

Evolution of star clusters including IMBHs and their feeding to the SMBH

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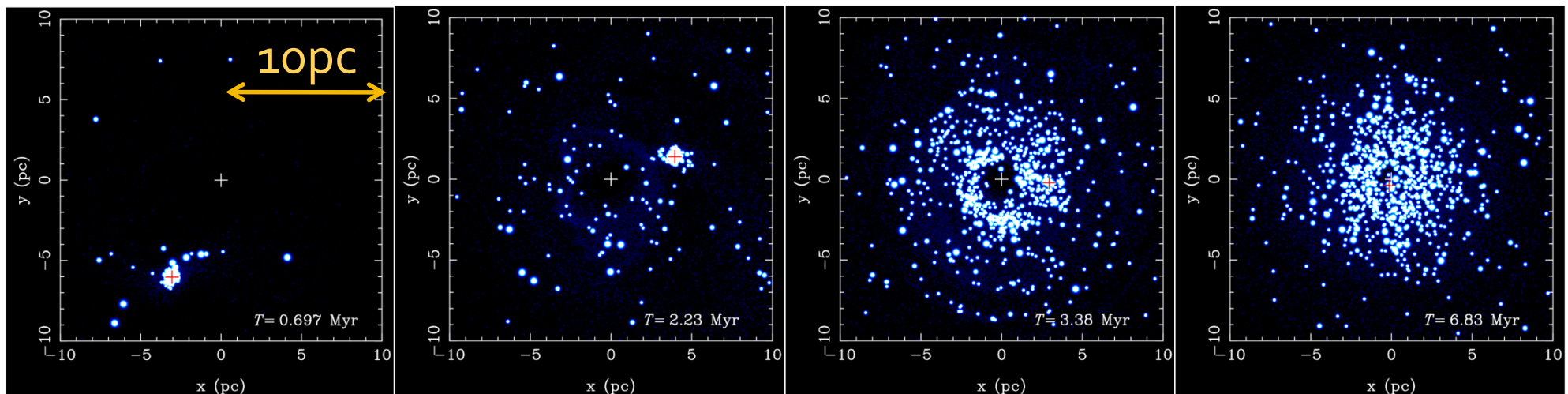
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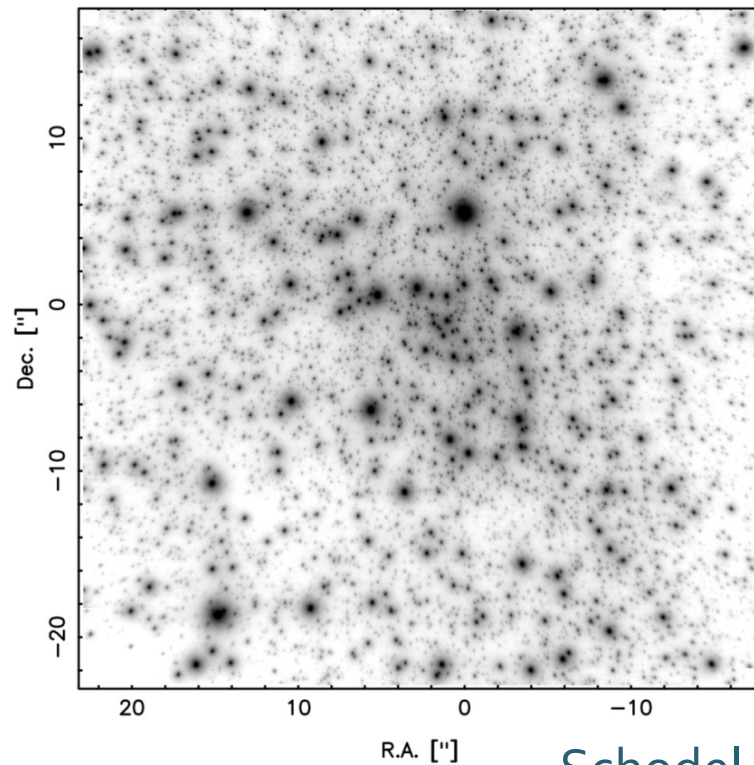
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Abstract

