THE IMPACT OF VELOCITY ANISOTROPY ON THE DYNAMICS OF STAR CLUSTERS AND THEIR BINARY STARS

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INTRODUCTION

- The conventional dynamical paradigm describing star clusters has been **challenged**.
- The internal kinematics of these systems was thought to be simply isotropic and non-rotating.
- However, recent high precision *HST* and *Gaia* observations revealed that star clusters are often characterised by **internal rotation** and **anisotropic velocity distribution**.

(see, e.g., Bellini et al. 2014, 2017, 2018; Libralato et al. 2018; Bianchini et al. 2018; Sollima et al. 2019; Cohen et al. 2021)

METHODS

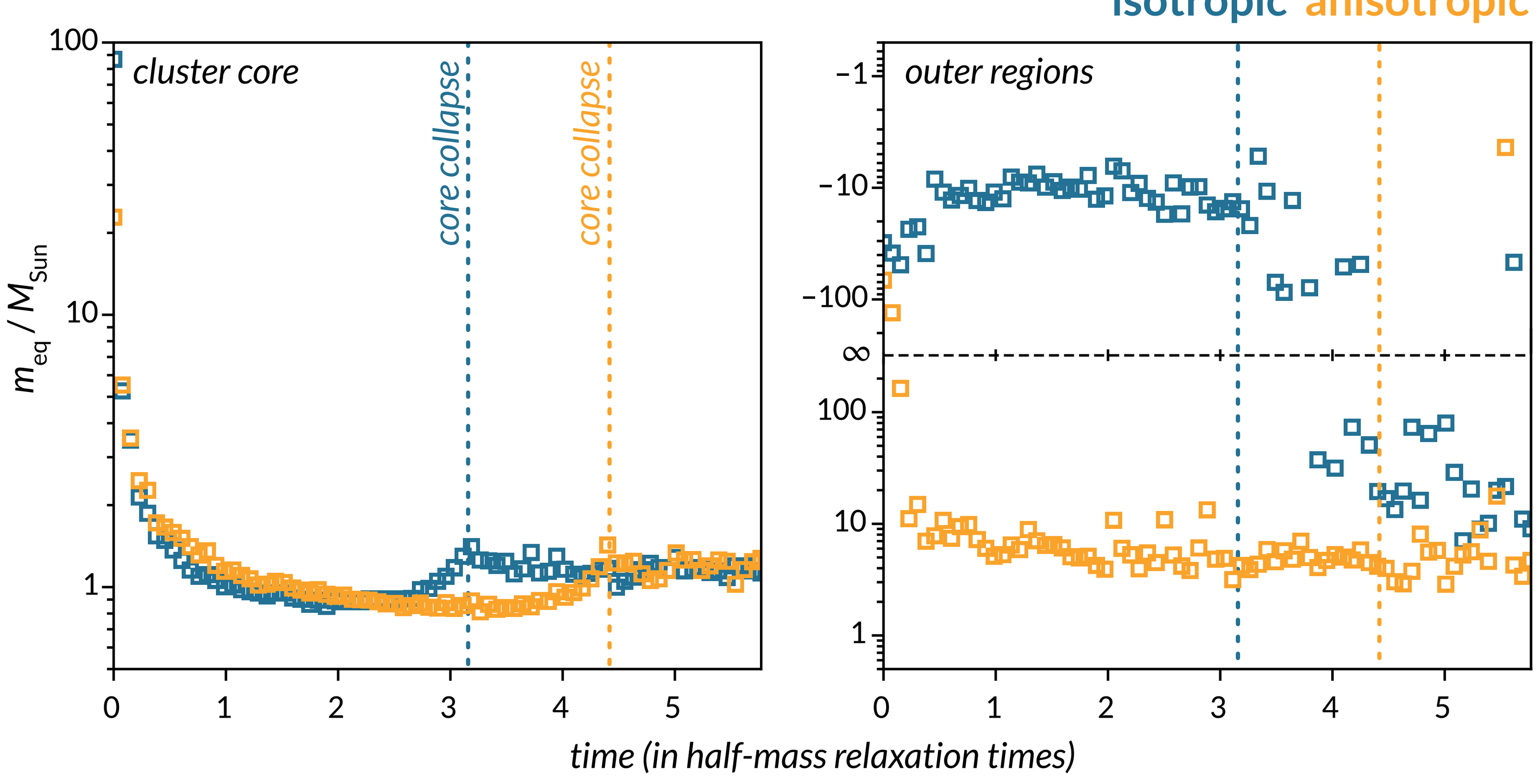
- We present *N*-body simulations (100k stars with **10 % primordial binaries**, $0.1 < m / M_{Sun} < 1$, and Kroupa IMF), integrated with NBODY6++GPU.
- The initial spatial distribution is according to the King model ($W_0 = 6$) in an external Galactic potential (tidally underfilling clusters are shown here).
- We compare the evolution of star clusters with initially **isotropic** and **radially anisotropic** velocity distributions (using the Osipkov–Merritt profile).

