Contribution ID: **950** Type: **Invited talk in the parallel session**

Standing on the Shoulders of Giants: New Mass and Distance Estimates for Betelgeuse through Combined Evolutionary, Asteroseismic, and Hydrodynamic Simulations with MESA

Thursday, 8 July 2021 17:45 (25 minutes)

We find that the famous giant star Betelgeuse is closer, smaller, and less massive than previously thought. Our theoretical predictions include results from three different modeling techniques: evolutionary, oscillatory, and hydrodynamic simulations conducted with the Modules for Experiments in Stellar Astrophysics (MESA) software suite. We use MESA stellar models and statistical techniques to infer that the star is undergoing its core helium burning giant branch phase. This in combination with estimates of Betelgeuse's present-day mass provides a rough constraint on its remaining lifetime before the onset of a supernova: our simulations revise the timeline for this event from 10,000 to 100,000 years.

This discovery was made possible by drawing on the synthesis of new observational data and exploiting multi-timescale simulations of the evolution and structure of stars. Seismic results from both perturbed hydrostatic and evolving hydrodynamic simulations constrain the frequencies and underlying physics of Betelgeuse's periodic brightness variations in new ways, allowing us to determine conclusively, and for the first time, the reasons for Betelgeuse's most prominent oscillation modes. In this talk, I will discuss the novel ways in which I combine precision stellar evolution calculations with seismology and observational and theoretical constraints to build a predictive timeline for Betelgeuse and other stars, revise best estimates for their fundamental parameters, and conquer their notorious modeling difficulties.

Primary author: JOYCE, Meridith (Space Telescope Science Institute)

Presenter: JOYCE, Meridith (Space Telescope Science Institute)

Session Classification: The "Fall and Rise" of Betelgeuse

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