Complex Planetary Systems II: Latest Methods for an Interdisciplinary Approach
Proceedings IAU Symposium No. 382, 2024
A. Lemaitre & A.-S. Libert, eds.
doi:10.1017/S1743921323003630

On the retrograde planar co-orbital asteroid motion with Jupiter

George Voyatzis and Thomas Kotoulas

Aristotle University of Thessaloniki, Department of Physics, Post Code: 54124, Thessaloniki, Greece
email: tkoto@physics.auth.gr

Abstract. We study the motion of an asteroid being in retrograde 1/1 resonance with Jupiter (co-orbital motion). We consider the planar case (i=180^o) and Jupiter is on a circular or elliptic orbit ($e' = 0.048$). In the cirular model we compute families of symmetric periodic orbits and their stability type. In the elliptic model we have isolated periodic orbits which affect the orbital modes of motion as it is shown by the FLI dynamical maps.

Keywords. asteroids, restricted 3-body problem, retrograde co-orbital motion

1. Model and results

We use the Elliptic Restricted Three Body Problem (ERTBP) with primaries Sun and Jupiter on the rotating $Ox-$axis and of masses $1-\mu$ and $\mu = 0.001$, respectively. We consider planar retrograde motion of an asteroid with osculating orbital elements: the semimajor axis a, the eccentricity e, the longitude of pericenter ω and the mean anomaly M (prime quantities refer to Jupiter). For the planar 1/1 retrogade motion the resonant angle is defined as $\phi = \lambda - \lambda' - 2\omega$, where λ is the mean longitude.

The planar circular problem has been studied by Huang (2018) and Morais (2019) who distinguished three types of motion called *mode 1, 2* and *3*. We recomputed the families of periodic orbits of these modes and found the periodic orbits of period multiple of 2π, which are generating orbits for families of periodic orbits in the elliptic model with the eccentricity e' as parameter. There are two initial configurations: Jupiter at perihelion ($\omega' = 0°$) or at aphelion ($\omega' = 180°$). The characteristic curves of the families are shown in Fig. 1. At $e' = 0.048$ we have isolated periodic orbits ($1p, 1a$, etc). Kotoulas (2020) computed such families for several retrograde resonances in the main asteroid belt. In Fig. 2 we present dynamical FLI maps for $e' = 0.048$. Compared with the case $e' = 0$, the maps reveal relatively slight differences. The region of stable orbits of mode 1 (Morais (2019)) is quite large. The white region indicates strongly unstable orbits which are not apparent for $e' = 0$. The stable regions of mode 3 and mode 2 are centered around stable periodic orbits, which exist at small and very large eccentricities, respectively.

2. Conclusions

We explored the phase space structure of the planar elliptic RTBP ($e' = 0.048$) in the 1/-1 resonance by computing families of periodic orbits and dynamical maps. Compared with the results of the circular model, the eccentricity of Jupiter affects mainly the modes 2 and 3 of motion. The mode 1 is the most stable motion but a zone of strong instability appears at high eccentricities.

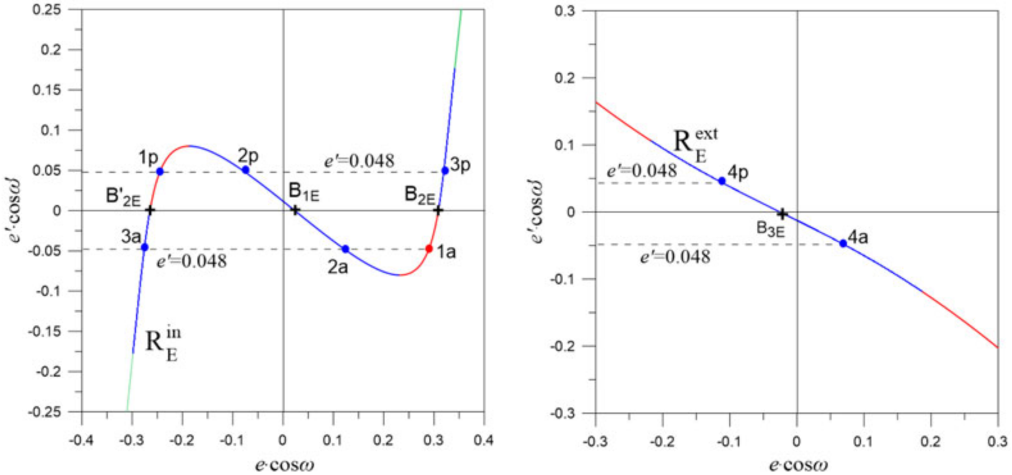

Figure 1. Families of 1/1 retrograde periodic orbits in the elliptic model. Numbered dots indicate the isolated orbits for the Jupiter's eccentricity $e' = 0.048$.