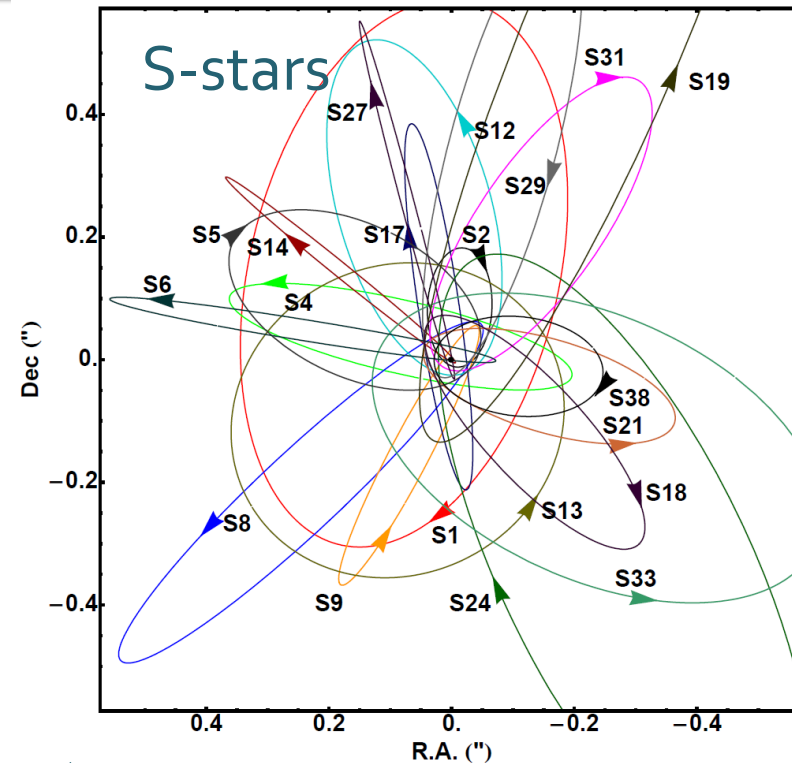
- We performed N-body simulations of a young star cluster spiraling into the Galactic center (GC).
 - An IMBH formed in the cluster via runaway collisions.
- We found that a mean motion resonance of the central SMBH and the IMBH carries young stars to the GC.
 - a new formation scenario of S-stars
- IMBHs can feed the SMBH.



The Galactic center



Schodel et al. (2007)



Gillessen et al. (2009)

- Young massive stars have been observed
- One or two disks ($0.1 < r < 1$ pc) ; Lu+(2007), Paumard+ (2006)
- S-stars (< 0.1 pc); a random orbital distribution

