# Dynamical Evolution of Dense Star Clusters in Galactic Nuclei

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By means of direct numerical $N$-body modelling, we investigate the orbital evolution of an initially thin, central mass dominated stellar disc. We include the perturbative gravitational influence of an extended spherically symmetric star cluster and the mutual gravitational interaction of the stars within the disc. Our results show that the two-body relaxation of the disc leads to significant changes of its radial density profile. In particular, the disc naturally evolves, for a variety of initial configurations, a similar *broken power-law* surface density profile. Hence, it appears that the single power-law surface density profile $\propto R^{-2}$ suggested by various authors to describe the young stellar disc observed in the Sgr A* region does not match theoretical expectations.

## Model

The components of the studied system are: (i) the dominating central mass, SMBH, represented by the Keplerian potential, (ii) the stellar disc treated as a group of gravitating particles on initially circular orbits, and (iii) the spherical cluster which we model either by a static analytical gravitational potential or by a larger number of gravitating particles. The dynamical evolution of the system is followed numerically, by means of the $N$-body integration code NBODY6 (Aarseth 2003).

## Surface density profile evolution

Our calculations show that the evolution of the disc leads, for a wide set of its initial density profiles, to a broken power-law surface density profile: $\Sigma(R) \propto R^{\beta_i}$. Furthermore, we find that its shape is not influenced by the possible presence of the spherical cluster in the system.

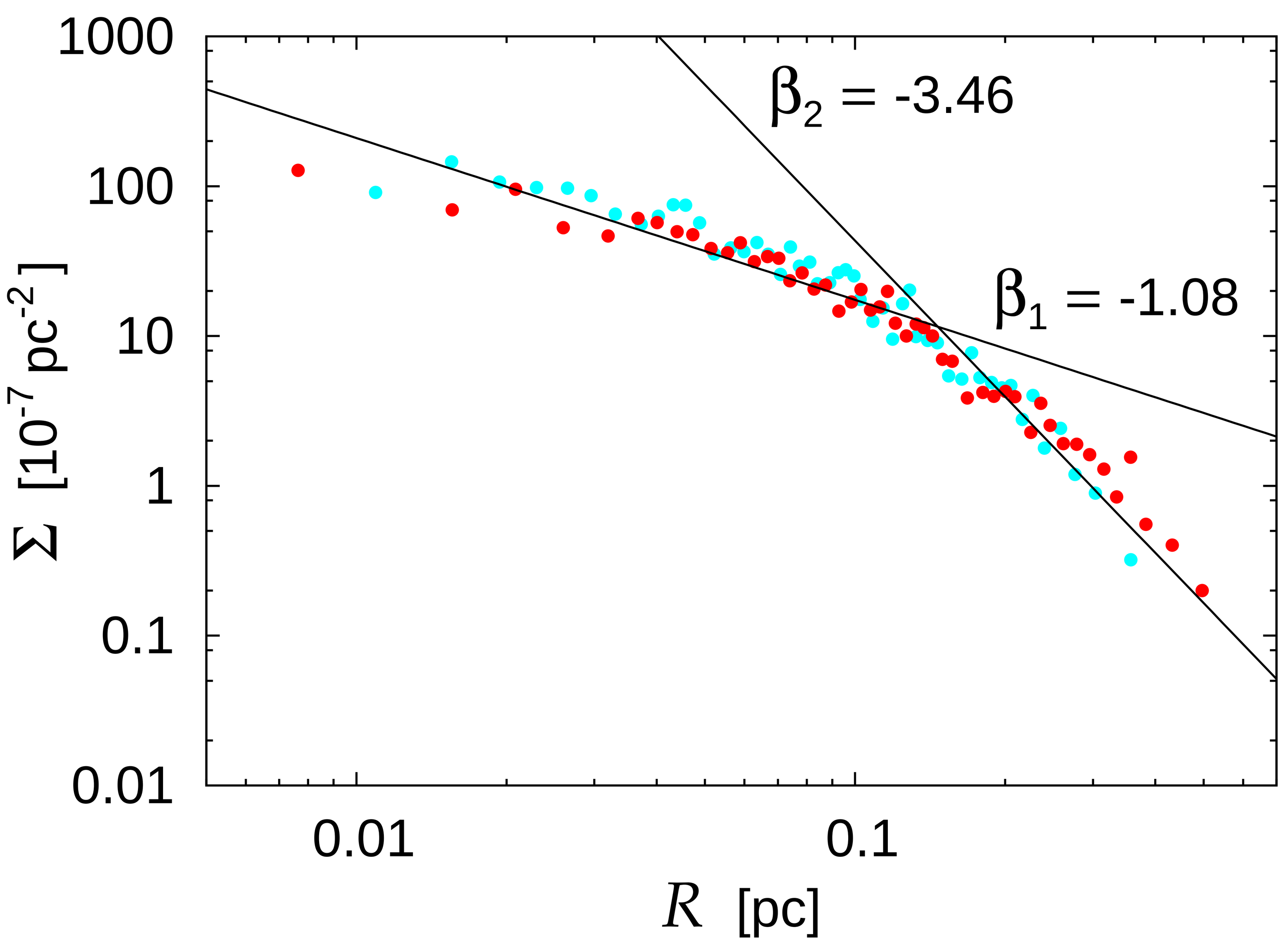


Figure 1: Projected surface density profile of the disc at $t = 6$ Myr for two different initial distributions of the radii of the individual stellar orbits: $\mathrm{d}N/\mathrm{d}R \propto R^{-1}$ (red) and $\mathrm{d}N/\mathrm{d}R \propto R^{-2}$ (cyan).

