Two's Company: Adding Tidal Forcing to GYRE

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OVERVIEW

- GYRE is an oscillation code that calculates the mode frequencies and wavefunctions of an input stellar model.
- Although originally designed to simulate free oscillations, we are extending GYRE to model the *forced* oscillations that arise in tidally interacting binary systems.
- During the development process, we invite interested community members to try out code prototypes and provide feedback.

TECHNICAL DETAILS

- Tidal interactions are modeled as a time-dependent response of each star to forcing by the gravitational potential of its companion.
- Forcing potentials are decomposed in space using spherical harmonics, and in time using Fourier harmonics.
- GYRE calculates the separate response of the star to each term in this decomposition (Fig. 1), and then adds up the net response via superposition to synthesize observables (Figs 2 and 3).
- In addition to calculating light curves, the tidal response can be used to evaluate the secular rates of orbital evolution (Fig. 4).

HOW *YOU* CAN HELP

- Visit the website, try out the code prototypes, and share feedback.
- Collaborate with us on applying the code to observations (heartbeat stars, tidally excited oscillations, etc.).

The GYRE oscillation code can now model stellar tides — try it yourself!

Take a picture to visit the website

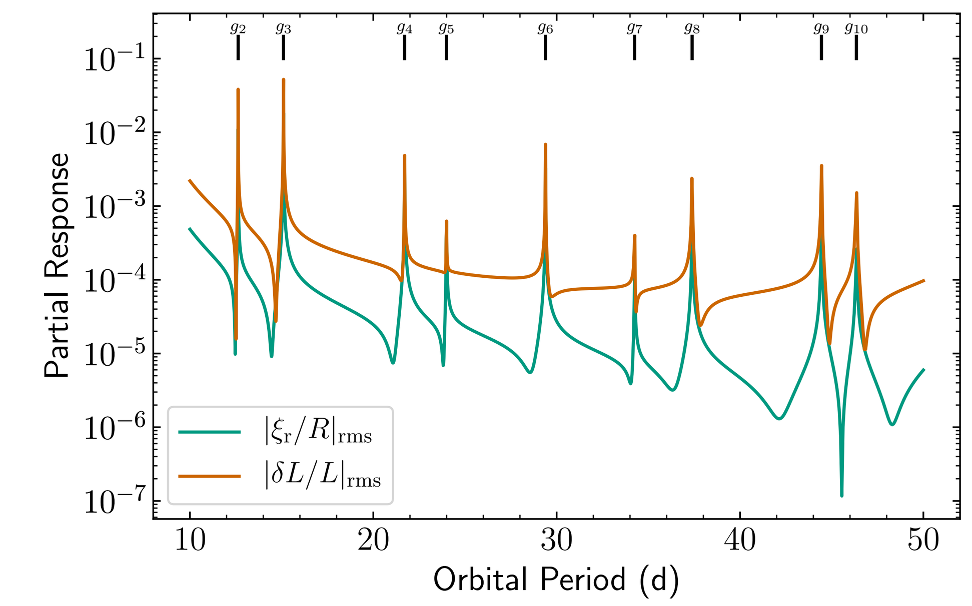

Fig 1 Displacement and luminosity response of the primary star to the $(\ell, m, k) = (2,0,25)$ term in the forcing potential decomposition, for a model of the massive heartbeat system ι Ori (O9 III+B1 III). The response is large when the forcing period matches one of the star's free-oscillation modes (indicated at top).

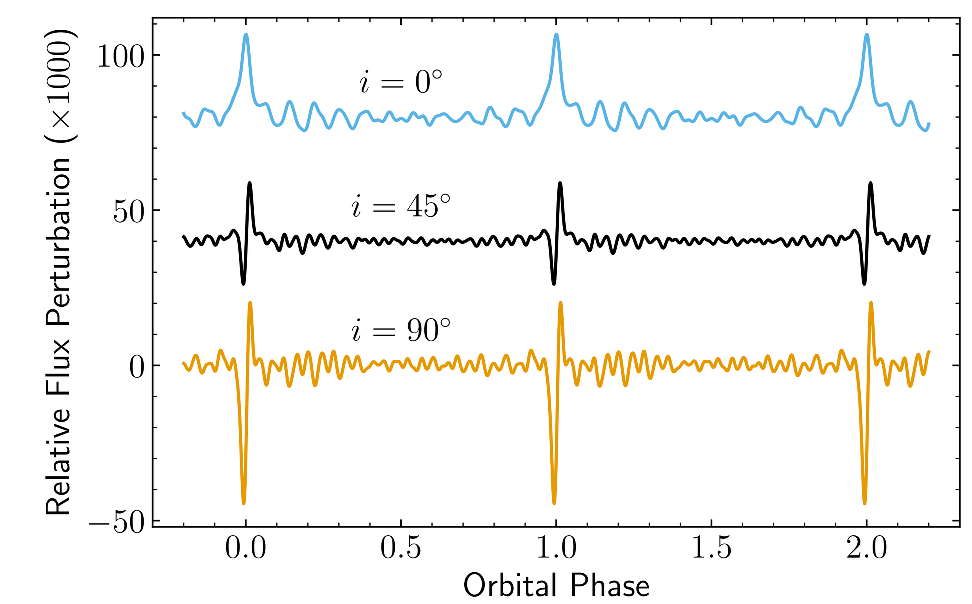

Fig 2 Synthetic Light curves for the ι Ori model, for three different choices of the viewing inclination. The characteristic heartbeat pulse near periastron can clearly be seen.

