Resonant Dynamical Friction in the Galactic Centre

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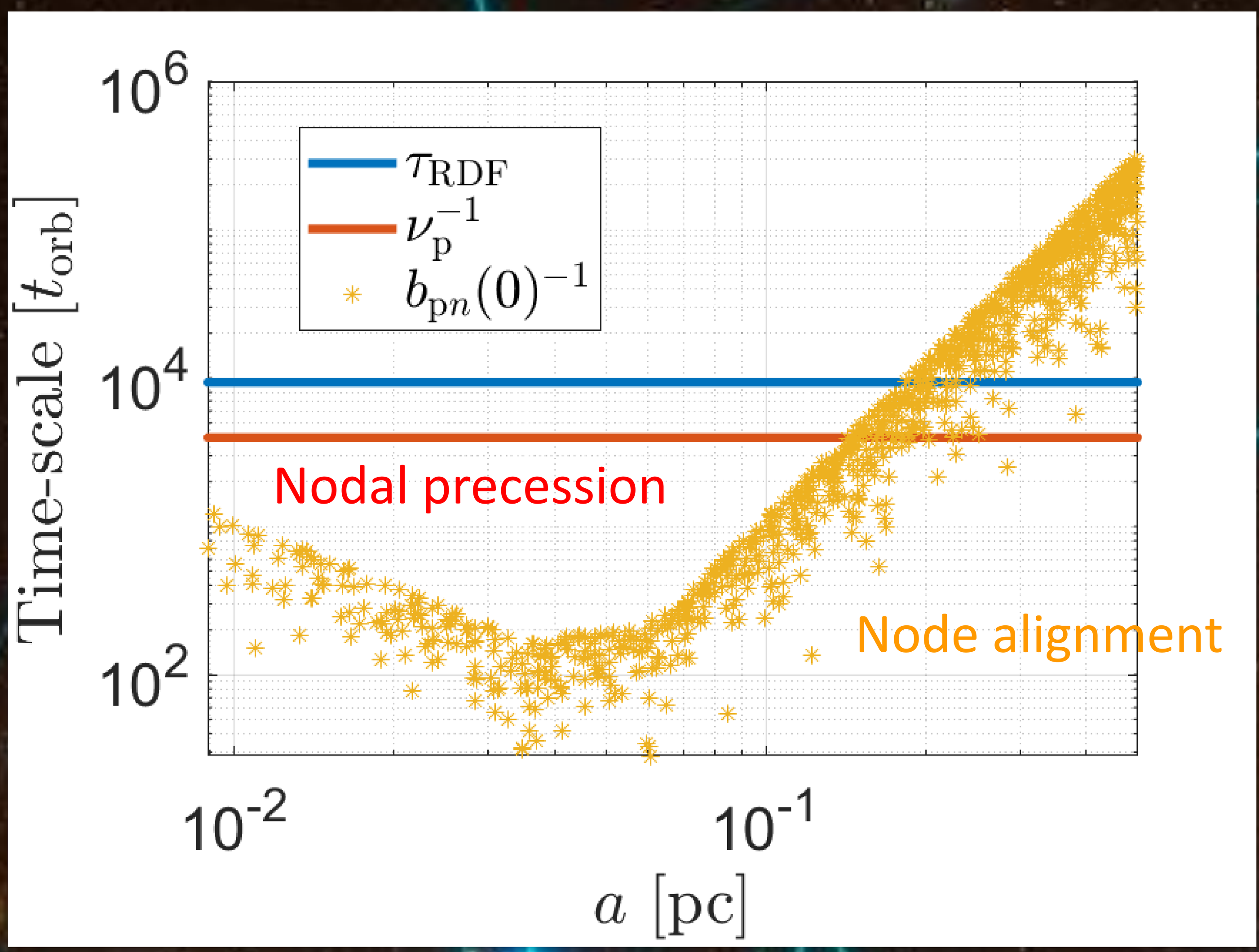
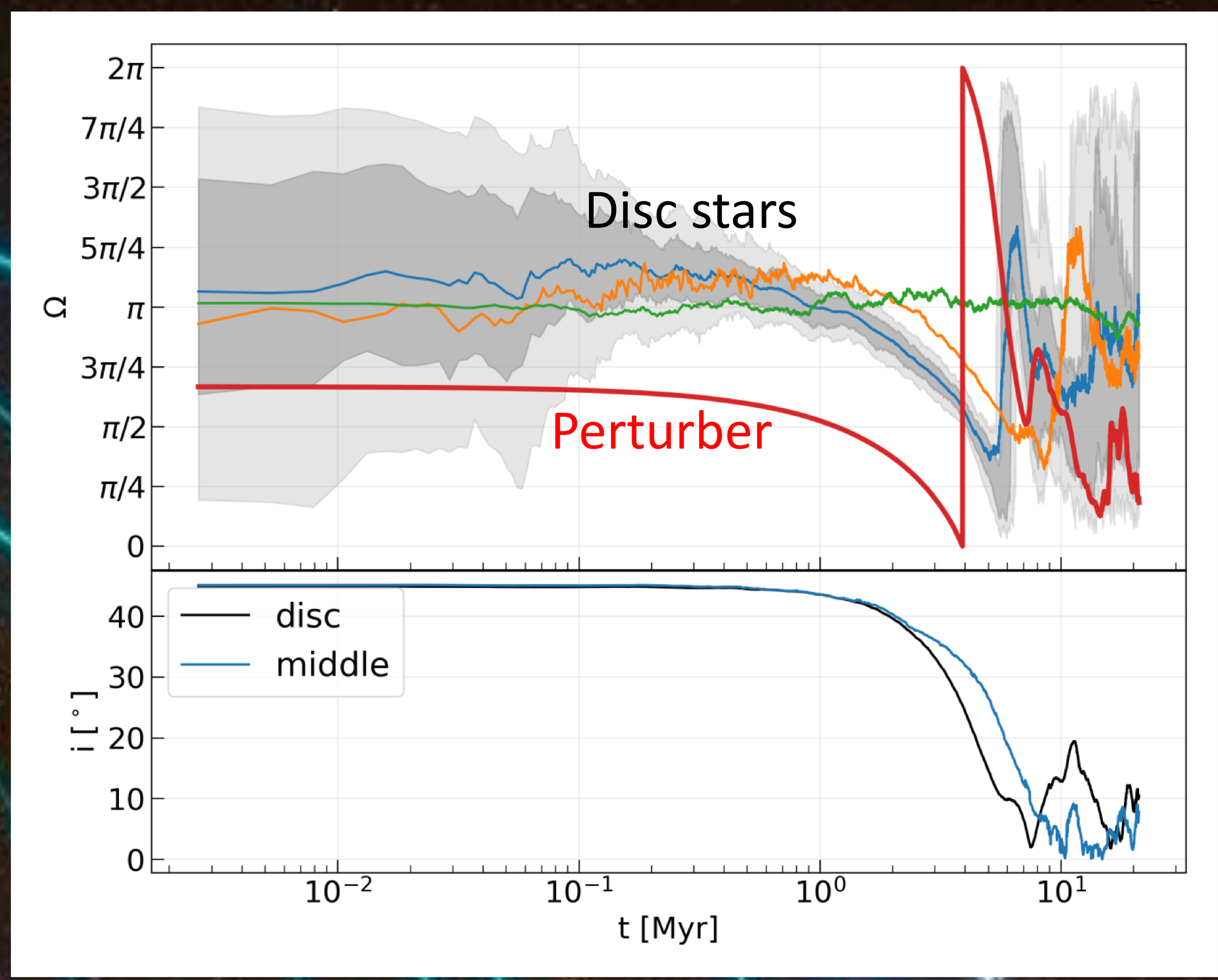
Based on: Ginat et al. (2022), arXiv:2211.14784