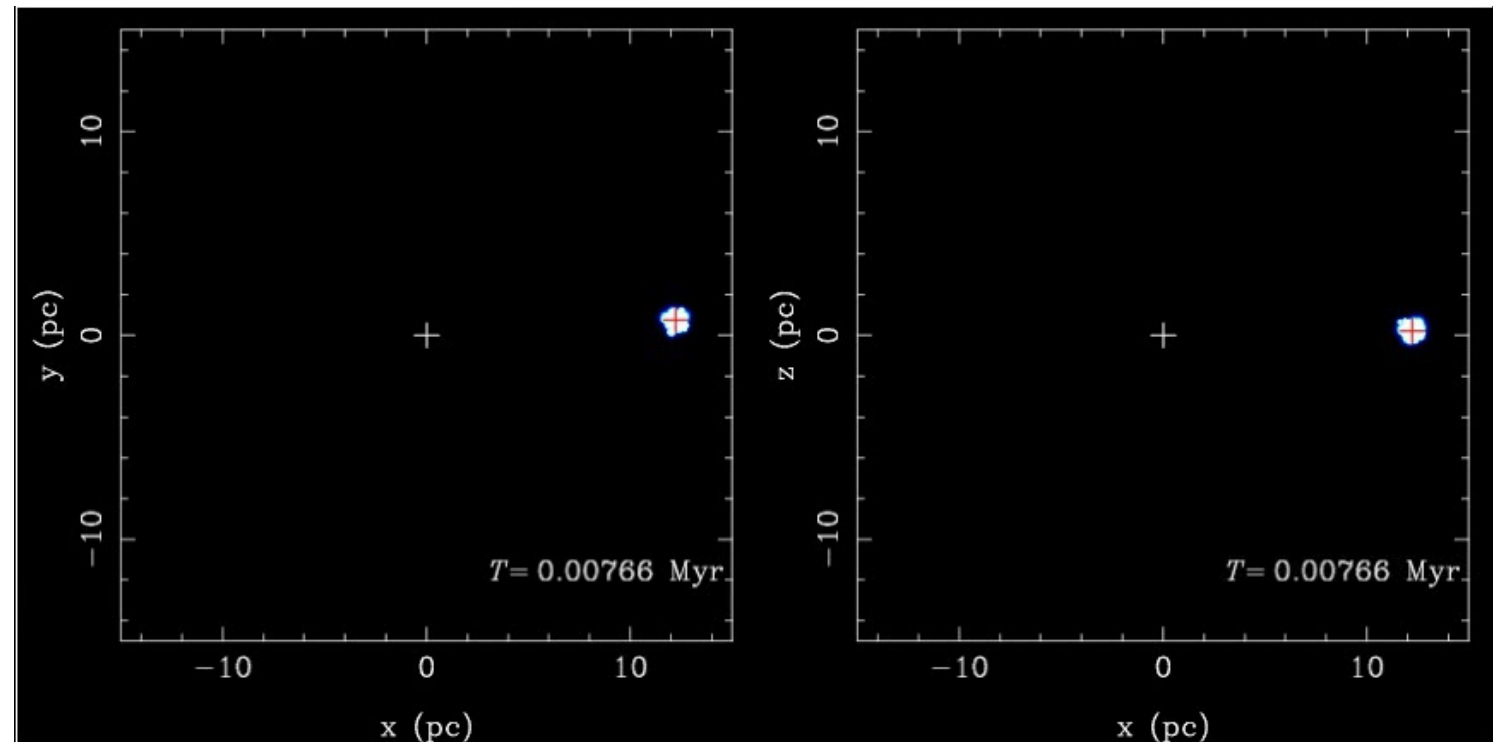
Can migration of a star cluster form these system?

N-body simulation

- Star cluster ($\sim 10^5 M_{\text{sun}}$) spirals in the GC from ~ 10 pc
- BRIDGE: a hybrid of tree and direct code
 - It can treat both star clusters and galaxies as N-body systems.
 - Includes collision of stars and formation of an IMBH ($\sim 10^4 M_{\text{sun}}$)

Only the star cluster is plotted.
The origin is the central SMBH.

Cluster was disrupted,
but stars were carried to the GC!

