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Tidal evolution in the quadrupolar three-body problem

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Abstract

We investigate the dynamical evolution of hierarchical three-body systems under the effect of tidal forces, when the ratio of the orbital semi-major axes is small and the mutual inclination is relatively large. Using the quadrupolar non-restricted approximation, we derive the averaged equations of motion in a very simplified vectorial formalism, which is suitable to model the evolution for long-term studies of a wide variety of exoplanetary systems. In particular, it can be used to derive constraints for stellar spin-orbit misalignment, capture in Cassini states, Kozai-tidal migration, or damping of the mutual inclination.

1. Summary and Conclusions

We confirm previous results on the migration scenario for hot Jupiters based on Kozai gravitational interactions combined with tidal effects [1], but we find a new distribution for the misalignment angles between the spin of the star and the orbit of the planet (Fig 1). We also show that for planets around binary stars, initial prograde orbits may become retrograde and vice-versa, only because of tidal migration within the stellar components [2].

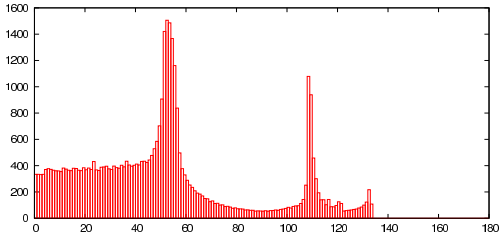

Figure 1: Histogram of the final distribution of the misalignment angle in the HD 80606 system. We observe two pronounced peaks of higher probability around 53° and 109°, which is consistent with the observations of the Rossiter-McLaughlin anomaly [3].

Acknowledgments

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References

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