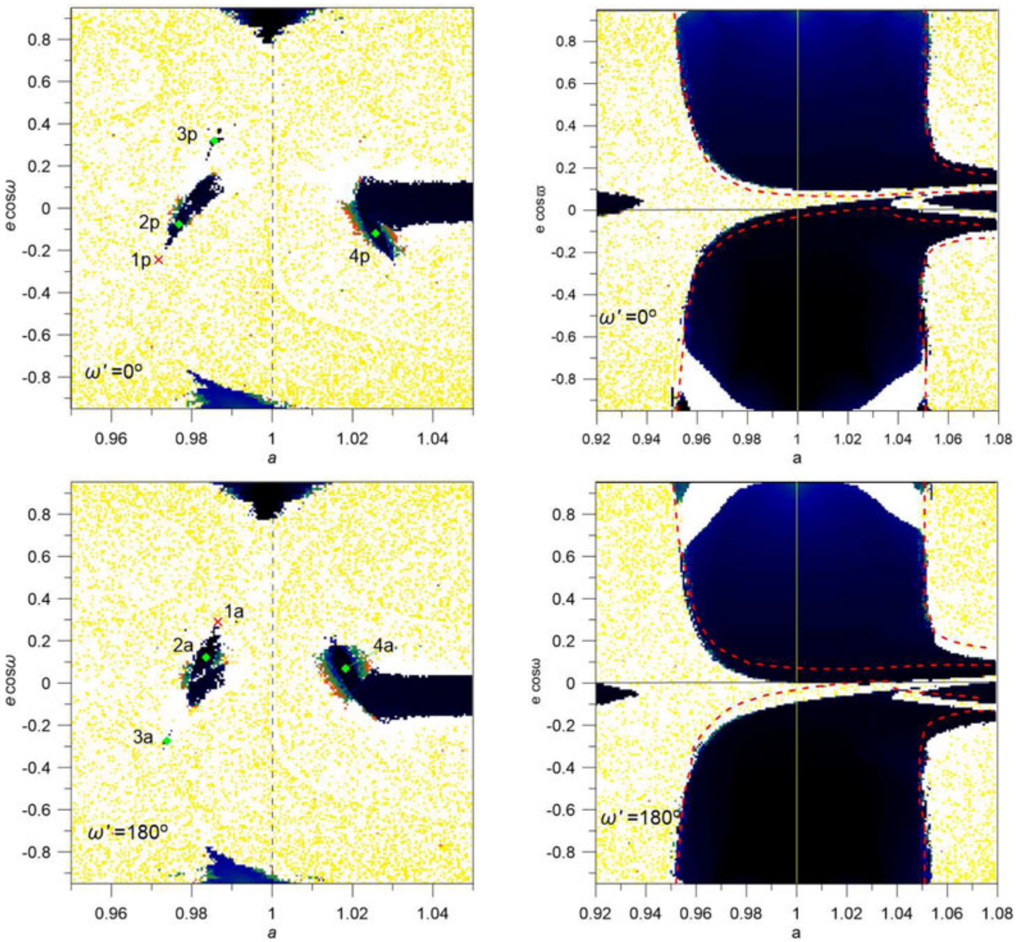

Figure 2. FLI maps for the planar elliptic problem ($e' = 0.048$), $\omega' = 0°$ (top) and $\omega' = 180°$ (bottom). Left column refers to modes 2 and 3 and the right one to mode 1. Dark colors indicate low FLI values, i.e. stable motion.

https://doi.org/10.1017/S1743921323003630 Published online by Cambridge University Press

Supplementary material

To view supplementary material for this article, please visit http://doi.org/10.1017/S1743921323003630

References

Huang, Y., Li, M., Li, J., Gong, S. *et al.* 2018, *AJ*, 155, 262
Kotoulas, T.A., Voyatzis, G., 2020, *Planet. Space Sci.*, 182, 1
Morais, M.H.M., Namouni, F. 2019, *MNRAS*, 490, 3799

https://doi.org/10.1017/S1743921323003630 Published online by Cambridge University Press