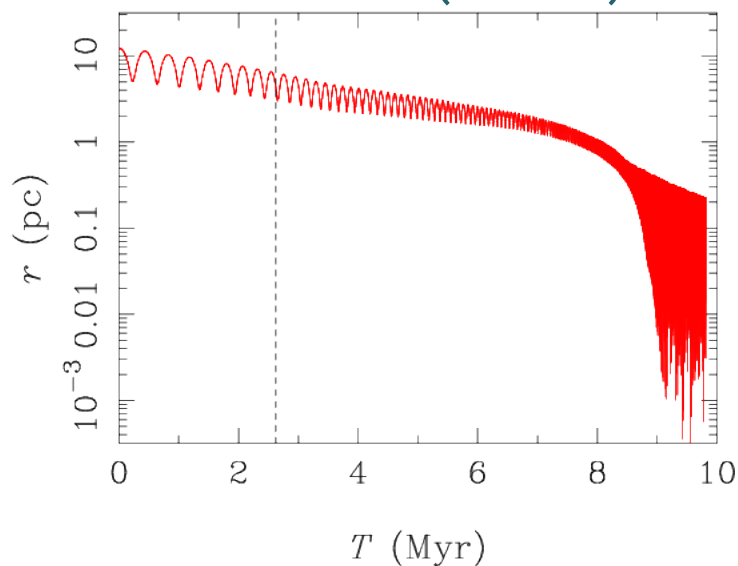


1:1 mean motion resonance

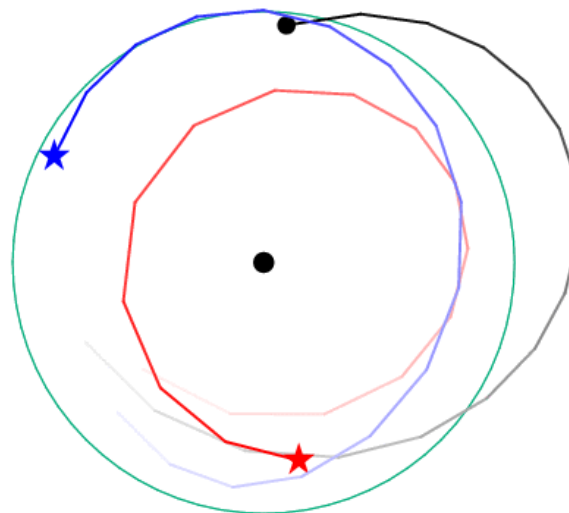
Fujii et al. (2009)

- The IMBH sinks to the GC due to the dynamical friction.
- Stars captured in the mean motion resonance of the SMBH and IMBH follow the IMBH.
 - Similar to Trojan asteroids of Jupiter.

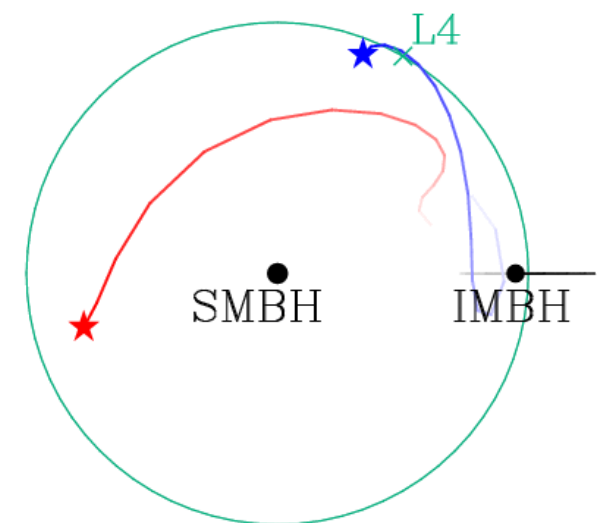
Orbital evolution of the cluster (IMBH)



