Detailed tides for stellar populations

UNIVERSITY OF SURREY

We compute stellar populations including binary systems. These systems interact, notably through tides, that can modify the orbits.

To compute these populations, **binary_c** relies on a set of fitting relations to derive stellar parameters and **compute evolutionary tracks at lightning speed**.

With the **MINT project**, we modify the algorithm to rely on **interpolations of state-of-the-art MESA grids** and update tidal prescriptions.

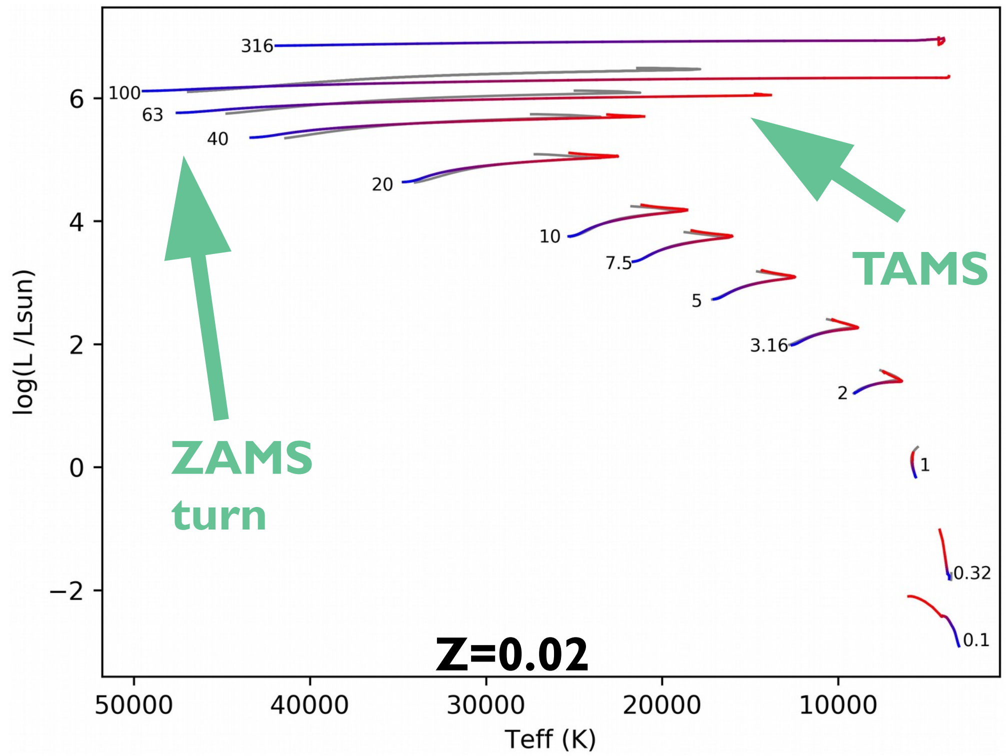
We study circularisation for an application to **stellar cluster ages.**

Giovanni M. Mirouh
R.G. Izzard
D.D. Hendriks
g.mirouh@surrey.ac.uk

NAM2021

Our grid of models:

Main sequence from **0.1 to 316 Msun**
Different metallicities from **0 to 0.04**
Includes **detailed tidal prescriptions**

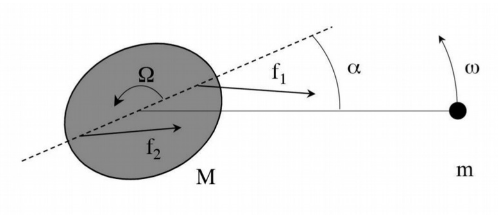


Main differences:
high-mass ZAMS turn, TAMS inflation

Theory of tides

Two kinds of tides:
convectively-damped **equilibrium tides** and radiatively-damped **dynamical tides**

