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Light and Period Variations in Two K-type Contact Binaries: HI Leo and V523 Cas

Yuangui Yang[1], Shuang Wang[1], Huiyu Yuan[1] and Haifeng Dai[1]

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Article and author information

Abstract

We presented a low-precision spectrum for HI Leo, Transiting Exoplanet Survey Satellite data for V523 Cas, and new photometry for both K-type contact binaries. Comparing their light curves on different observing dates, we found small intrinsic variabilities, such as variable amplitudes for HI Leo and the varying heights around the second maxima for V523 Cas. By the Wilson–Devinney Code, we deduced six photometric solutions. The dark spot of V523 Cas may appear on the surface of the more massive component on BJD 2458768, while it disappears on BJD 2458779. Our results indicate that the two binaries are W-type shallow-contact binaries ($f \leq 10\%$). From the eclipse timing residuals, we found that the orbital periods may continuously increase, accompanied by one to two light-time effects due to additional bodies. The modulated periods and semi-amplitudes are $P_3 = 25.8(\pm1.0)$ yr and $A_3 = 0\overset{d}{.}0066(6)$ for HI Leo, $P_3 = 114.8(\pm2.0)$ yr and $A_3 = 0\overset{d}{.}0448(12)$, $P_4 = 18.89(\pm0.14)$ yr and $A_4 = 0\overset{d}{.}0025(2)$ for V523 Cas, respectively. The orbital period secularly increases at a rate of $dP/dt = 2.86(\pm0.11) \times 10^{-7}$ day yr^{-1} for HI Leo and $dP/dt = 3.45(\pm0.07) \times 10^{-8}$ day yr^{-1} for V523 Cas, which may be attributed to mass transfer from the secondary to the primary. With mass transferring, the shallow-contact binaries, HI Leo and V523 Cas, will evolve into the broken-contact configurations.