Collaborative Research: New Standard Stellar Population Models

Intellectual Merit: The proposed set of stellar population models (isochrones plus stellar colors and spectra) will set a new standard of completeness and excellence. The most novel feature of the models is that they will incorporate flexible chemistry so that almost any interesting chemical mixture can be interpolated. Abundance will be described by parameters for He/H, C, N, O, three choices for "alpha" element mixture, and an overall scaling factor for heavy element abundance. The proposed models will be generated from `PHOENIX` model atmospheres for stellar fluxes and low-temperature opacities, `OPAL` interior opacities, and a state-of-the-art stellar evolution code, `DSEP`, which incorporates accurate equations of state, helium diffusion, heavy element diffusion, and convective overshooting. Known flaws and omissions (temperature issues, mass-loss, late-stage evolution, binarism) of current models will be eliminated or minimized.

Our goals are to demonstrate 10% absolute mean ages derived from a single integrated light spectrum, to derive ages for a sample of local galaxies, to discover the origin of the scatter in 1500-V among elliptical galaxies, to measure He, O, Cr, and Ni abundances from integrated light (high risk), and to measure C, N, Ca, Si, Sc, V, Ti, Fe, and Mg abundances from integrated light (low risk). This new level of detail will open a whole new set of constraints for nucleosynthetic enrichment in clusters and galaxies. As a byproduct, homogeneous data for a series of star clusters of widely varying age and abundance will be collected and made available.

Broader Impact: Population models are consulted almost any time that starlight is being studied (or subtracted). They are used to transform isochrones to the observable plane to get star cluster distances and ages, to derive star formation histories of local dwarf galaxies, to investigate the Milky Way field population, to estimate distribution and frequency of several gravitational wave sources, to study extragalactic star clusters, to age-date elliptical galaxies and the bulges of spiral galaxies, to measure abundance ratios in these galaxies, to predict surface brightness fluctuation magnitudes, to study starburst and post-starburst galaxies, to study quasar hosts, and, by subtraction, to study AGN central engines, to compute cosmological ***k***-corrections and evolutionary corrections for high redshift galaxy populations, to allow chemo-dynamical galaxy formation models to make predictions about observable quantities, and to investigate the chemistry of local group galaxies through color-magnitude diagram studies.

The proposed models will impact all of these areas. Upon completion, integrated and star by star photometry in all major filter systems, surface brightness fluctuations, line strength indices, and both synthetic and empirically-derived spectra will be made available in catalog form and over the web via form-based interpolation engines. Two graduate students, a postdoc, and several undergraduate students will receive training.