xy-plane

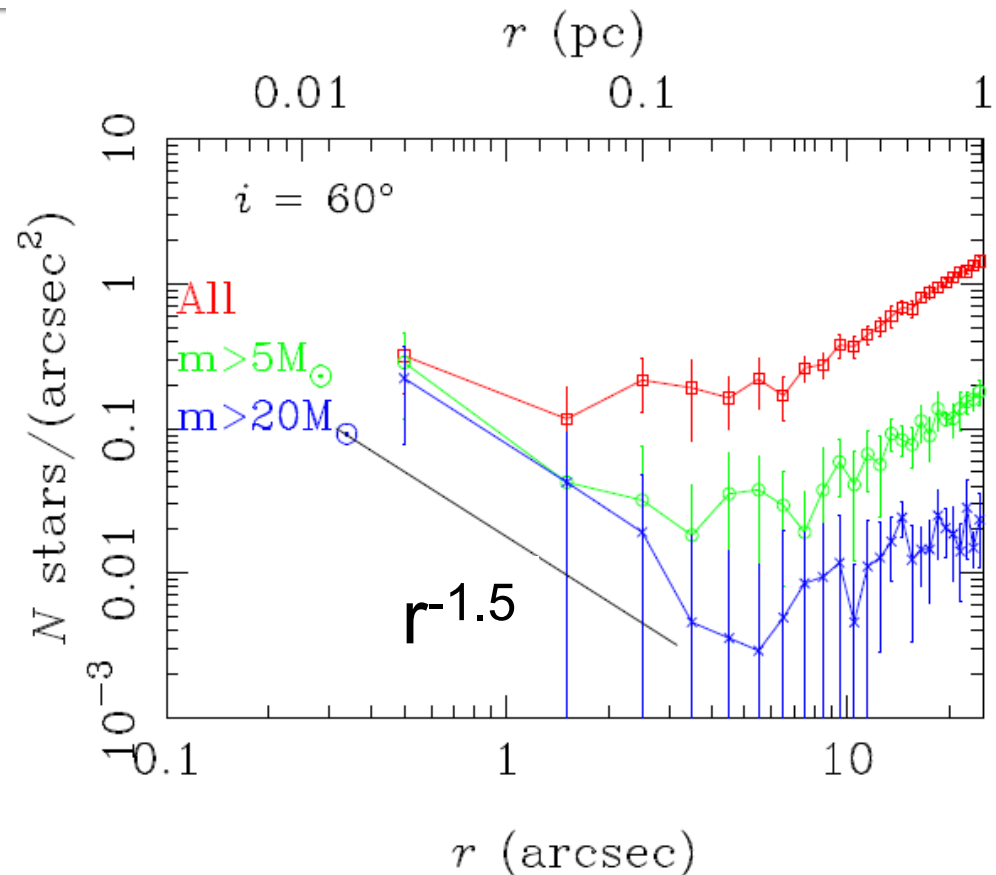
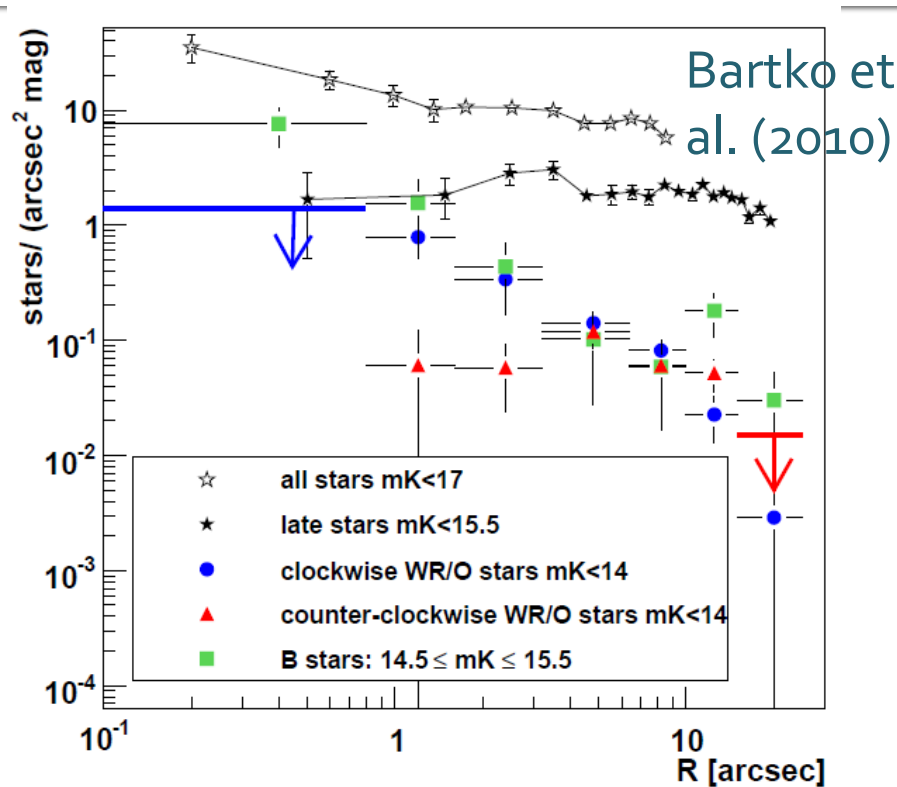