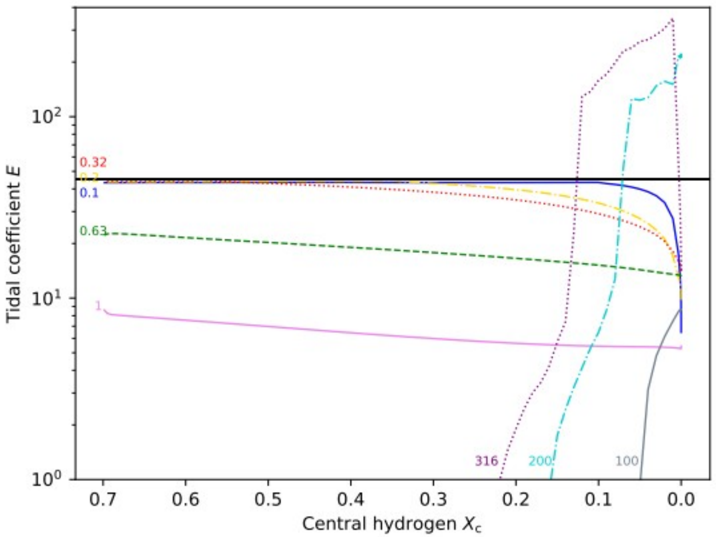
Equilibrium tides



pull from companion
→ large-scale flows
→ friction → **dissipation**

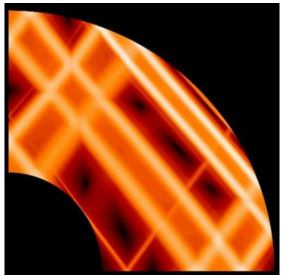
Zahn (1989)

Active in stars with a convective envelope



Tide efficiency measured by the **E coefficient**
→ equilibrium tides active at M>90Msun

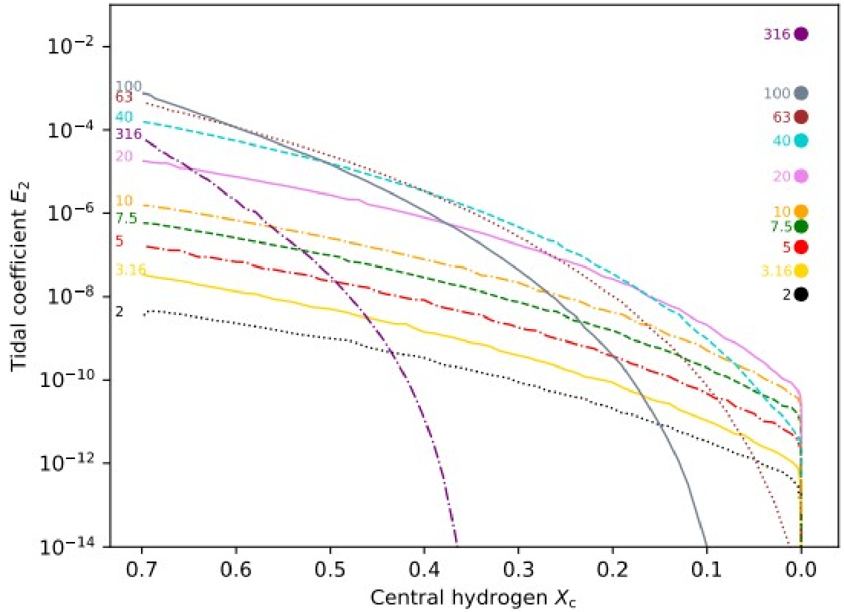
Dynamical tides



modes at core boundary
→ shear layers in envelope
→ **dissipation**

Zahn (1977)

