PLANET MIGRATION IN SELF-GRAVITATING DISCS: SURVIVAL OF PLANETS

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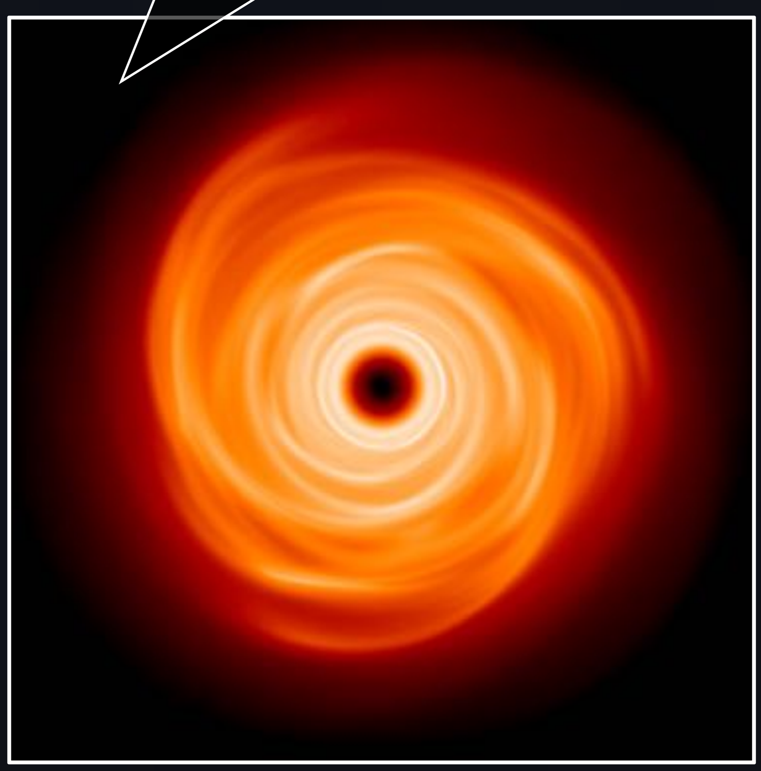
Modelling the disc thermodynamics 1

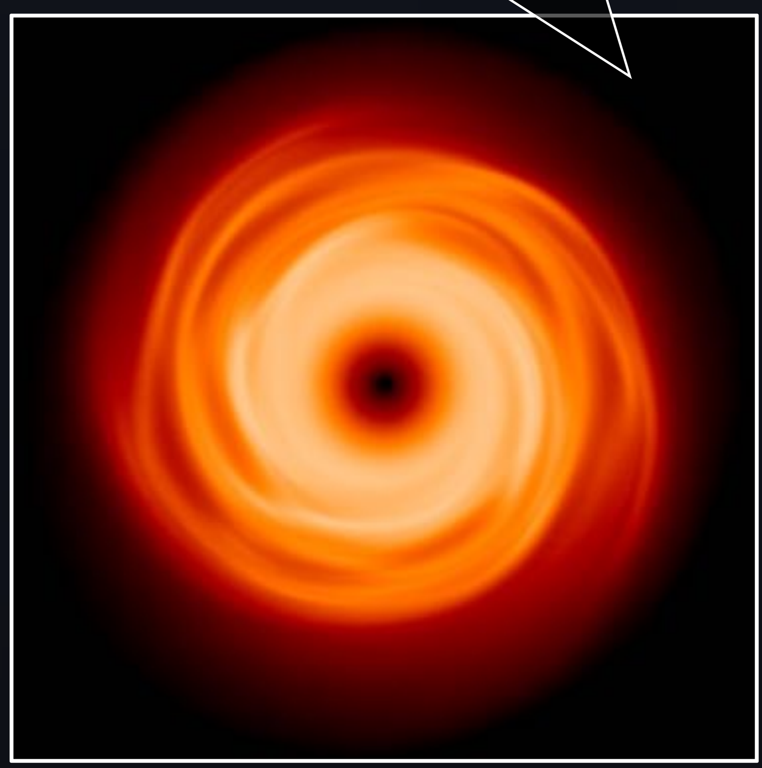
The balance between the heating and cooling rate determines the stability of self-gravitating discs. A simplified approach models the cooling as

