Research investigates the effects of stellar rotation in star cluster NGC 1850

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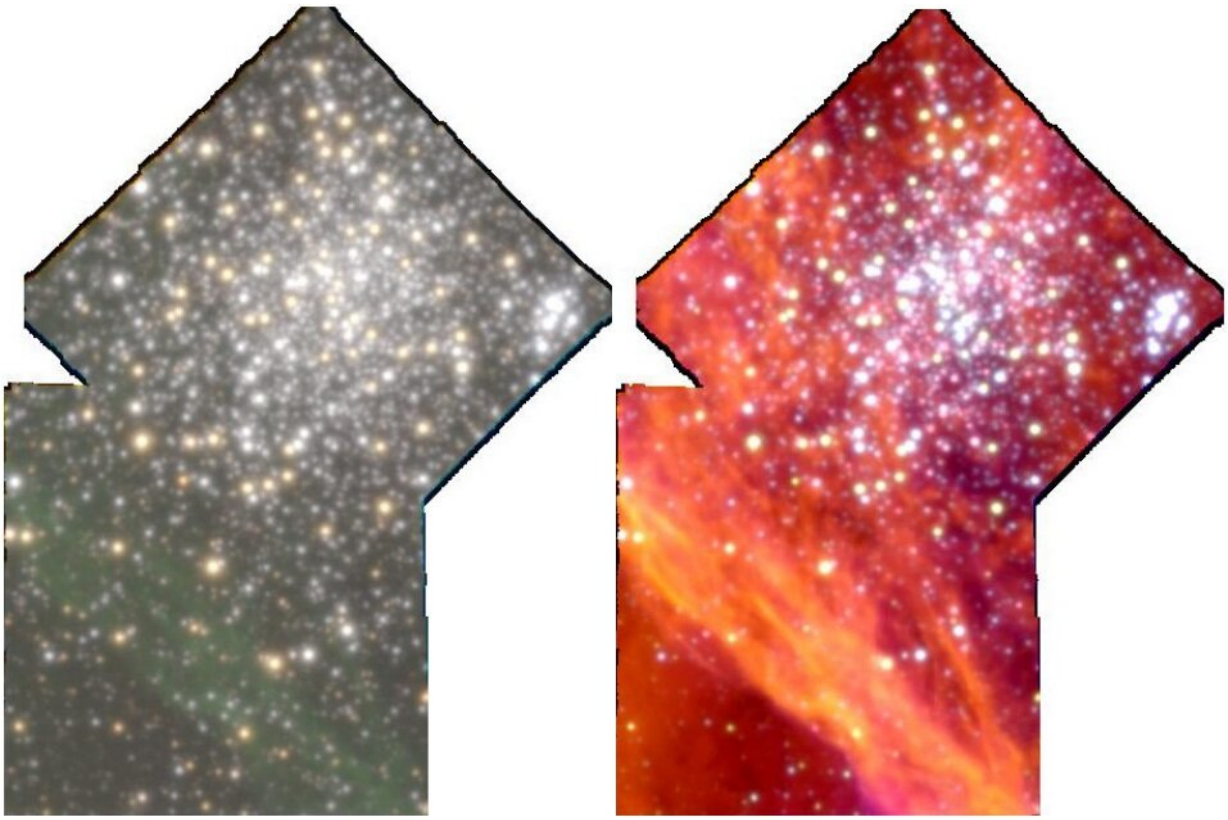

(Left) SDSS-gri image created from the MUSE data of NGC 1850. (Right) Narrow-band image created from the same data to better visualize the nebular emission overlaid on the cluster. Credit: Kamann et al, 2022

An international team of astronomers has conducted spectroscopic and photometric observations of the young massive cluster NGC 1850 with the aim of investigating the effects of stellar rotation across its stellar population. The findings, presented November 1 on arXiv.org, could help us advance our knowledge about young massive clusters.

In general, young massive clusters (YMCs) are dense aggregates of young stars that form the fundamental building blocks of galaxies. They give astronomers an opportunity to inspect the effects of stellar rotation on an ensemble of stars of the same age but with different stellar mass.

At a distance of about 168,000 light years, NGC 1850 is a YMC located in the northwest part of the bar of the Large Magellanic Cloud (LMC). The cluster has a radius of about 16.2 light years, mass of some 42,000 solar masses, and its age is estimated to be 100 million years.

In order to better understand the stellar populations within YMCs, a group of researchers led by Sebastian Kamann of the Liverpool John Moores University in Liverpool, UK, performed a multi-epoch observational campaign of NGC 1850 using the Multi-Unit Spectroscopic Explorer (MUSE) instrument at the Very Large Telescope (VLT) in Chile. Their study was complemented by photometric data from the Hubble Space Telescope (HST).

"We have presented an analysis of multi-epoch MUSE spectroscopy of the stellar populations within the ~100 Myr LMC star cluster, NGC 1850. Our full sample consists of more than 4,000 stars, and each star has been observed for a number of typically 16 epochs," the astronomers wrote in the paper.

Kamann's team investigated the stellar rotation of the NGC 1850 stars in two ways. They looked at individual stellar spectra and they examined stacked spectra, obtained by summing up the MUSE spectra extracted for stars that are expected to be fast or slow rotators based on their positions in the HST color-magnitude diagram (CMD).

All in all, by combining the single-epoch spectra on a star-by-star basis and, following cuts based on signal-to-noise (S/N) and cluster membership probabilities, it resulted in a sample of 2,184 stars with MUSE spectra. Afterward, the astronomers analyzed this sample in order to understand the distribution of stellar rotation across the stellar population of NGC 1850.

The study found a clear correlation between the color of stars on the main sequence turn-off (MSTO) and their rotational velocity value as the fast rotators appear redder. This may indicate that the extended MSTO phenomenon is driven by the stellar rotation distribution.

The results show that the two branches of the split main sequence have different rotational velocity distributions, with the blue arm made up primarily of slow rotators while the red arm consists mainly of rapid rotators. Moreover, the MSTO of NGC 1850 shows a lack of stars with rotational velocities close to the predicted critical value of 400 km/s.

The research also found that the Be star fraction in NGC 1850 is a strong function of magnitude, increasing towards the MSTO, and going to zero on the nominal main sequence. In general, it turned out that within the Be star population, 23% of them are the so-called "shell stars"—Be stars that are seen nearly equator-on. The researchers added that these shell stars were found almost exclusively on the red side of the MSTO, which seems to suggest that they are self-extinct by their own disks.

More information: Sebastian Kamann et al, The effects of stellar rotation along the main sequence of the 100 Myr old massive cluster NGC 1850, *arXiv* (2022). DOI: 10.48550/arxiv.2211.00693