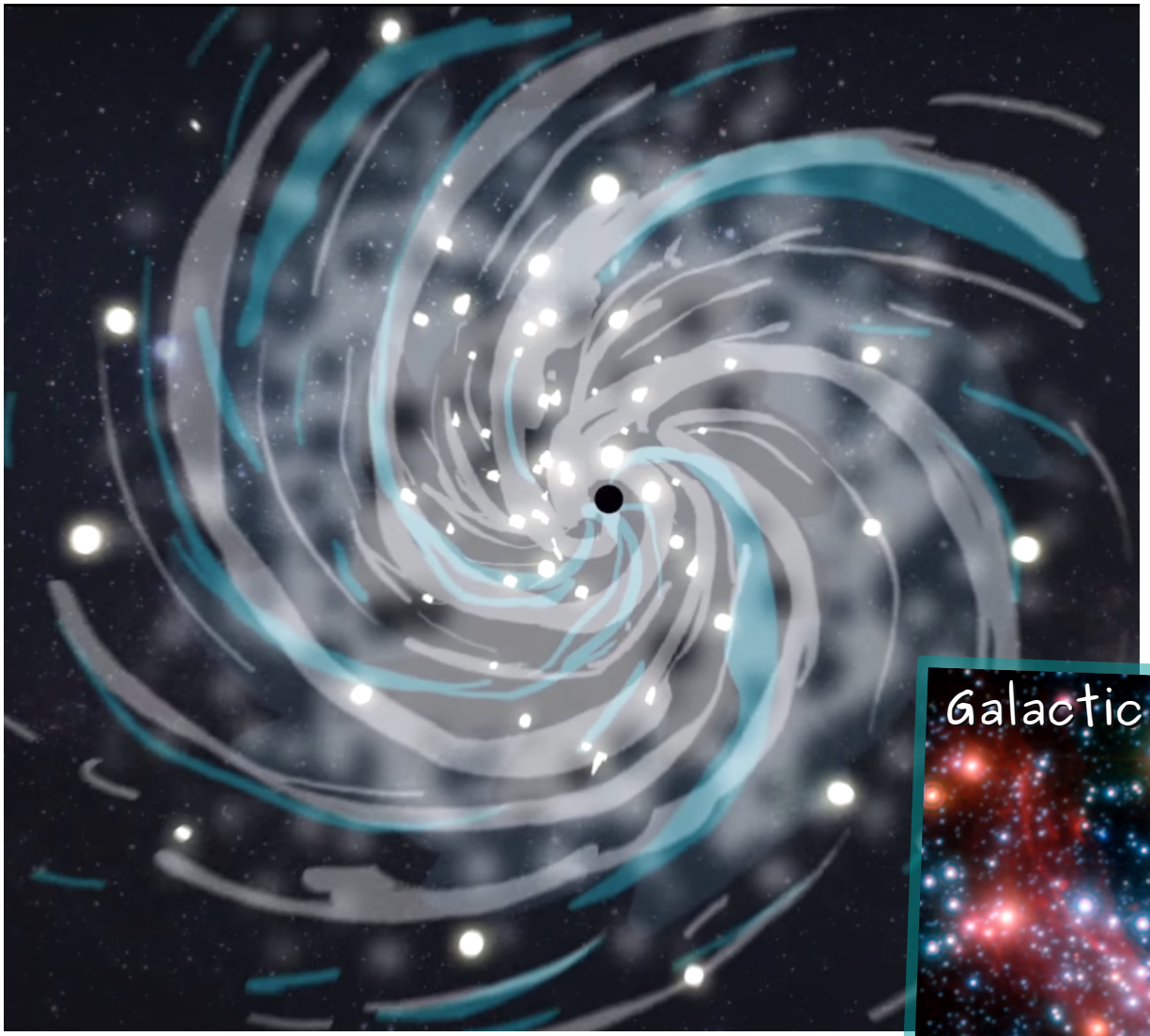
Dynamical evolution of galactic nuclei hosting supermassive black holes

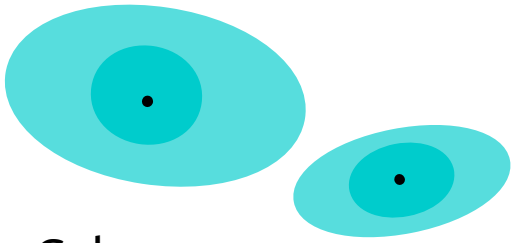


All sufficiently massive galaxies contain **supermassive black holes** (SMBHs)

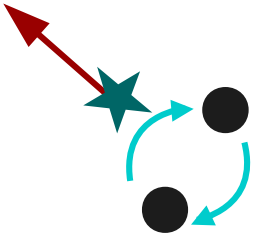
High stellar densities, extreme environments for both stars and gas

