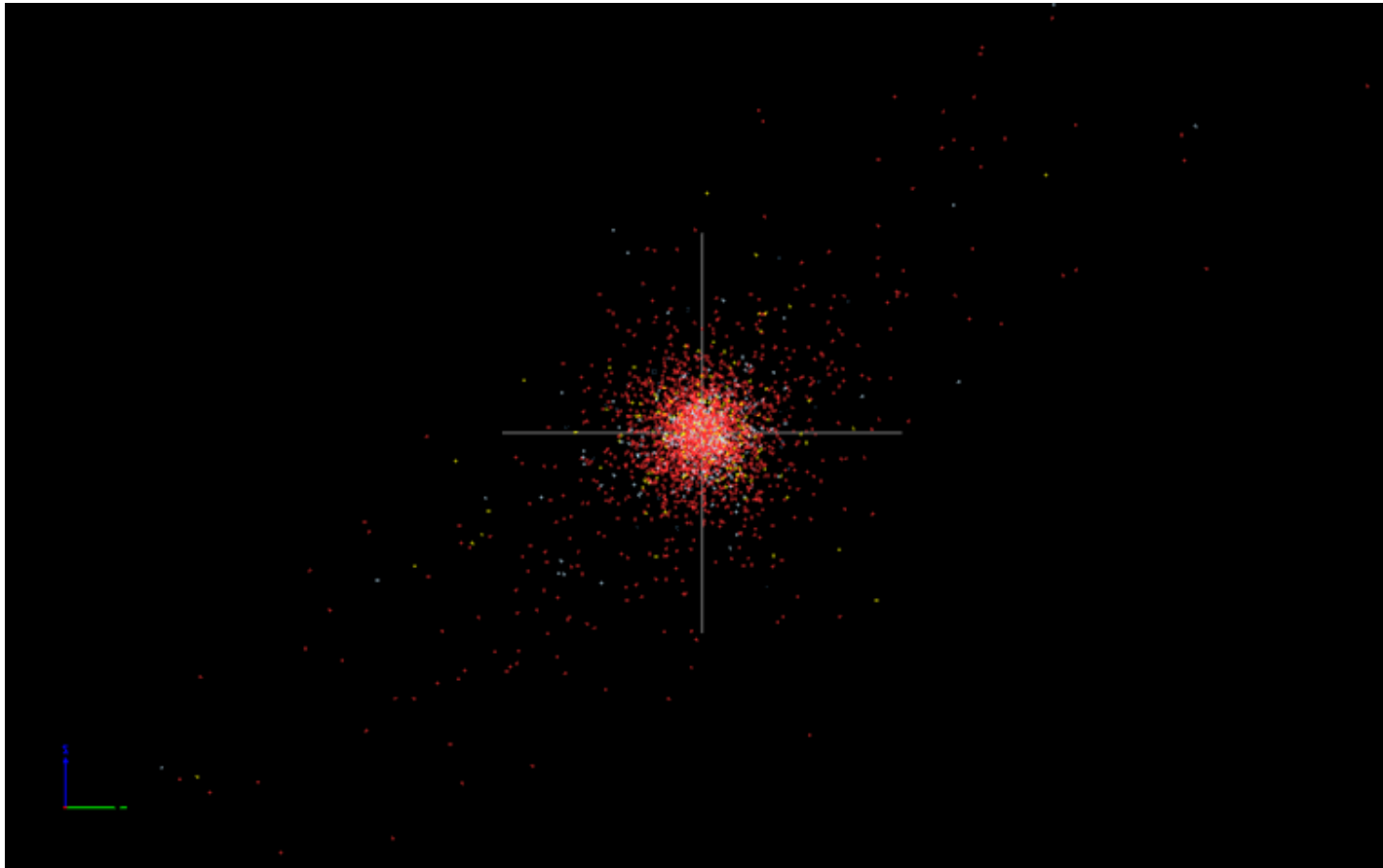


Star Cluster with Tidal Tails



Swinburne Astronomy Online 3D PDF

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1 Description

1.1 Star clusters

Star clusters (SCs) of different sizes are substantial components of galaxies. They can be found in different galactic environments, such as in the bulge and the disk of the Milky Way. Due to their residence within galaxies they are subject to an external tidal field. Hence they are constantly losing stars to the galaxy and will ultimately dissolve. Globular clusters (GCs), which are the most massive star clusters with at least 100,000 stars, manage to survive far beyond the current age of our galaxy. This is not the case for low mass clusters.

