Supernova Kicks and Dynamics of Compact Remnants in the Galactic Centre

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Introduction

The Galactic Centre (GC) is an ideal laboratory to study the extreme dynamical processes occurring in proximity of a super-massive black hole (SMBH).

The GC is a very crowded and puzzling place, and it still poses a plethora of questions:

- What is the origin of the S-cluster of young B stars around the SMBH?
- What is the nature of G1 and G2, two dusty objects recently spotted near the SMBH?
- Why pulsars seem to be missing in the GC?
- Why do we observe a cored distribution of red giants instead of a cuspy one?

We make use of **3-body simulations** to understand **what is the role of Supernova (SN) explosions occurring in binary stellar systems within the GC** ?

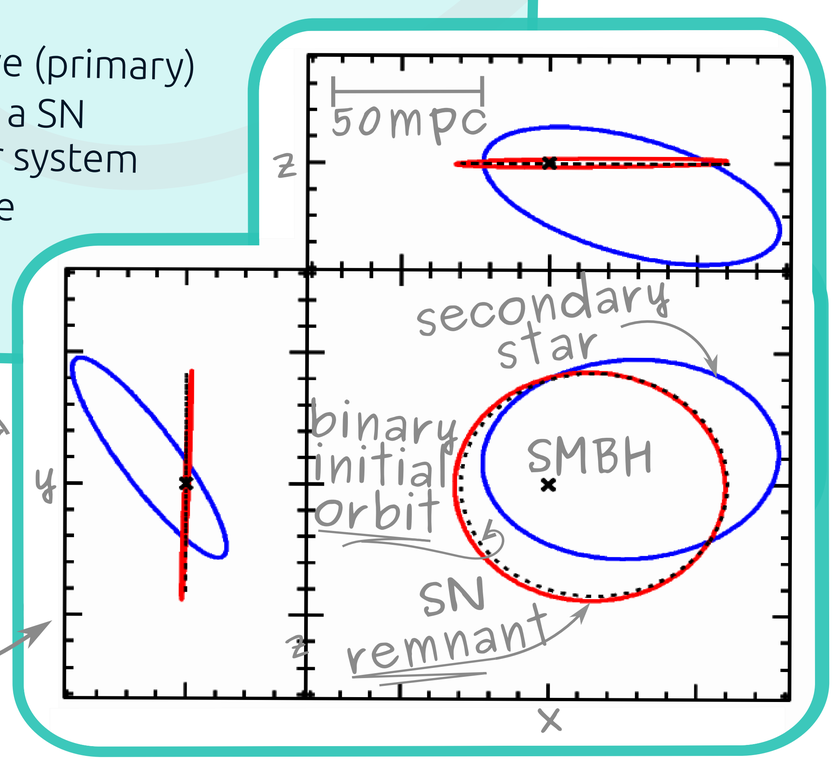
SN kicks may:

- reshuffle the orbits of pulsars, other dark remnants and red giants
- push low mass stars into highly eccentric orbits, such as the ones of G1and G2

Methods

- We perform 30k **regularized** 3-body simulations
- *In each run:*
  1. a stellar binary is placed within the clockwise disk and orbits around the SMBH
  2. the more massive (primary) star explodes as a SN
  3. the perturbed stellar system is evolved around the SMBH for 1 Myr