Numerical study of galactic nuclei

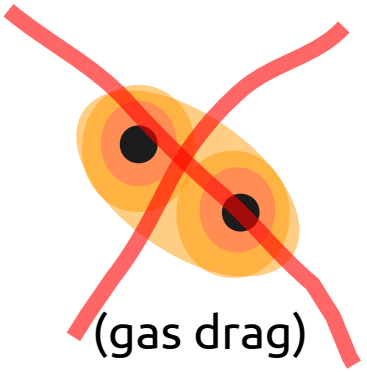
Galaxies Merge and SMBH binaries form



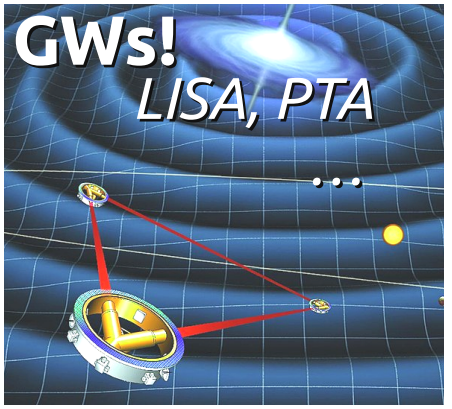
Galaxy merger



Slingshot ejections



(gas drag)



We should get accurate solutions to best constrain SMBH binaries evolution...

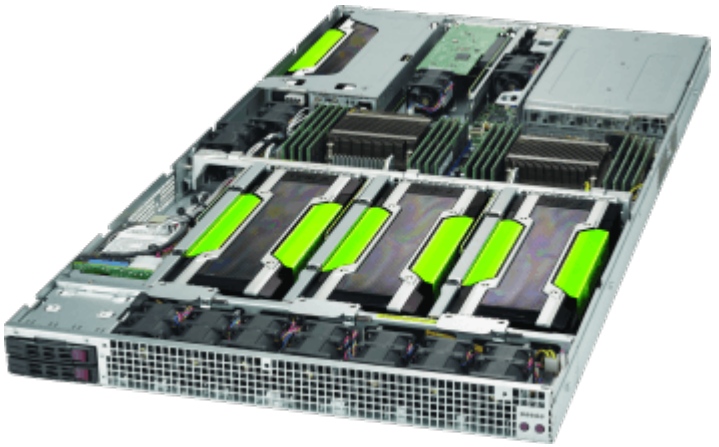
Direct summation N-body code

$$\mathbf{F}_i = -Gm_i \sum_{j=1,\ j\neq i}^{j=N} m_j \frac{\mathbf{r}_i - \mathbf{r}_j}{|\mathbf{r}_i - \mathbf{r}_j|^3}.$$

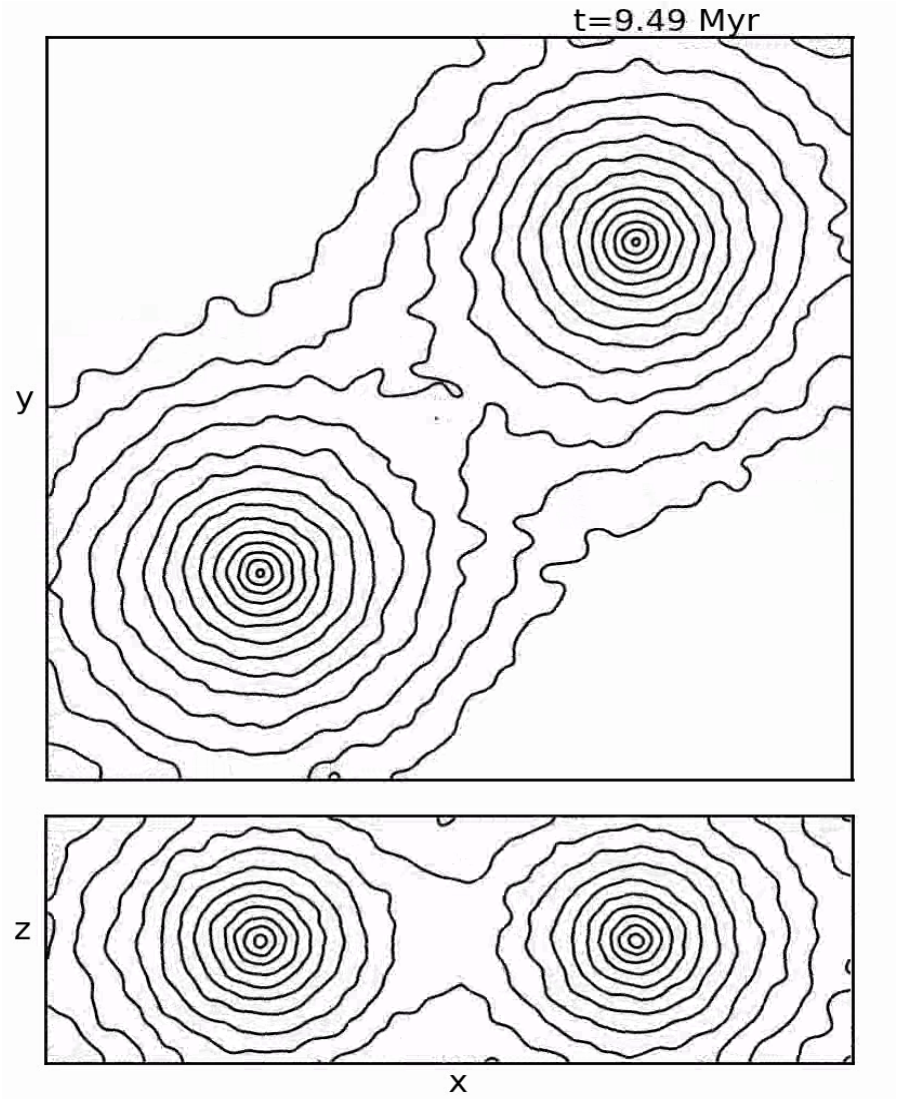
Running on 4 GPUs × 4 nodes = 16 GPUs on Galileo, a CINECA Italian Cluster