1.2 The model in this PDF

In this example you can see a model of an open cluster at an age of 1.1 Gyr. The cluster is severely affected by its host galaxy's tidal field, causing the formation of tidal tails. These can be seen by rotating the cluster. Some of these stars have already crossed the tidal boundary and are no longer cluster members. You can find more information on the study of tidal tails in GCs in Kuepper et al. (2008, MNRAS, 387, 1248).

During the dynamical evolution of SCs, a process called mass segregation occurs. This equipartition of energies causes heavier stars to sink to the centre of the cluster, while accelerating low-mass stars are flung out towards the outskirts via two- or few-body encounters. Since the stars in the outskirts are those most easily lost to the host galaxy, you can see a colour gradient in the cluster and tidal tails. See Baumgardt & Makino (2003, MNRAS, 340, 227) for more details about this process.

The 3D model presented in this PDF contains 3806 stars from a 1.1 Gyr star cluster. Those stars whose luminosity exceeds that of the Sun are drawn as larger spheres, rather than as points. The axes have a radius of 200 pc.

The stars are coloured either red, yellow or light blue according to the following groupings:

- if $(\text{magB} - \text{magI}) > 2.5$, then the star is red
- if $2 \leq (\text{magB} - \text{magI}) \leq 2.5$, then the star is yellow
- if $(\text{magB} - \text{magI}) < 2$, then the star is light blue.

where magB = magnitude in the B band (445 nm), and magI = magnitude in the I band (806 nm).

The data used for this PDF was provided courtesy of Anna Sippel and the simulation was run on the the Swinburne supercomputer using the N-body code NBODY6 (Aarseth, 2003, Cambridge University Press). While it is computationally expensive to create cluster models with many stars, the largest model currently in existence features 250,000 stars at the beginning of the cluster evolution. As a result of tidal interactions and few-body encounters approximately 180,000 remain at 12 Gyr, which is the average age of GCs in the Milky Way (Sippel & Hurley, 2013, MNRASL, 430, 30).

1.3 How to use this 3D PDF

The interactive 3D content appears on the next page of this document. You can interact with the 3D content in a variety of ways. Most of these can be found in the 3D toolbar (see below) that appears when you move the mouse cursor over the 3D figure.



To start, click and hold the left mouse button anywhere within the 3D figure. Then move the mouse around and see how the orientation changes. You can use the right mouse button in the same way to zoom in and out. Other interaction modes are also available. You can explore these by clicking on the drop-down menu of the left-most icon on the 3D toolbar.

Every 3D figure has a default view, which can be returned to by selecting View 1 from the toolbar Views menu. Some figures may also have other interesting views available for you to try.

