ICCUB | Institut de Ciències del Cosmos

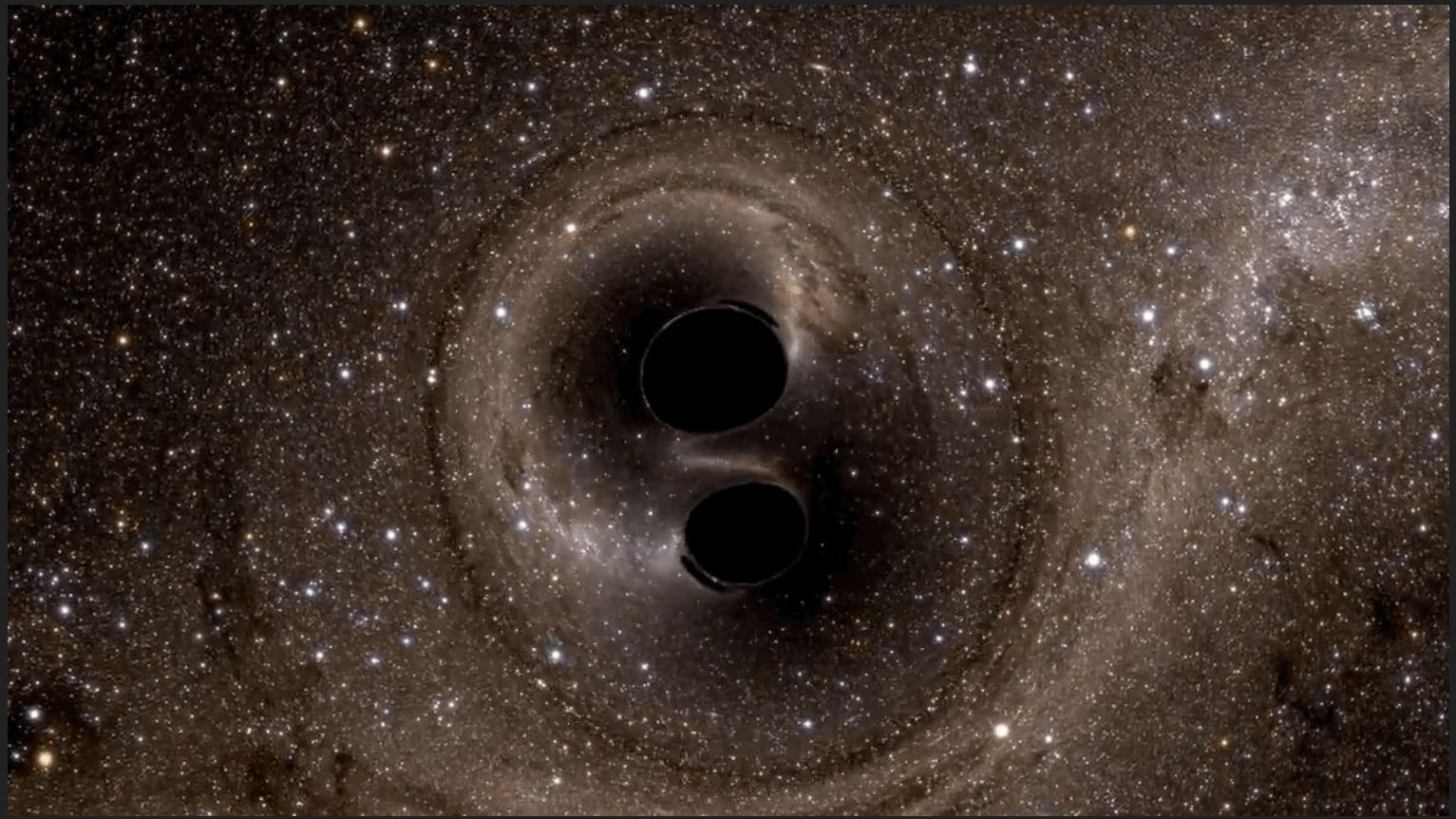
EXCELENCIA MARÍA DE MAEZTU

Black hole mergers from star clusters

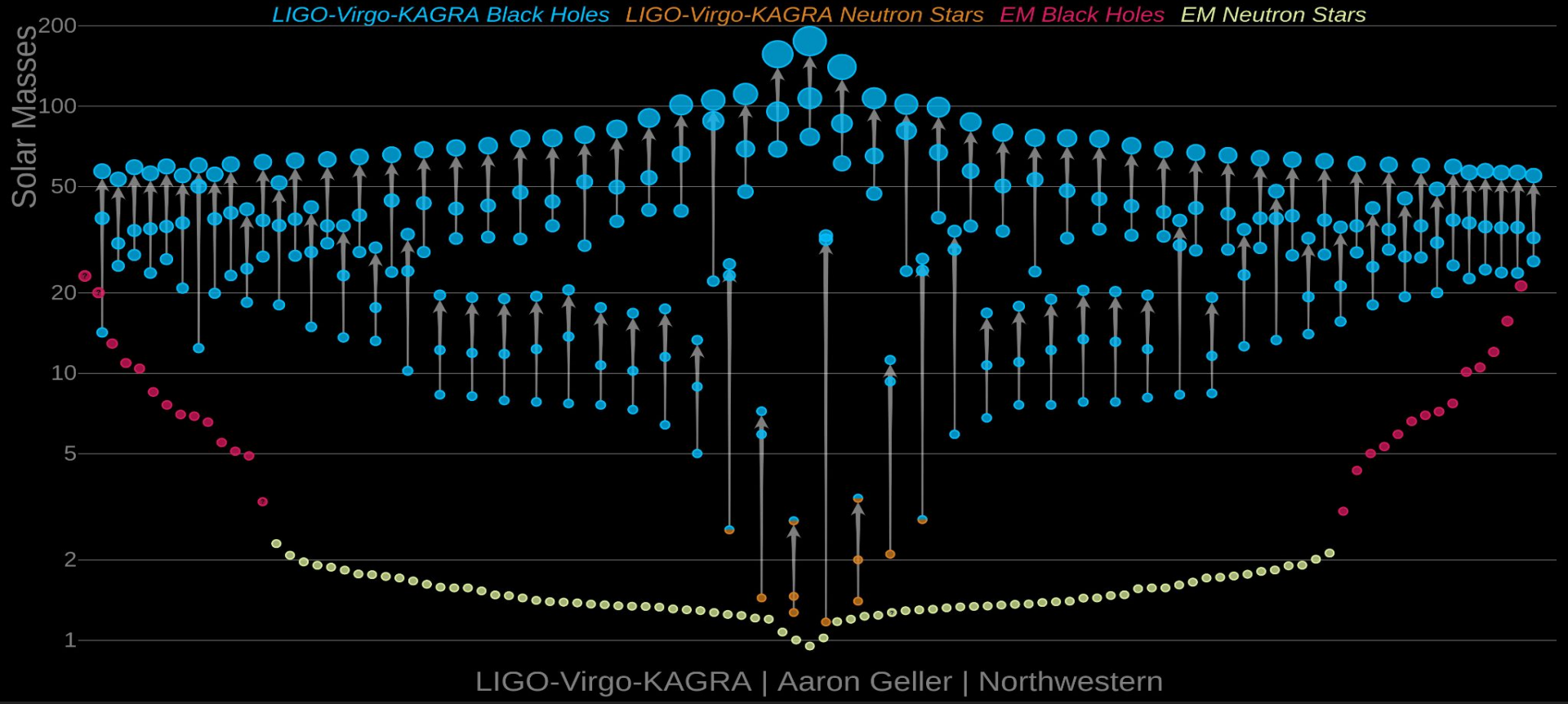
Winter Meeting 2022

Daniel Marín @ Universitat de Barcelona