1. The super-massive black hole at the Galactic centre is surrounded by a disc of stars.
2. If a massive perturber approaches at an inclined orbit, resonant relaxation is dominates the dynamics.
3. Rapid alignment of the arguments of the ascending node of the disc stars with the perturber Ω_p.
4. This causes a net torque on the disc.
5. Warped disc reacts back by pulling the perturber towards it.
6. Effect stops when the perturber enters the disc.
7. Entire phenomenon – roughly one period of Ω_p.

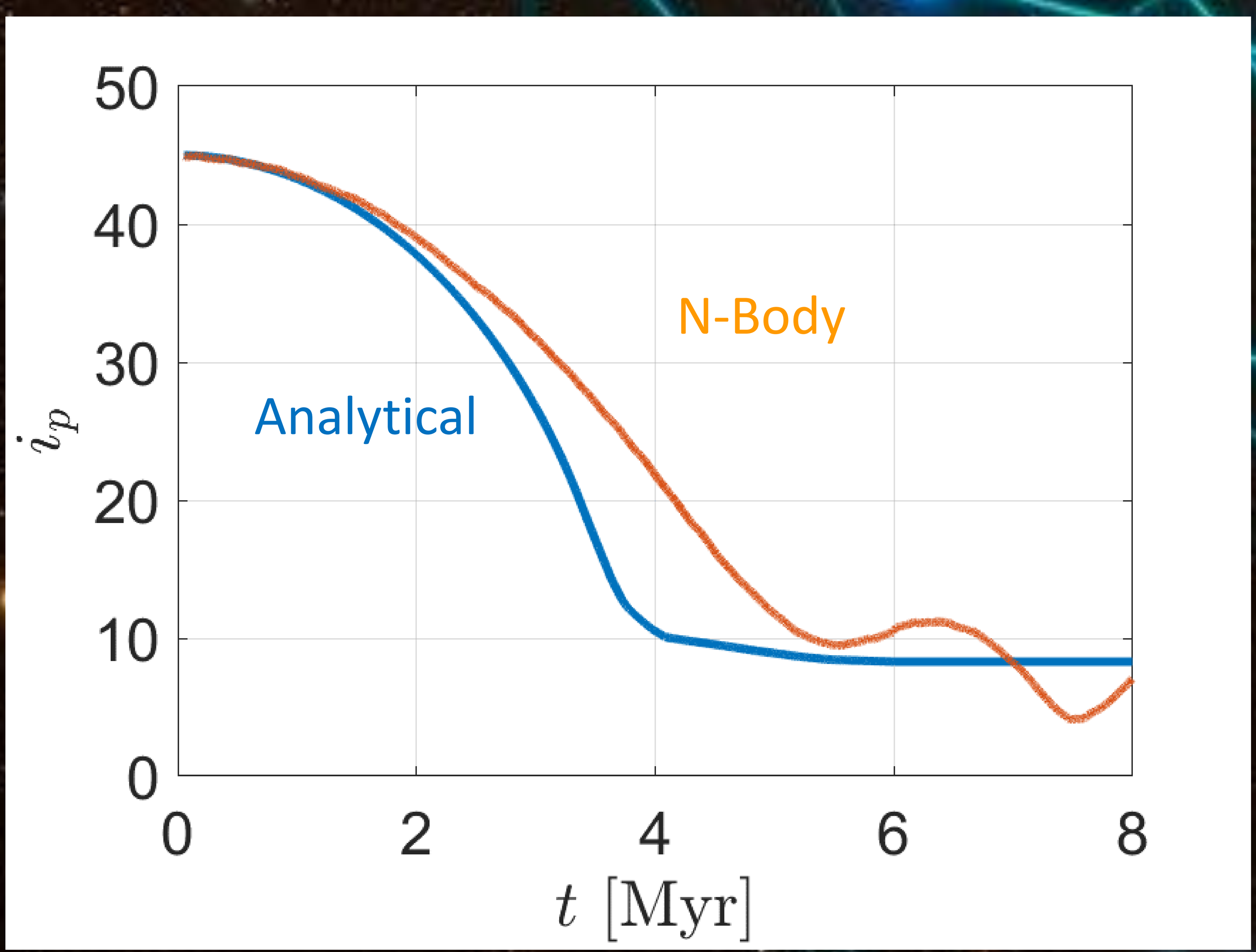
$$\tau_{RDF} \sim \frac{M_{BH}}{\sqrt{M_d m_p}} \frac{t_{orb}}{\sin 2i_{p0}}$$