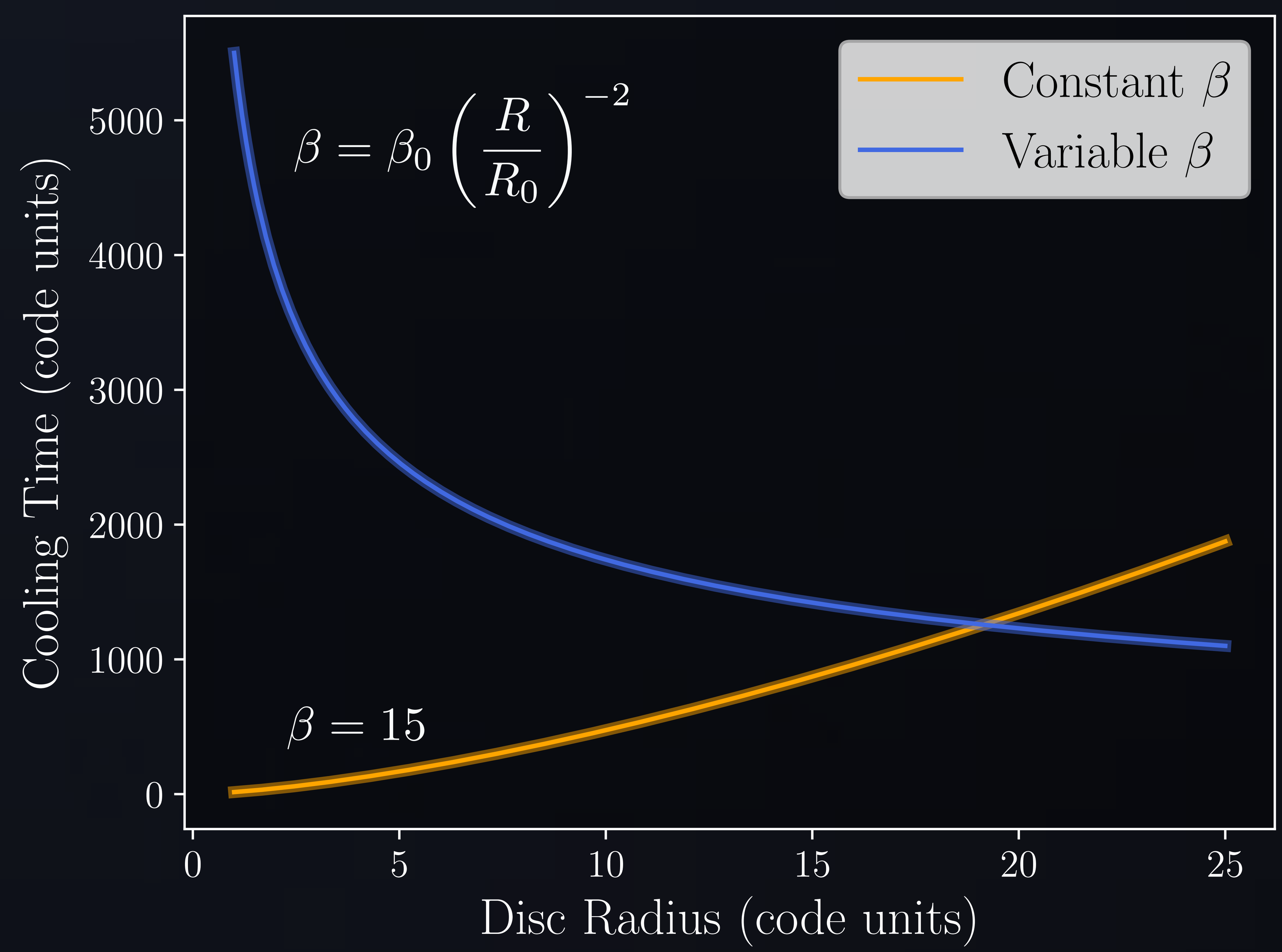
$$t_{cool} = \beta\Omega^{-1}$$

Traditionally – β is a constant. Entire disc becomes gravitationally unstable, which is not expected in realistic self-gravitating discs.

This work – β is radially dependent. Only outer regions becomes gravitationally unstable, mimicking a realistic self-gravitating disc.