Rotating frame



Surface density profile of young stars

Fujii et al. (2010)

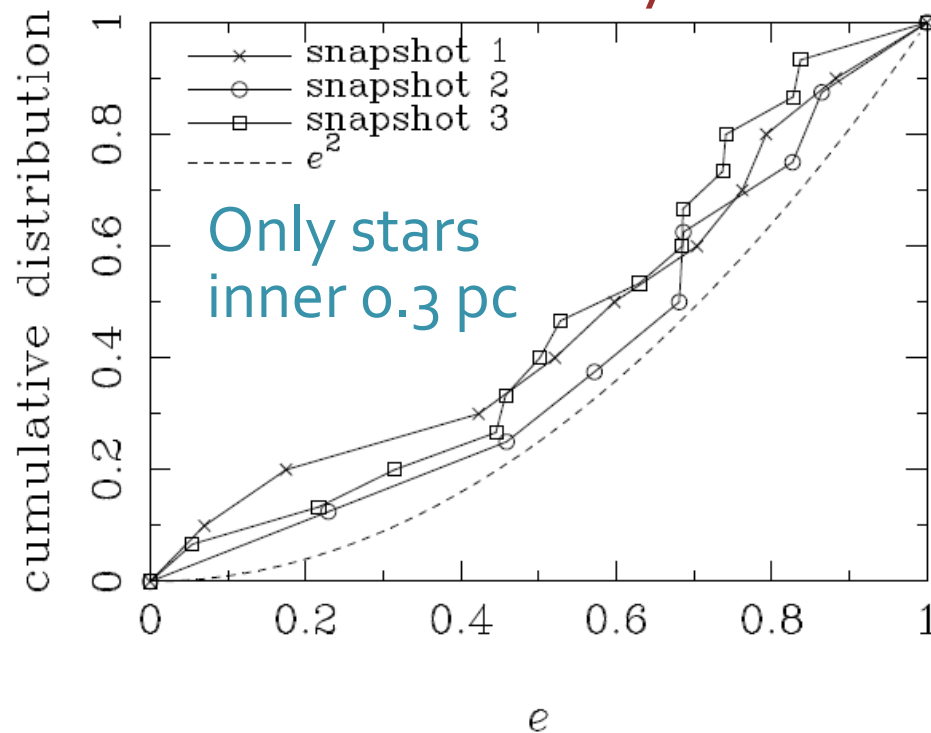


- Similar to S-stars.
 - Further from the GC than S-stars, but it depends on the model
- The surface density profile of massive stars is similar to observed one in the GC.
- Massive stars concentrate on the GC.