0.5-1 Million objects in each run

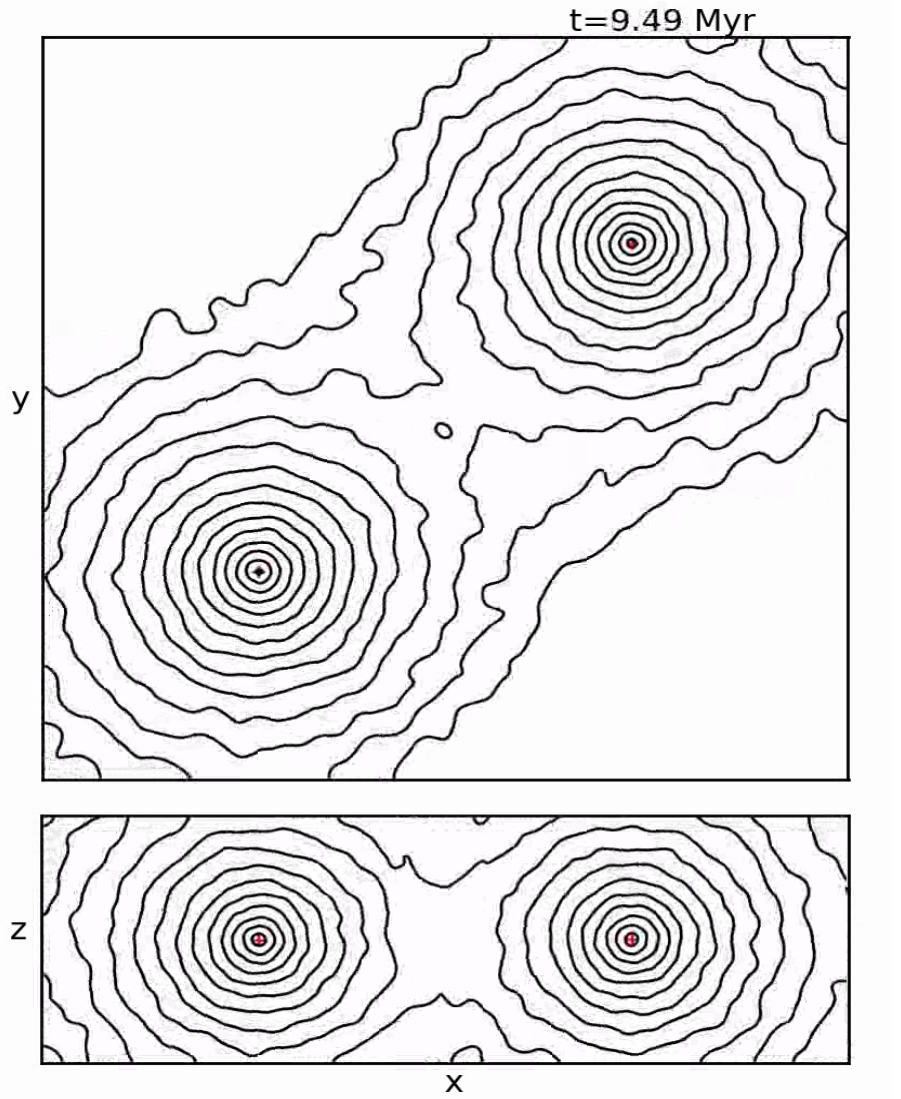
Fully parallel code **HiGPUs**
Exploiting MPI, OpenMP, CUDA and using Block timesteps, 6th order Hermite scheme
(Capuzzo-Dolcetta+,2014)