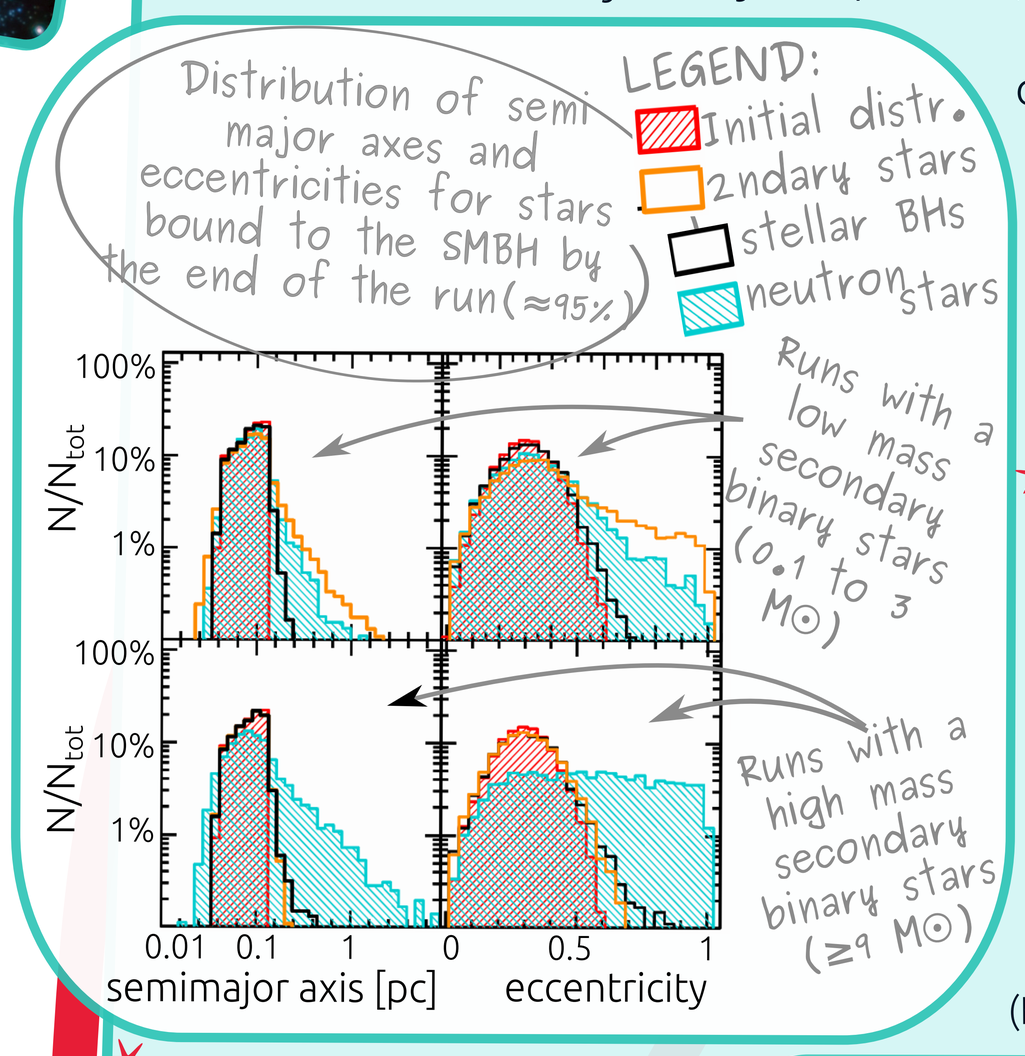
An example in the right Fig.



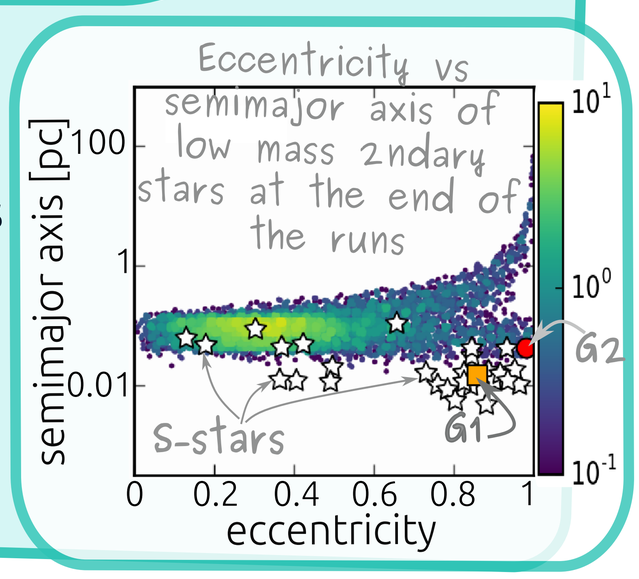
Orbits of the two stars before and after the SN kick in a selected run

Results

- After the kick, the **lighter stars** (i.e. neutron stars or low mass secondary binary components) are generally scattered on completely **different orbits**, with higher eccentricities and inclinations.
- Stellar mass **black holes** (BHs) and **massive secondary stars retain memory of their initial orbit** instead (Fig. on the left).



- ~40% of remnants stay bound to the companion after the SN kick → up to 70% of them might become **X-ray binaries** through Roche lobe filling.
- ~3% of the low mass secondary star orbits are compatible with those of **G1** and **G2** (right scatter plot).



Conclusion

- **BHs** do not change their orbits significantly →a **cusp of BHs** may have formed around the SMBH
- **Neutron stars** are generally scattered away from the SMBH → the missing pulsars problem may be a result of SN natal kicks.
- **G1**and **G2** might have been low-mass stellar companions to massive GC stars.

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