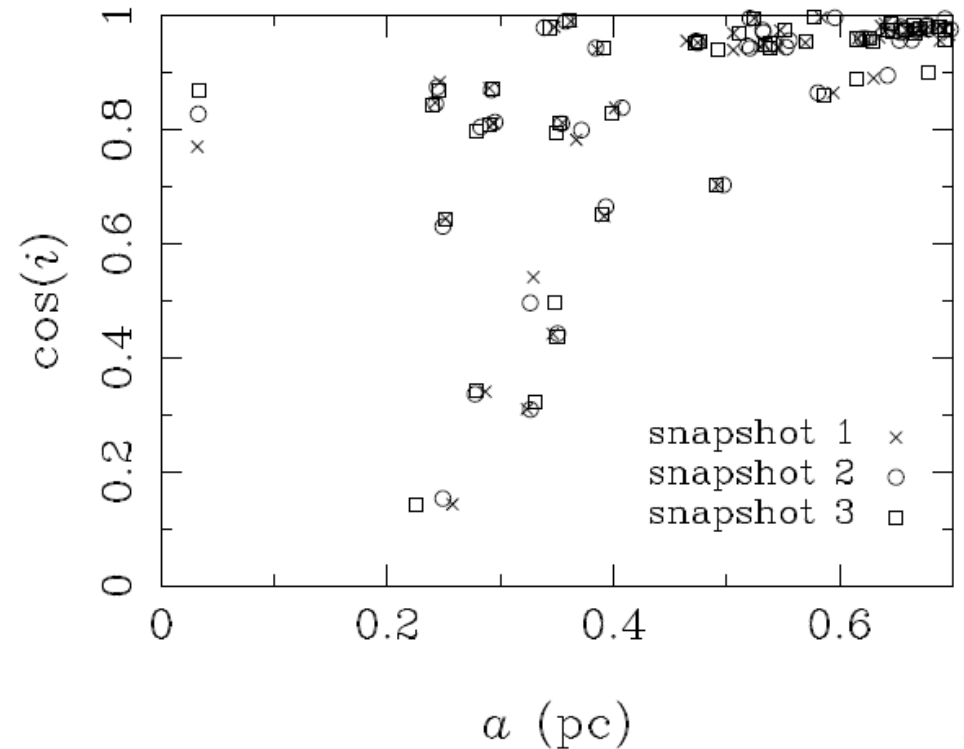
Distributions of eccentricities and inclinations

Fujii et al. (2010)