Binary black hole merger



Masses in the Stellar Graveyard

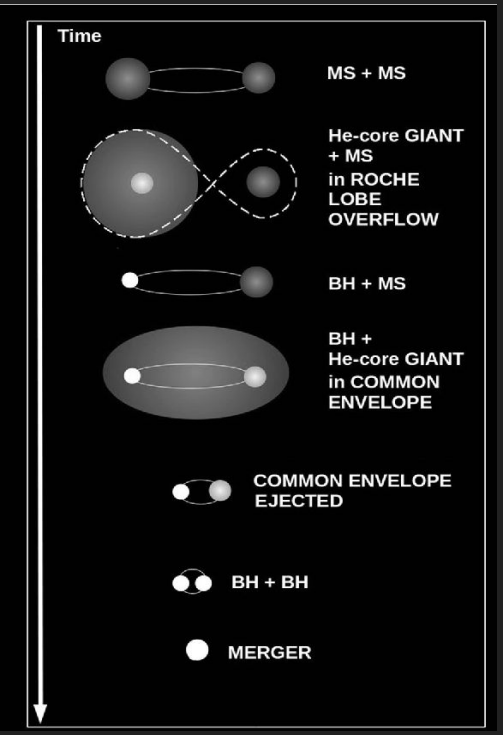


$$\mathcal{R} \sim 44\ \mathrm{Gpc}^{-3}\mathrm{yr}^{-1}$$

How do black holes get so close to each other?