Active in stars with a radiative envelope

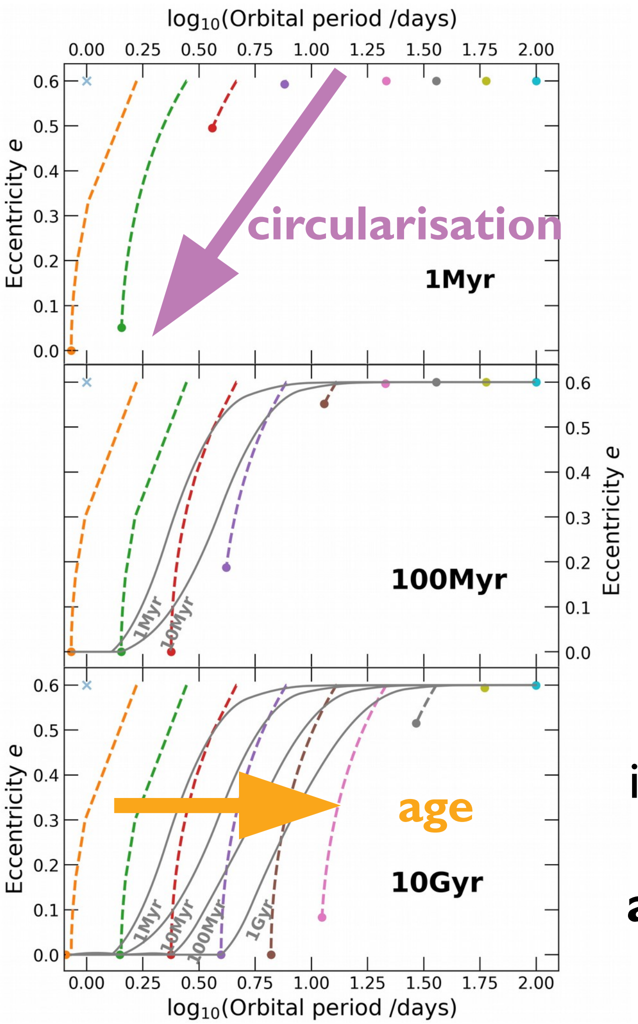


Tide efficiency measured by the **E_2 coefficient**
→ age-dependent tides, less efficient than BSE

Applications to cluster ages

Tides circularise binary systems → closer systems get **circularised earlier**

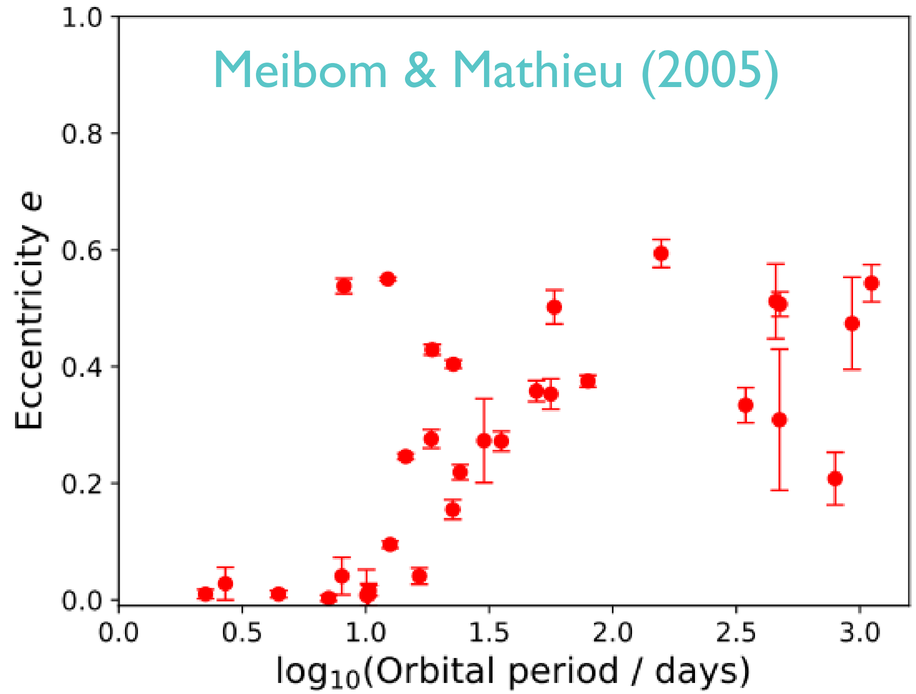
In populations of originally eccentric systems



close systems become circular → **cutoff period**

Cutoff period increases with age → provides an **age estimate** for clusters

We compute populations to compare with the **M35 cluster**



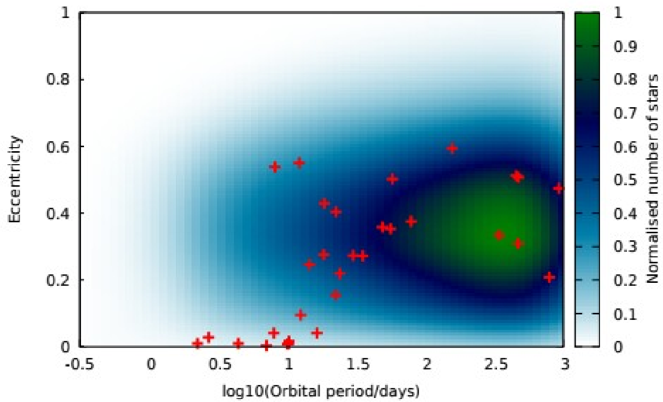
32 binary systems with e, P measurements