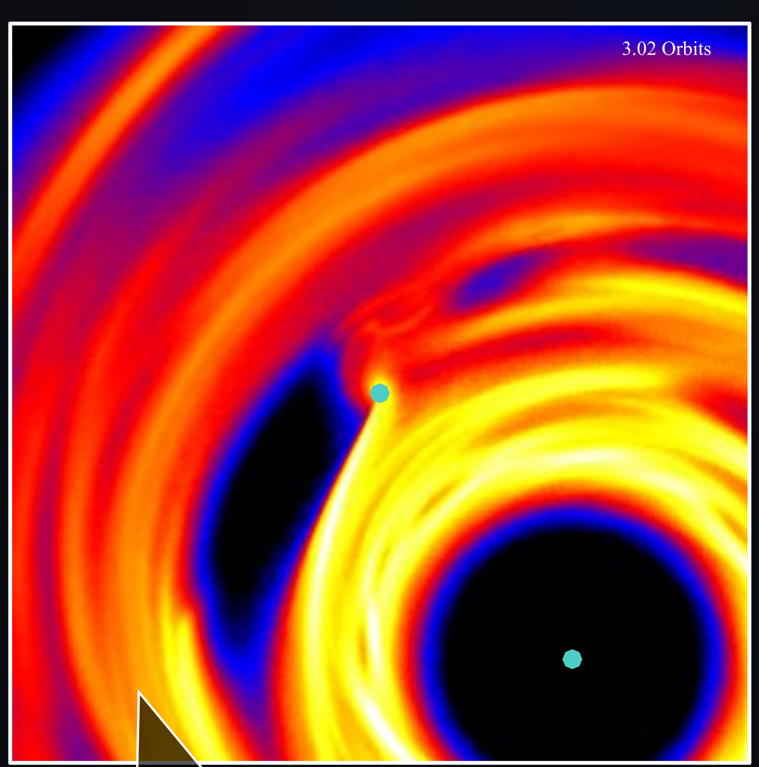


Can planets slow their migration in the gravitationally stable inner disc?

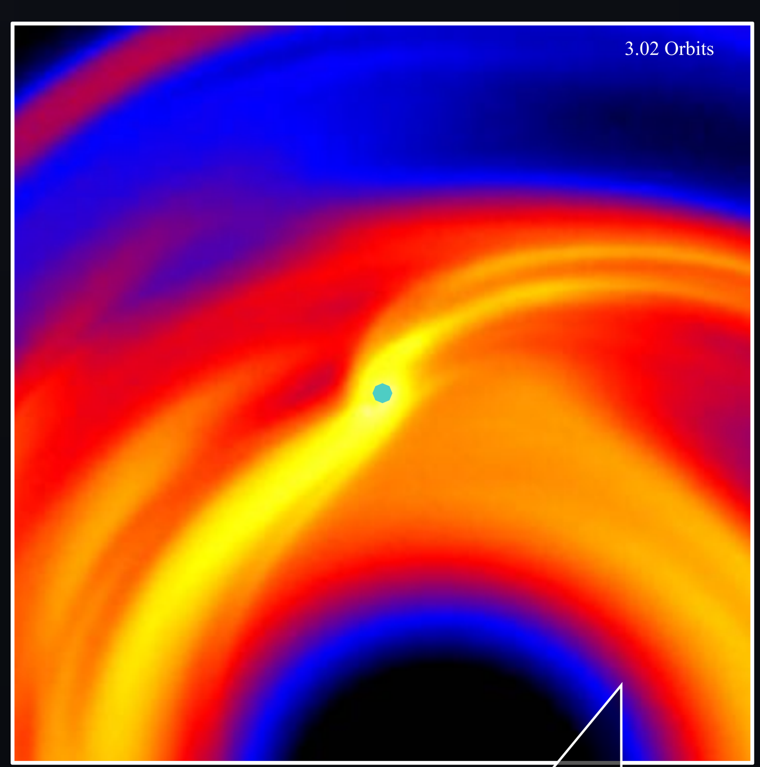
Rowther & Meru (2020) , "Planet Migration in Self-Gravitating Discs: Survival of Planets". MNRAS, Volume 496, Issue 2, August 2020, pp1598-1609