Mechanisms for binary black hole merger formation

Binary stellar evolution

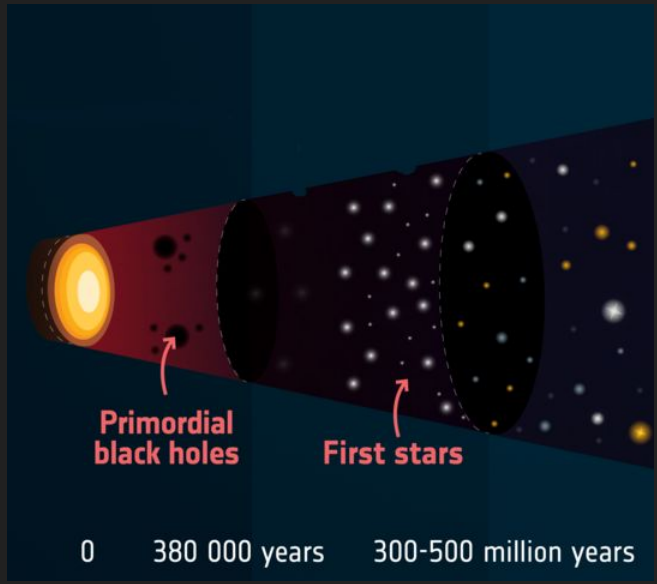


Mapelli (2021)

Dynamics in star clusters

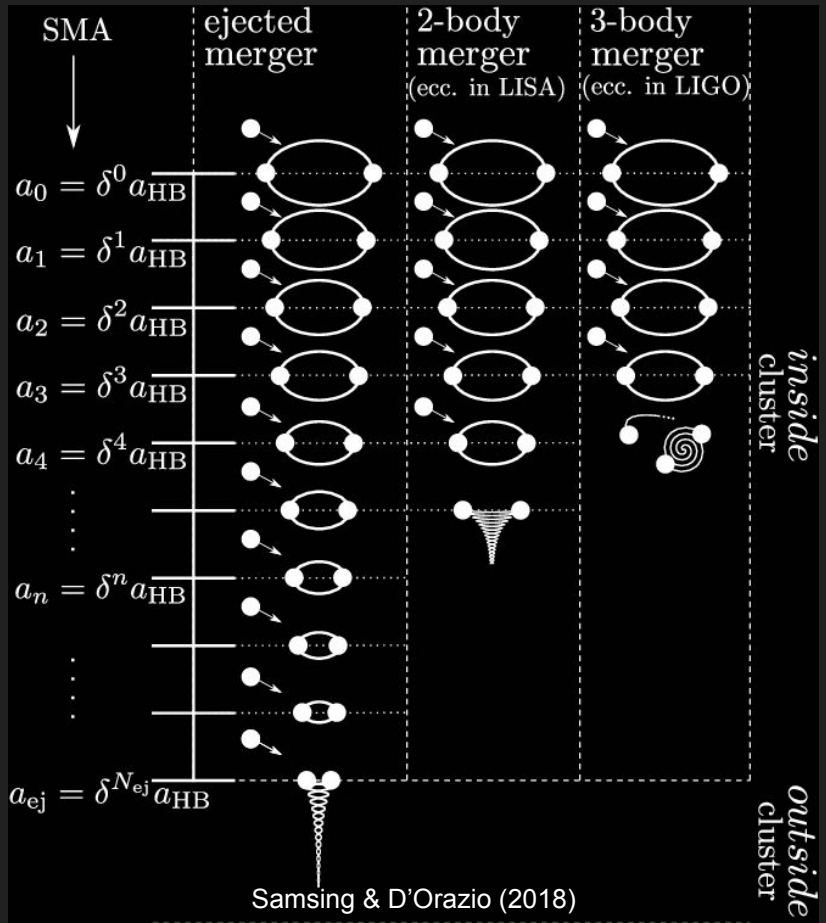
Isaac Newton Telescopes, La Palma

Primordial black holes



ESA (2021)

