TIDAL INTERACTIONS IN COMPACT BINARY SYSTEMS

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Abstract. An analytic model has been constructed for the change of orbital elements because of tidal drag in a binary system where one of the components is compact (Lecar *et al.*, 1976). The basic assumptions are (i) tides on the compact object are neglected (ii) only P_2 deformations of the non-compact star are considered (iii) the lag angle is linearly proportional to the difference between the instantaneous orbital angular velocity and the spin angular velocity of the non-compact star (iv) the semi major axis a and eccentricity e do not change significantly in a single orbit. The results are exact solutions for $\dot{a}$ and $\dot{e}$ as a function of e and the ratio of primary star to orbital angular velocity, Ω/ω.

Tidal instability in this model is manifest by the dynamical inability to attain or sustain synchronism. An analysis to second order in e and first order in $(\Omega/\omega-1)$ shows that the criterion for instability is the same as in the work of Counselman (1973), namely $ma^2 > \frac{1}{2} I$ where m is the reduced mass and I the moment of inertia of the primary star. This criterion is shown to apply to eccentric orbits and is thus more general than the criterion derived from the energetics of circular orbits. Stable systems may overshoot the condition of synchronism before settling into the final circular synchronous orbit.

References

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