Models of Low Mass Stars in the Local Solar Neighborhood and in Globular Clusters

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Abstract

Over its approximately 100 year history stellar modeling has become an essential tool for understanding certain astrophysical phenomena which are not directly observable. Modeling allows for empirical constraints — such as elemental abundances, luminosities, and effective temperatures — to strongly inform non-observables such as a star's age, mass, and radius. Here we propose a thesis in five parts, related through their use of both modeling and the Dartmouth Stellar Evolution Program (DSEP) to conduct this modeling. In two of the parts of this thesis we will use DSEP, in conjunction with atmospheric boundary conditions generated by collaborators, to build chemically self-consistent models of multiple populations (MPs) in the globular clusters NGC 2808, 47 Tuc, and NGC 6752. We will infer helium abundances across MPs and compare these inferred abundances to those from models which do not consider as careful a handling of a star's chemistry. The remaining three parts of this thesis will address a recently discovered feature in the Gaia $G_{BP} - G_{RP}$ color-magnitude-diagram (colloquially the Jao Gap). Throughout this series we will update DSEP's high-temperature opacity tables to the most modern available (OPLIB from Los Alamos) and show how this change affects the theoretical location of the Jao Gap. Subsequently, we will use synthetic color-magnitude-diagrams (CMDs) — covering the Jao Gap regime — in conjunction with kinematically derived age distributions to test the feasibility of population age-dating by measuring the Jao Gap's location in a CMD. Finally, we will apply techniques developed in our theoretical testing of Jao Gap based age-dating to the solar neighborhood, attempting to identify coeval groups and roughly age-date them. These five parts will compose the scientific chapters of a thesis to be submitted to the faculty and advising committee no later than the summer term of 2024.