Impact of co-orbital material on planet migration 2

Constant β



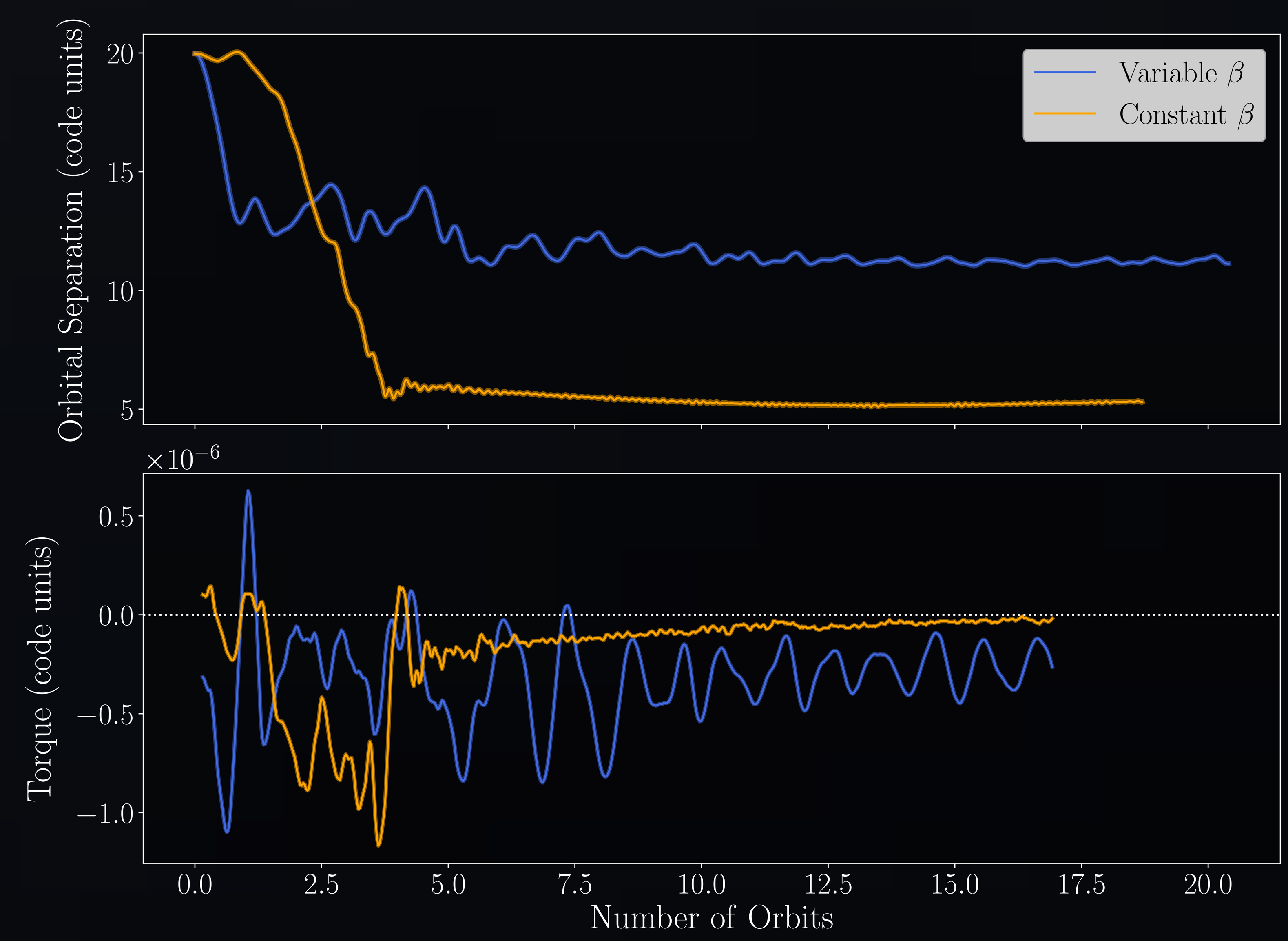
Variable β



Density fluctuations throughout results in asymmetric structure around the planet as it migrates. Hence, the negative corotation torque remains high and the planet is unable to stop its inward migration.

Smooth inner disc results in symmetric structure around the planet once it reaches the inner regions. Hence, the negative corotation torque becomes smaller and the planet is able to slow its inward migration.

Migration of a $1M_{Jup}$ planet 3



Constant β – Gravitationally unstable throughout the disc; hence torque remains largely negative until planet reaches the disc boundary.

Variable β – Torque is less negative when it reaches the gravitationally stable inner disc, where it continues to migrate at a slower rate.

Conclusions 4

With a cooling prescription that mimics a realistic self-gravitating disc that is only gravitationally stable in the outer regions, **planets are able to survive in the inner regions of the disc.**

Software used: Phantom - Price, Daniel J. et al. (2018). "Phantom: A Smoothed Particle Hydrodynamics and Magnetohydrodynamics Code for Astrophysics". Publications of the Astron. Soc. of Australia 35, e031.