Cutoff period ~ 11.3 days

Age ~ 150 Myr , **M** ~ 0.7-1.4 Msun

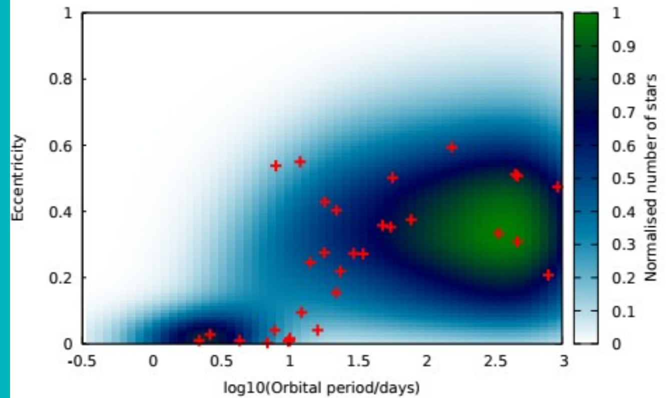
Cluster populations

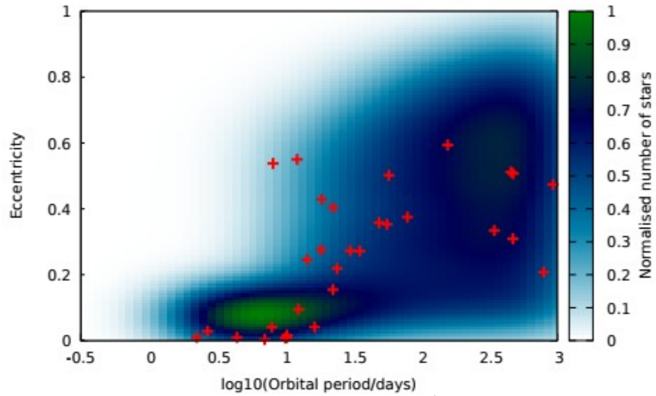
Starting from BSE tides and Gaussian initial distributions

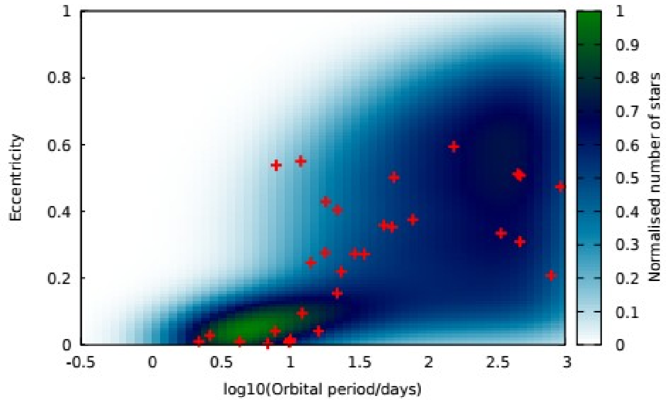


better tides

better initial populations



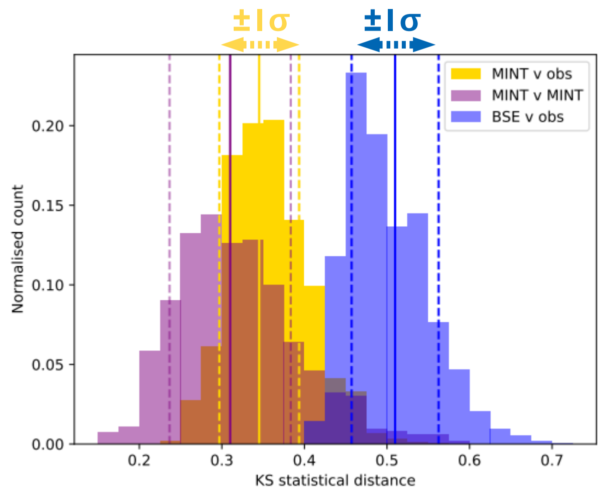




Using **MINT** tides and Moe & di Stefano (2017) distributions

To assess the match between **population and observations**

We bootstrap samples from pop, assess its **distance to obs** with a 2D Kolmogorov-Smirnov estimate and repeat 1000 times



The distance between two samples from pop is a reference:

→ **BSE pop** is incompatible

→ **MINT pop** is compatible

MINT population is a suitable **population underlying M35**