Eccentricity



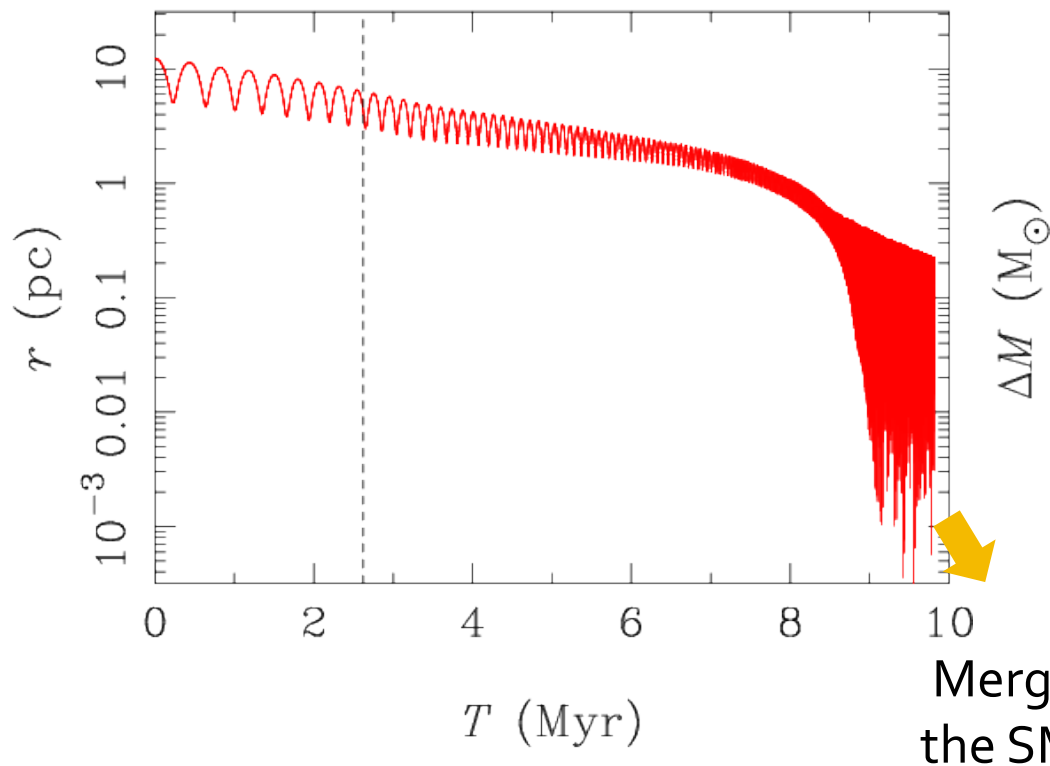
Inclination



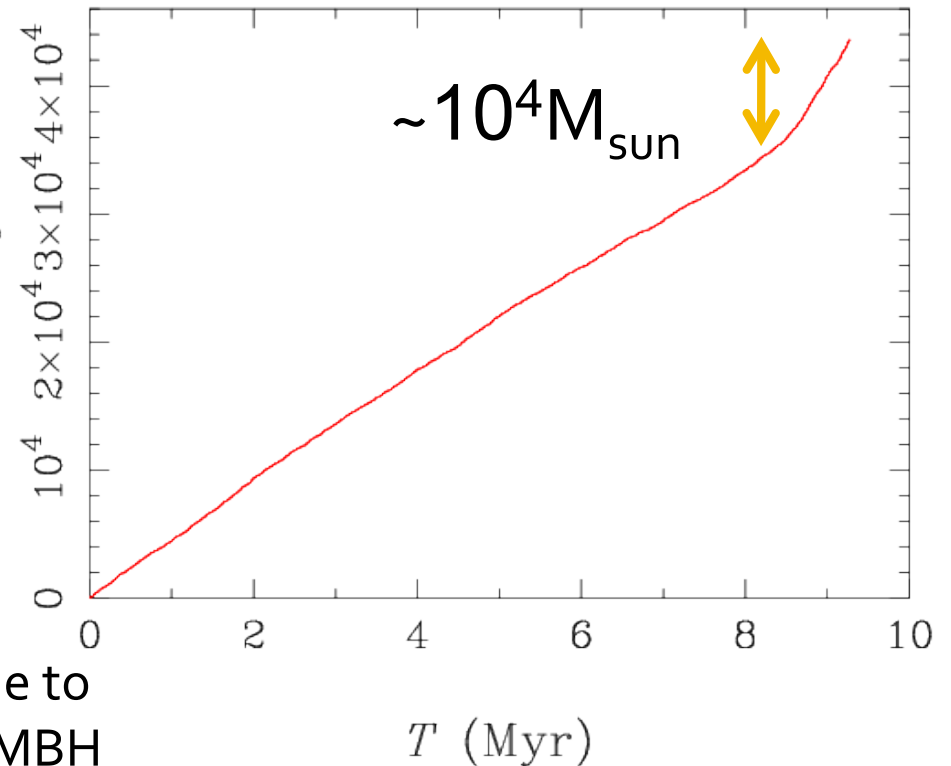
- Eccentricities show a thermal distribution
- The orbits of stars are randomized near the central BH.
 - Similar results with Gualandris and Merritt (2009)

Feeding to the SMBH

Orbit of the star cluster (IMBH)



Increase of the SMBH mass



- Not only the IMBH itself, field stars also fall into the SMBH when the IMBH approaches to the SMBH.
 - The mass is comparable to the IMBH mass.

Summary

- We performed an N-body simulation that a star clusters sinks to the Galactic center.
- If an IMBH forms in the cluster, it can carry young stars to the GC by the mean motion resonance of the SMBH and IMBH.
- It might forms S-stars.
- The distributions of carried stars were similar to S-stars.
- The IMBH can feed the SMBH (IMBH + stars)