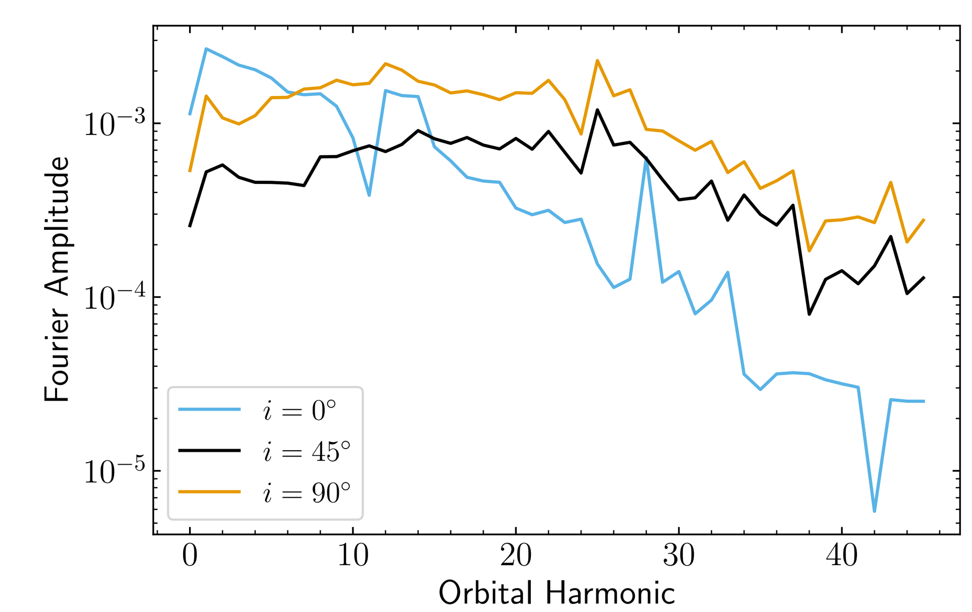

Fig 3 Fourier transform of the light curves in Fig. 2, showing the broad distribution of harmonics that superpose to form the heartbeat pulse.

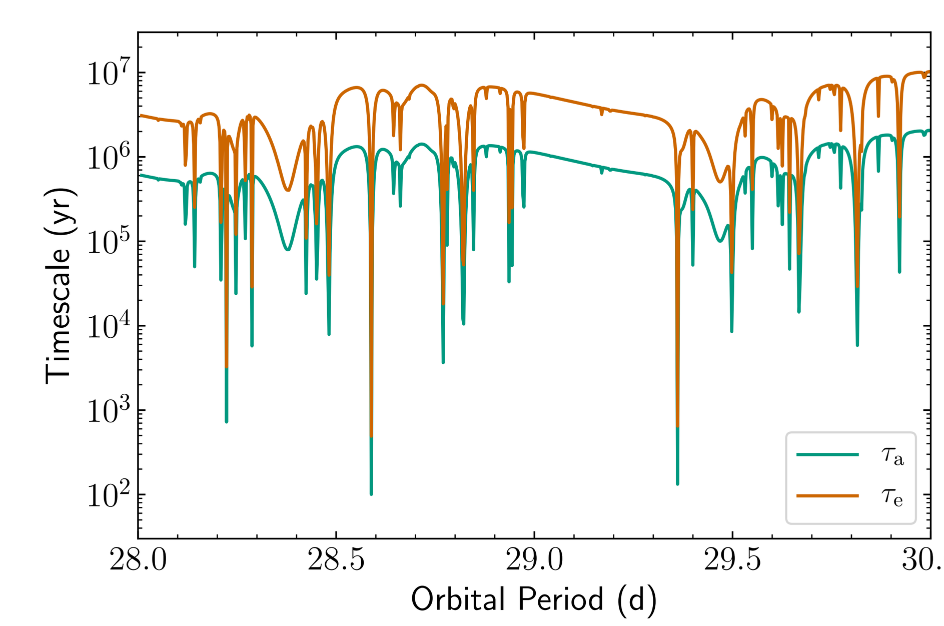

Fig 4 Characteristic timescale τ for secular evolution of the semi-major axis a and eccentricity e, for the ι Ori model.