Binary black hole dynamics in star clusters

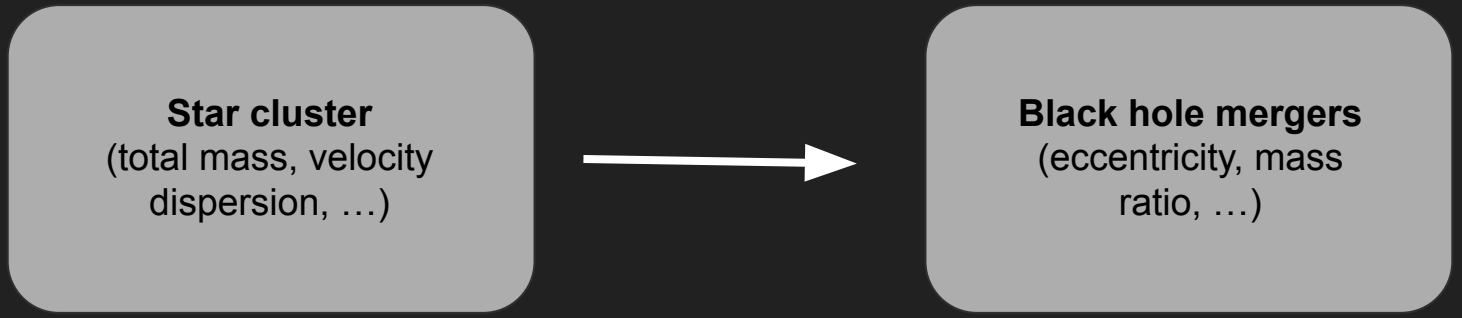


Samsing & D'Orazio (2018)

Separate mechanisms using GW data

	Binary stellar evolution	**Dynamical interactions**	**Primordial binaries**
Spin	Aligned	Randomly misaligned	Non spinning
Redshift dependence	Following SFR	Skewed towards z	Steep z dependence
Eccentricity	No	Yes	No

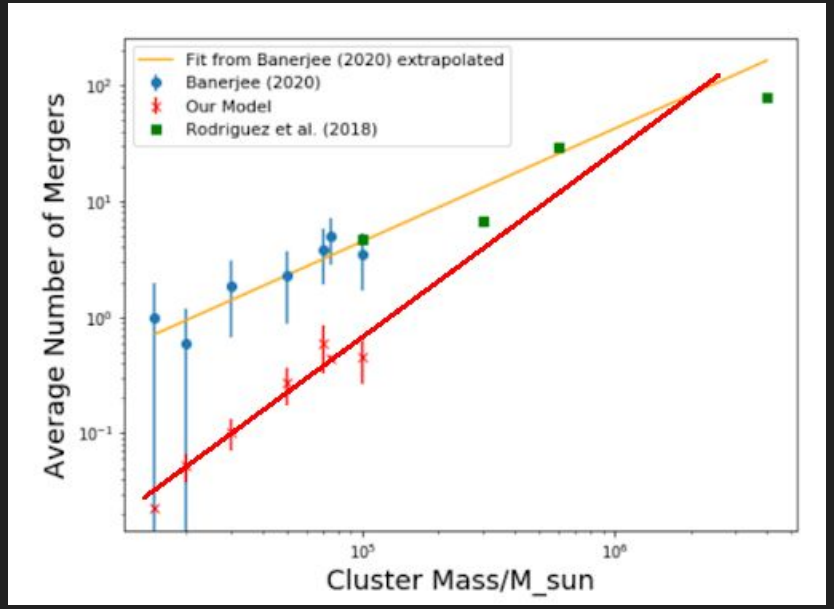
Understanding the dynamical origin of black hole mergers



How do we simulate star clusters?

