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Galaxies
4-1-11
Paper Review

Testing the universal stellar IMF on the metallicity distribution in the bulges of the Milky Way and M31.

S.K. Ballero, P., Kroupa, & F. Matteucci

Overview

This paper attempts to fit several initial mass functions to the metallicity distribution of giant stars observed in the bulge of the Milky Way and M31.

Summary:

The authors attempt to fit the metallicity distribution in the bulge of the Milky Way and M31 with a variety of initial mass functions (IMFs) and with varying parameters, where the form for the IMF is:
$\varphi(\mathrm{m}) \propto \mathrm{m}^{-(1+x)}$
The three IMFs they consider are the Salpeter IMF, the universal IMF (UIMF), and the integrated galaxial IMF (IGIMF). The Salpeter IMF assumes x = 1.35 for stars of all masses. The UIMF set x = 0.3 for masses between 0.08 and 0.5 solar masses and x = 1.3 for masses smaller than 0.5 solar masses. The IGIMF set x = 0.3 for stellar masses between 0.08 – 0.5, x=1.3 for stellar masses between 0.5 – 1, and x = 1.7 for stellar masses greater than one solar mass.

The observed metallicity distribution of Milky Way and M31 halo star could not be fit with UIMf or IGIMF, which had a metallicity that was too low. In an attempt to make either function fit, they adjusted the yields (up to unphysical levels) for stars with mass greater than 80 solar masses. However, this only produced only a negligible effect. They also attempted to adjust the chemical evolution in their models. They adjusted the star-formation efficiency and infall time scale in order give more time for Type Ia supernovas to enrich the interstellar medium. Neither scenario for high star-formation efficiency or lower star-formation efficiency fit observed metallicity distributions. However, they were able to fit an IMF model to the bulge of M31 if they assumed an x value of 1.

They conclude by stating that their predicted metallicity distributions are too metal poor than the observed metallicity distribution in the Milky Way and M31. Changing their nucleosynthesis assumptions did not effect their results. Therefore, they suggest that if the bulge was formed through an inside-out accretion (where the bulge forms in ~10^8 years through free fall) then different IMFs are needed for different environments and an x ~ 1 value is preferred.

Ties to class material

We discussed the importance of the IMF and the various indexes authors have adopted. In particular, we discussed the Salpeter index of x = 1.35 (which this paper refers to at the IMF) and the local IMF determined by Kroupa, Tout, and Gilmore 1993 with $x = 1.7$ for stellar mass $M > 1$ solar masses, $x = 1.2$ for $0.5 > M > 1$ solar masses, and $x = 1.3$ for $M < 0.5$ solar masses. This paper discussed two other IMFs, the universal inital mass function (UIMF) by Kroupa (2001) and the integrated galaxial IMF (IGIMF) by Weidner & Kroupa.

Question to Author

The data in figures 2 and 3 (histograms) seem to be not very well matched. Why are the observed distributions shifted?

Cume Question

The authors refer to alpha-elements. Name three alpha-elements.
Silicon, Calcium, Titanium.

Follow-up Research Project Idea

Observe more stellar clusters in the bulge of the Milky Way, M31, as well as other clusters in our local group. Consider not only an inside-out model for bulge formation but also a dynamical evolution.