(King 1966; Osipkov 1979; Merritt 1985; Kroupa 2001; Wang et al. 2015)

ENERGY EQUIPARTITION (EEP)

- Evaluated with the **"equipartition mass"**, m_{eq} (see Bianchini et al. 2016) defined from $\sigma(r,m) \propto \exp\frac{-m}{2m_{eq}}$ (σ is velocity dispersion, m is stellar mass)

Note: No EEP ⇔ σ is independent of mass ⇔ high (or infinite) m_{eq}



RESULTS

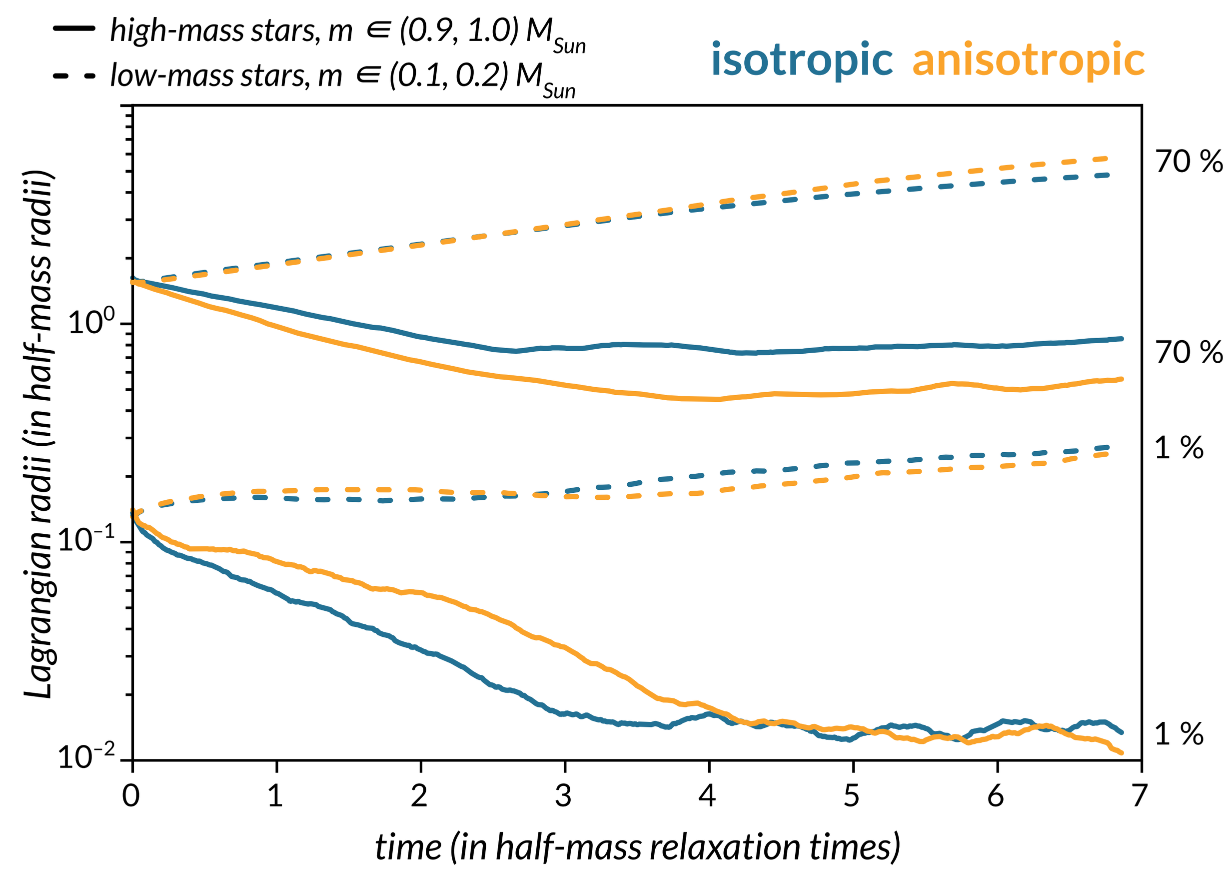
➔ *Core:* **both** models evolve **towards EEP** (low m_{eq}) but **never achieve it**.

➔ *Outer regions:* The **anisotropic** model evolves **towards EEP** while the **isotropic** one **away** from it (to **'inverted' equipartition** with $m_{eq} < 0$). This is caused by different rates of evolution towards EEP in the tangential and radial components of σ.

