.e., on the epoch of observation. As a result, the actual value of e may be as high as 0.125. We find that U=117.9+/-1.8, which is in agreement with previous determinations. Using the value R1=6.8 Ro derived by Palate et al. (2013) the value of the observational internal structure cinstant k_{2,obs} is consistent with theory. We confirm the presence of variability in the line profiles of the secondary star.

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