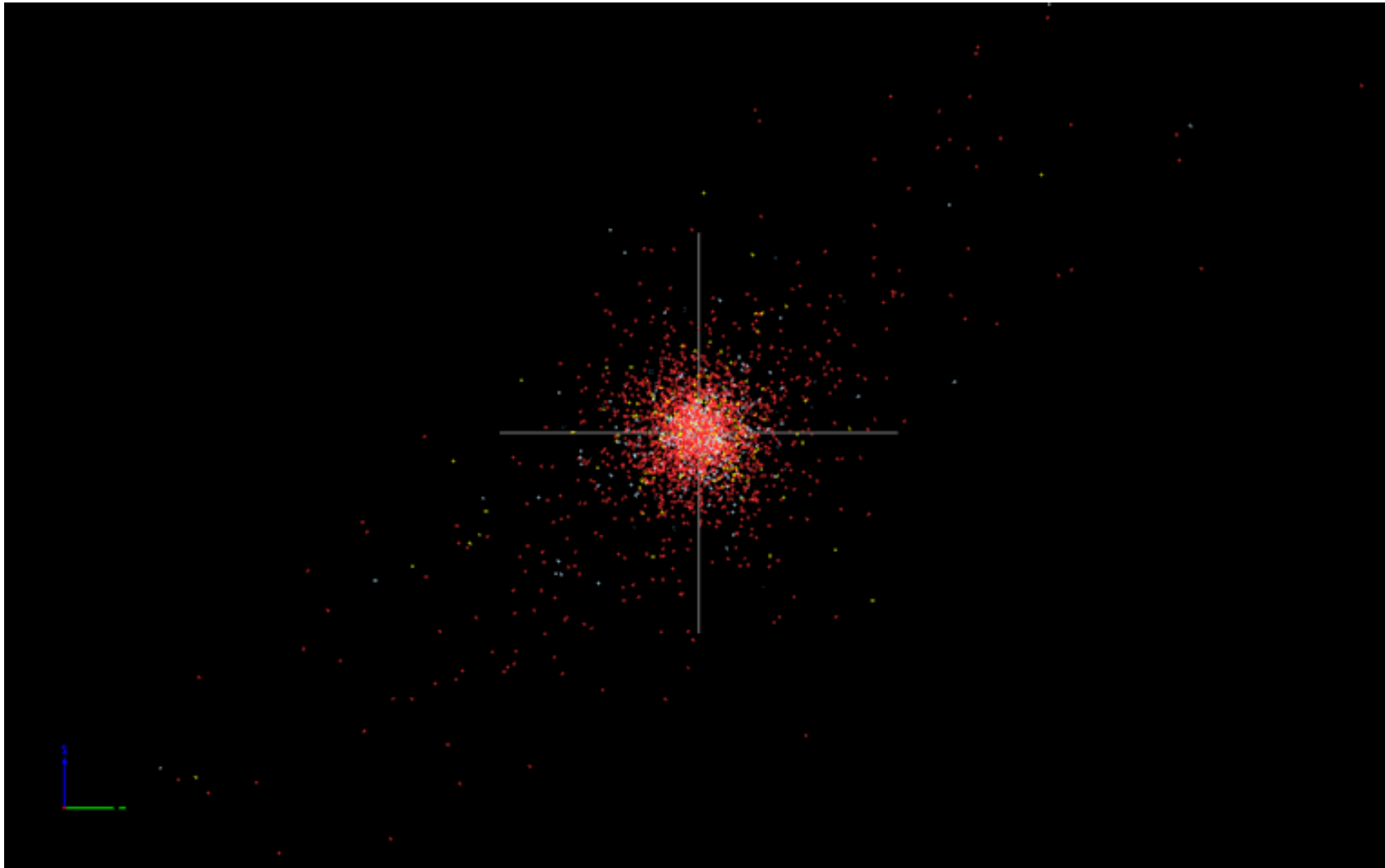
There are some additional keyboard shortcuts for you to use. (Note that you must first left mouse click on the 3D figure to utilise these shortcuts.)

arrow keys (up, down, left, right)	rotate the object
+ , -	zoom in or out
a	autospin
* , /	increase, decrease the autospin speed
[,]	roll the object clockwise, anti-clockwise
h	return to the default view

Some 3D figures may also allow you to show or hide certain types of objects from view. If available, this option will appear as a text link below the 3D figure, e.g. [Click here to...](#)

Note: The free Adobe Reader (Version 8 or higher) is required for these 3D PDFs.

2 1.1 Gyr old star cluster with tidal tails



[Click here to hide/show red stars.](#)

[Click here to hide/show yellow stars.](#)

[Click here to hide/show blue stars.](#)

3 Credits

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The 3D content in this PDF document was prepared with S2PLOT (Barnes et al., 2006, PASA, 23, 82; Barnes & Fluke, 2008, New Astronomy, 13, 599).

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