With respect to the young stellar disc observed in the Sgr A* region, our results are in a good agreement with the broken power-law reported by Buchholz et al. (2009) for this system ($\beta_1 = -1.08$, $\beta_2 = -3.46$; see Fig. 1), in contrary to the single power-law $\Sigma(R) \propto R^{-2}$ suggested by various authors (e.g., Paumard et al. 2006, Lu et al. 2009).

## Eccentricity distribution evolution

Unlike the surface density profile, the evolution of the eccentricity distribution in the disc is affected by the cluster gravity if the cluster is modelled by a group of gravitating particles. In such a case, the eccentricity evolution is slightly accelerated (red line in Fig. 2) in comparison to the situation with no cluster present (blue line in Fig. 2) or the cluster represented by an analytical potential (green line in Fig. 2).

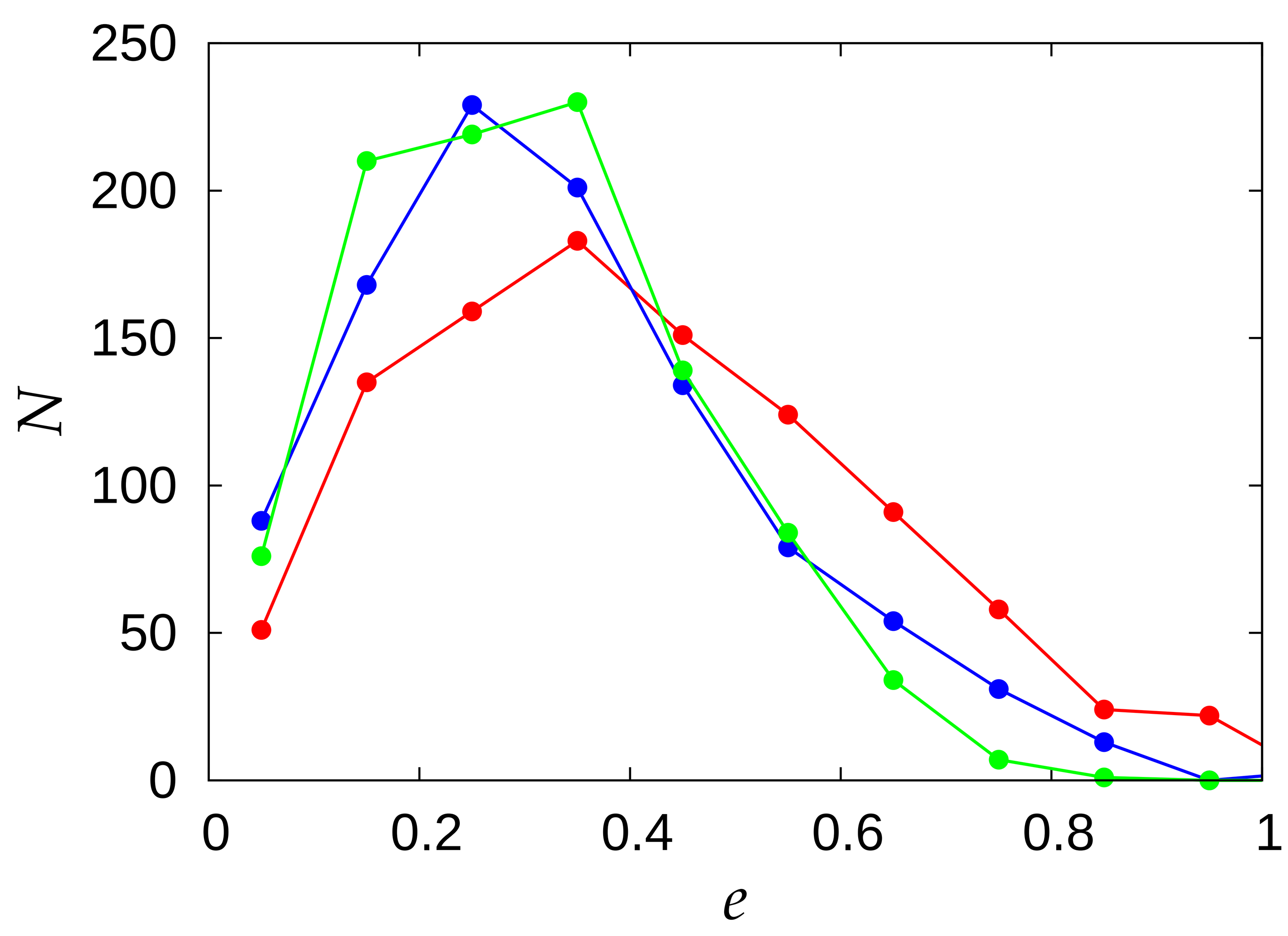


Figure 2: Eccentricity distribution in the disc at $t = 6$ Myr for three different treatments of the cluster gravity: no cluster present (blue), analytical potential (green) and a large number of gravitating particles (red).

## References and acknowledgments

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This work has been supported by project LD12065 of the research programme COST CZ of the Czech Ministry of Education, Youth and Sports.