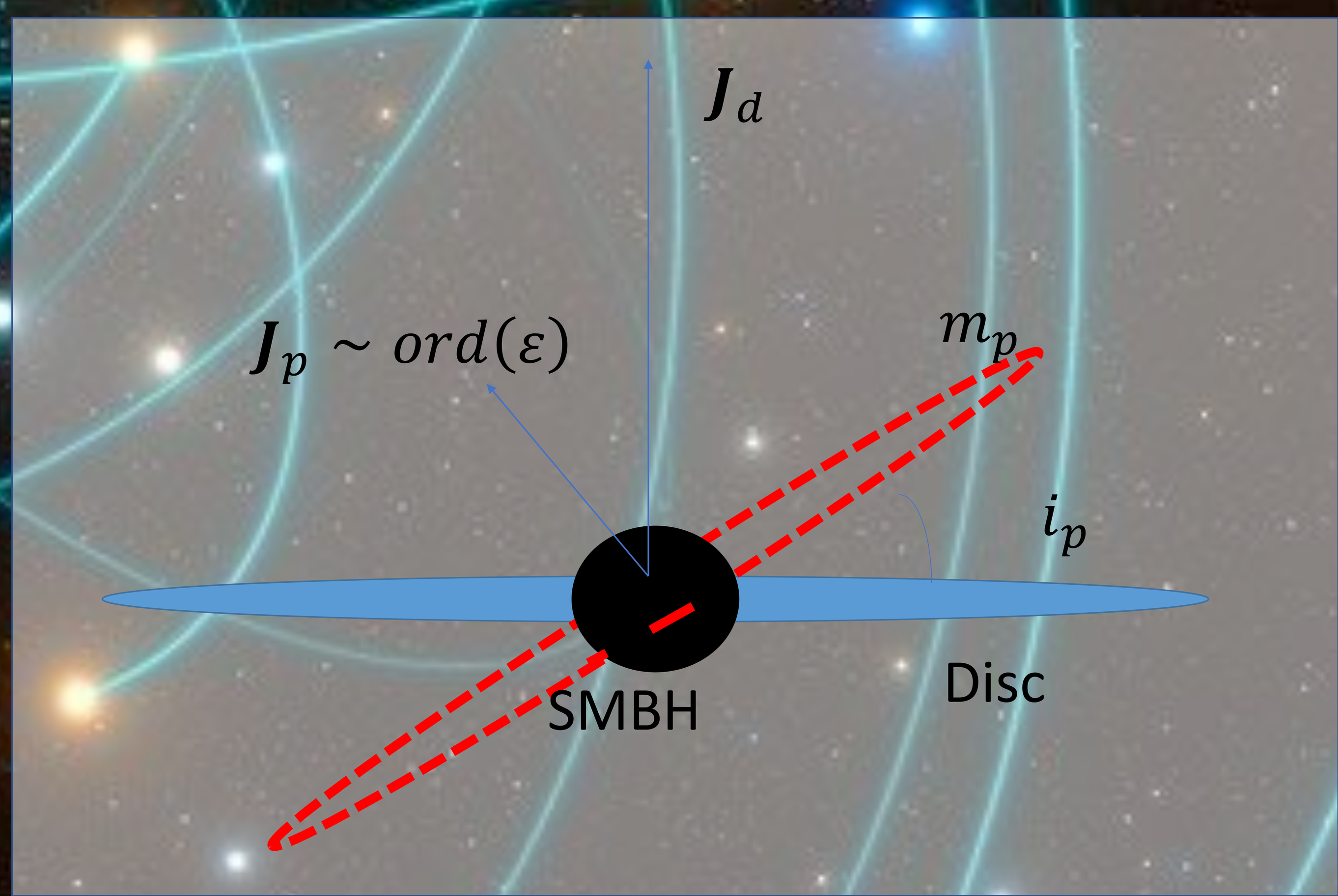


Three time-scales are involved in the process: the alignment of Ω_n with $\Omega_p + \frac{\pi}{2}$, the precession rate $\dot{\Omega}_p$, and the time-scale for the inclination change.



The nodal alignment with the perturber persists until the latter enters the disc.





Solving the equations of motion perturbatively in the mass ratio $\varepsilon \equiv \frac{m_p}{M_{BH}}$, and being mindful of the 3 time-scales involved, allows one to derive an analytic evolution equation for the inclinations.

We can see in the simulation data that the stars inside the perturber's orbit trail it with a phase-difference of 90°.