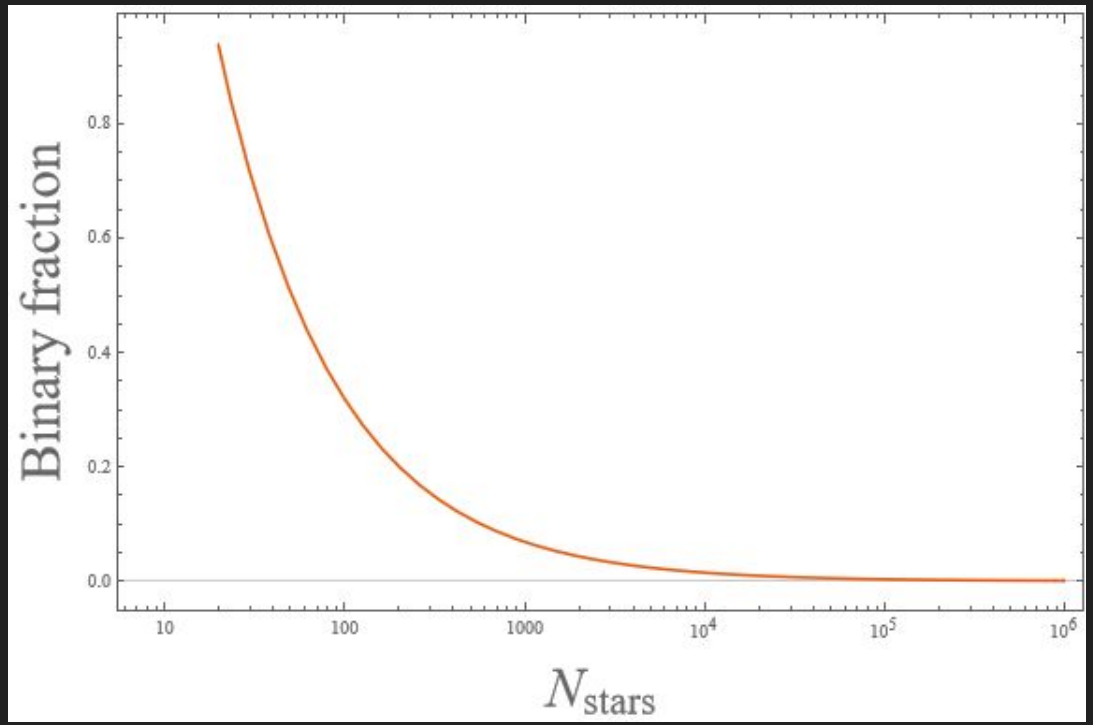
	N-Body integration	**Monte Carlo**	**Fast codes**
Speed	Slowest	Slow	Fast
Accuracy	Best	Good	Worst
Examples	NBODY7 PeTar	CMC	cBHBd FASTCLUSTER

Underprediction at low cluster masses



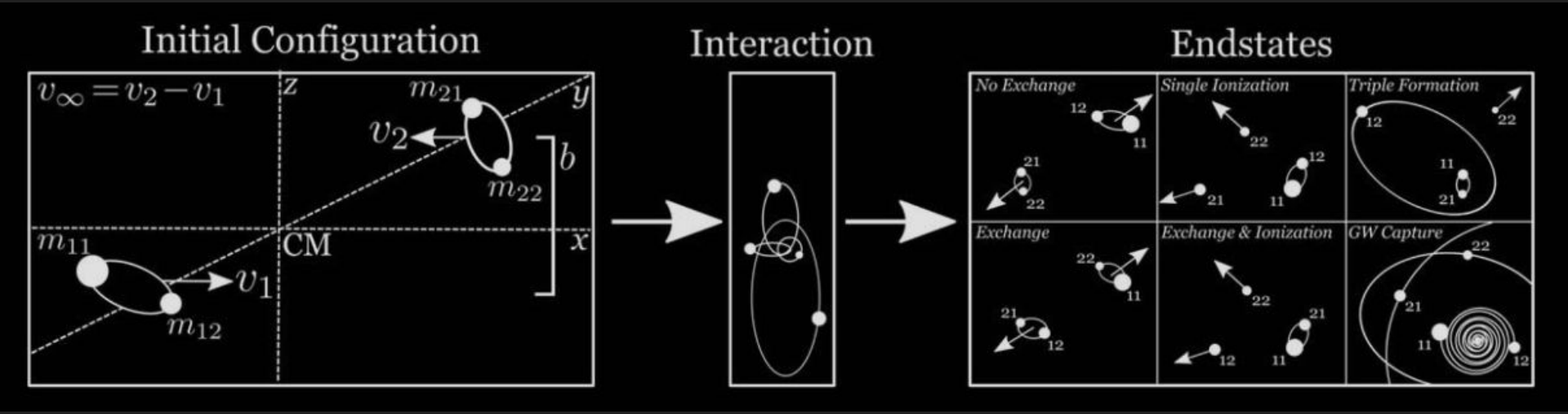
Is the assumption of a single *active* binary correct?

Dynamically-formed binaries



$$N_{\rm binaries} \sim 30 N_{\rm stars}^{-1/3}$$

Binary-binary interactions are more likely to merge



Zevin, M et. al. (2019)

$$N_{\text{binaries}} \propto W_0 N_{BH}^{-1/3}$$

A new key ingredient in untangling the merger rate: binary-binary interactions