News about giant stars three times as massive as the Sun: Shaking, but not stirred!

As is well-known James Bond takes his Martini shaken, but not stirred. Little did he know that astronomers would ever use a similar phrase to describe stars. However, an international group of astronomers lead by Karsten Brogaard who is affiliated with SAC at Aarhus University, is now doing just that. They studied giant stars oscillating due to convective motion at their surface - hence the "shaking" - of specific stars in a star cluster. To their surprise, the mixing processes in the stellar interiors had been much less effective than predicted by current 1D stellar models – hence the "not stirred!".

The stars studied belong to the same open star cluster NGC6866 and therefore share the same age, which was determined to be 0.43±0.05 Gyr, when the low mixing was considered. Since the stars turned out to be in the same evolutionary phase, where the energy comes from turning helium into heavier elements in their cores, they have very similar masses, a little less than 3 times that of the Sun.

Figure 1: An oscillating star in a Martini glass to illustrate that the stars studied behave like James Bond takes his Martini - shaken, but not stirred.

You can read the full article, which is now published in Astronomy & Astrophysics here: https://www.aanda.org/articles/aa/full_html/2023/11/aa47330-23/aa47330-23.html

In a continued effort, the group including SAC affiliates Torben Arentoft and Jeppe Sinkbæk Thomsen, is now investigating whether the low level of mixing is common among relatively young star clusters or whether there is more variety to the stellar cocktails.

Just like agent 007 astronomers work from mission to mission and with various gadgets as their tools while uncovering secrets of the Universe. In the current case, the mission was part of the the ERC asterochronometry project funded by the EU. The gadgets were the space telescopes *Gaia* and *Kepler* along with modern frequency analysis to study the stellar oscillations – a method known as asteroseismology.

Asteroseismology of stars in star clusters allows more information to be extracted because the stars share common properties like their age and composition. This is crucial for improving our understanding of stellar models and the asteroseismic methods, which are needed to extract reliable ages of stars and examine the history and evolution of our Galaxy. Unfortunately, only a few star clusters have ever been observed well enough to extract high-quality asteroseismic information. Two future space satellite missions have the potential to change that.

Figure 2: The star cluster NGC6866. The stars studied are the brightest red dots.

First, the Danish satellite mission STEP (https://space.au.dk/the-space-research-hub/step) with PI Hans Kjeldsen from Aarhus University is building its first space telescope for launch already in a few years from now. The scientific aim is to answer central questions related to exoplanets and stars, and the telescope has the potential to allow asteroseismology of stars in relatively young and nearby star clusters, should that be decided.

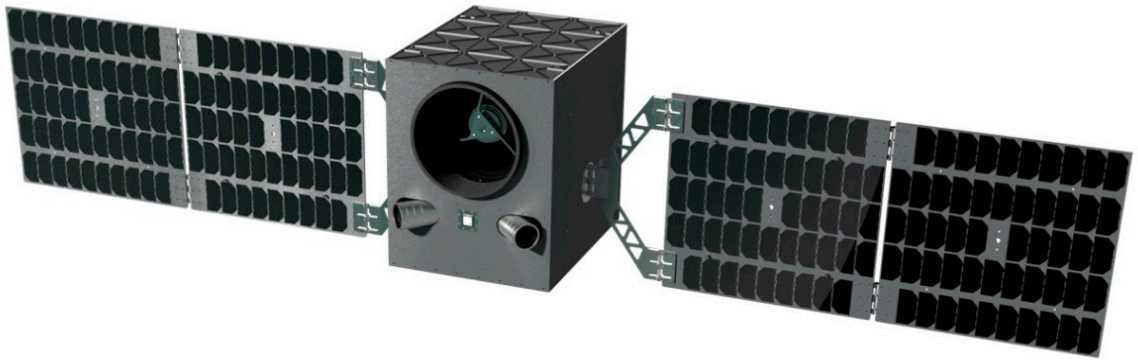

Figure 3: A first layout design of the STEP satellite.

In the longer term, a large international collaboration lead by PI Andrea Miglio at the University of Bologna in Italy has proposed and is designing a future ESA space satellite, Haydn (http://www.asterochronometry.eu/haydn/), dedicated to observing star clusters and the Galactic centre for high-quality asteroseismic measurements. This will provide many more new insights into stars, star clusters and our Galaxy.

Figure 5: Logo of the Haydn mission.

Astronomers are shaking with excitement. Cheers!

Figure 6: The study was supported by the Asterochronometry project.

Figure 4: Karsten Brogaard as astronomy "agent" in Naples where he recently presented the results of the study at the "Stars (across the Universe)" conference.