No SMBHs

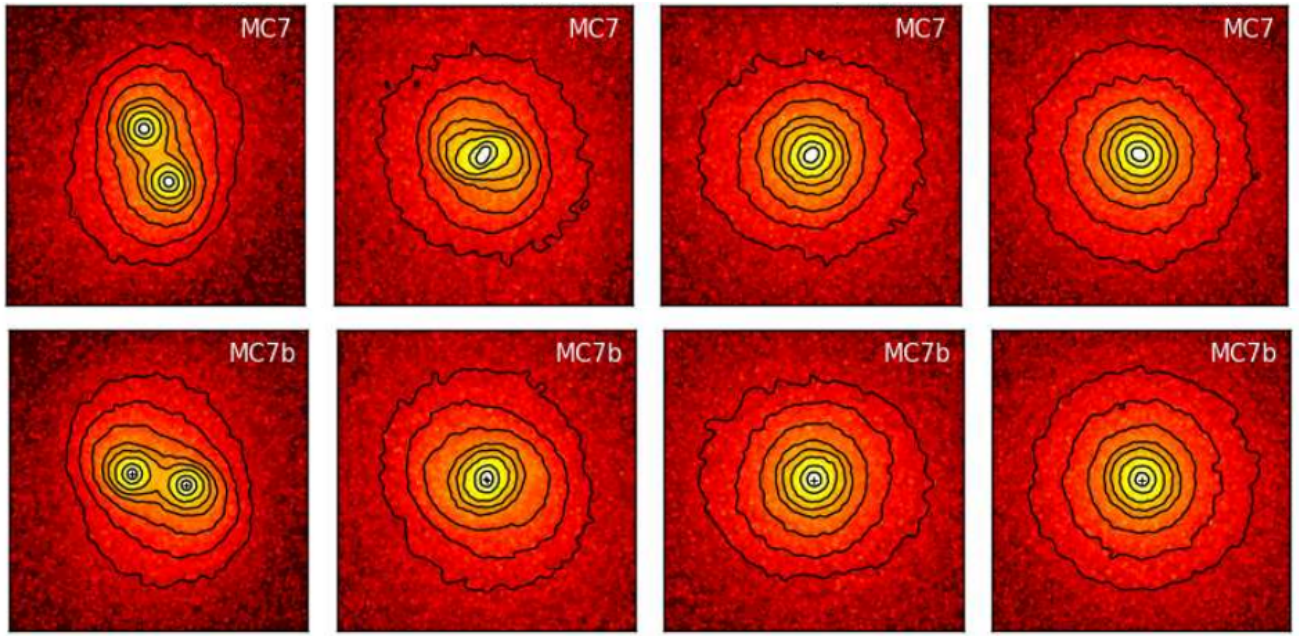


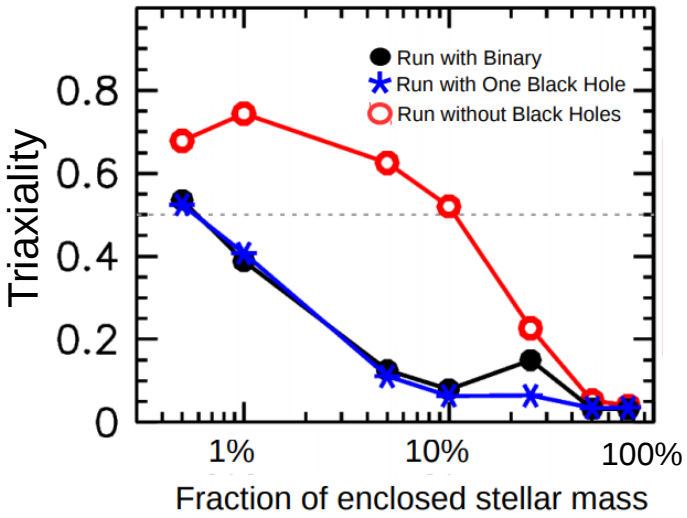
SMBHs (+)



Main results

The presence of a **SMBH binary** (or even a single SMBH) changes the shape of the merger remnant beyond its influence sphere!





The galaxy nucleus becomes more disky **(observationally important)**

No strong effect on the binary shrinking rate, which depends only on the galaxy stellar density → Gravitational wave emission stage is efficiently reached

EB+,2018