(see Pavlík & Vesperini 2021, 2022a for further details)

MASS SEGREGATION

- Evolution of low-mass and high-mass stars is shown separately with their 1% and 70% **Lagrangian radii**:



RESULTS

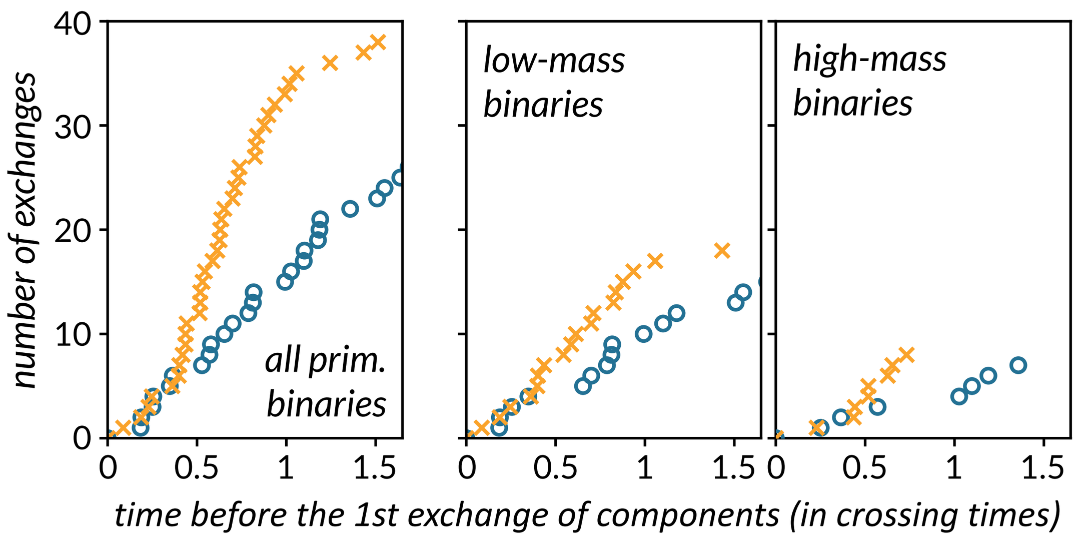
➔ *Core (1 %):* Mass segregation is **more rapid** in the **isotropic** model.

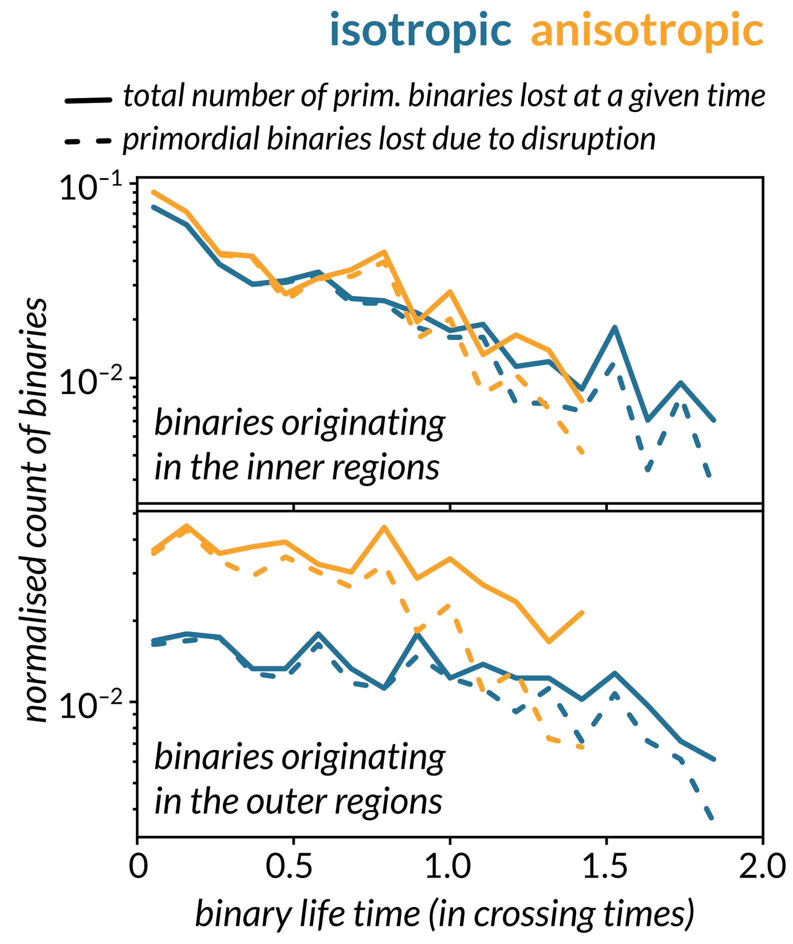
➔ *Outer regions (70 %):* Mass segregation is **more rapid** in the **anisotropic** star cluster.

(Pavlík & Vesperini 2022b)

BINARY STARS

- Primordial binaries are lost mainly due to **disruptions and ejections**. At what rate? See the right-hand panel:
- After close encounters, primordial binaries can also **exchange components**, see the plots below:





RESULTS

➔ The **disruption rate** of primordial binaries that were initially located in the outer regions is **higher in the anisotropic clusters** than in the isotropic ones.

➔ The rate of binary **ejections and exchange encounters** in which one of the binary primordial components is replaced by another interacting star is **higher in anisotropic clusters**.

(Pavlík & Vesperini 2022b)

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