THE APOGEE-KEPLER RED GIANT PROJECT: A TREASURY FOR STELLAR POPULATION AND STELLAR PHYSICS STUDIES

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We propose a comprehensive program that combines Kepler monitoring of 2034 red giants with ground-based spectroscopy for the entire sample. Kepler data yields information on both stellar non-radial oscillations and rotation periods from modulation of the light curve by star spots. The oscillation frequencies can be used to infer precise surface gravities, radii, and masses for the entire sample, along with diagnostics of evolutionary state (the presence or absence of core helium burning). Internal rotation and surface helium may be obtained for some of the stars. High-resolution IR spectroscopy from the APOGEE project in the 3rd Sloan Digital Sky Survey will provide effective temperatures, radial velocities, and individual abundances for 15 elements. The combination of Kepler and APOGEE permits an unprecedented combination of mass, age, chemistry, and kinematic information for red giants. We will provide a treasury of data on red giants which will serve as a fundamental tool for solving problems in stellar populations, stellar physics, and fields that rely on inferences from either. Our primary stellar population science goals from this are: 1) Anchoring the absolute location of the red giant branch and red clump as a function of mass and composition; 2)Inferring the age of the galactic disk and halo and the timescale for alpha-element enrichment; 3)Mapping rotation as a function of mass, chemical composition, and evolutionary state; 4) Testing models of the formation of the galactic disk; 5) Quantifying the age-metallicity relationship and age differences between the thin disk, thick disk, and halo at the solar circle. The Kepler data also provides key tests of stellar interiors and pulsation physics. Major goals of our program in these areas include: 1) Testing models of mixing and dredge-up on the red giant branch; 2) Testing the validity of scaling relations between mean pulsation properties, mass, and radius across a wide range of abundances and luminosities; 3) Studying stars with unusual pulsational properties; 4) Developing quantifiable diagnostics of evolutionary state and core properties; 5) Quantifying the scientific impact of additional time series data for existing targets. To answer these science goals we have designed a sample including both new targets and continued monitoring of a subset of the publicly released red giant sample. Our new targets are primarily luminous giants under-represented in the current Kepler sample. We have also used Washington photometry to identify rare metal-poor giants. Because monitoring of the publicly released red giant sample is not guaranteed, we identified key stars where additional Kepler data is crucial. This includes open cluster members, giants with detected star spot signatures, and stars with unusual pulsational properties. We have also defined a grid of first ascent and red clump giants that will be a fundamental resource for future population studies. We have a strong and multi-faceted team capable of addressing these ambitious goals. Team members have extensive experience in analyzing Kepler data to infer pulsation properties and rotation periods. The APOGEE spectra will be reduced by an automated pipeline that will be in operation by the time of the proposed Kepler observations. Other team members have expertise in stellar interiors, stellar evolution, models of galactic formation, and studies of chemical evolution. With our combined expertise we will provide a comprehensive treasury of public data. The large majority of the work will be funded through other sources. For this program we request 1 year of funding for a graduate student whose dissertation is related to the proposal. We also request funds for all members of the research team to attend the annual Kepler Asteroseismology Science Consortium meeting in 2013 and support for publications.