# Stellar Ages and Galactic Evolution

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## Stellar Ages from frequency separations

There is no one observable that is sensitive to age and age alone. However, some combinations of parameters such as Δν (large frequency separation) and δν (small frequency separation) are more sensitive to age (see C-D diagram on the right). The age can be better constrained by comparing these observables with parameters extracted from stellar models. Extracting ages from stellar models is an optimization problem that seeks the initial stellar conditions and amount of time elapsed that gives the best fit to a measured set of observables.

We have developed an *in situ* genetic algorithm wrapped to the GARSTEC (Weiss & Schlattl 2008) and ADIPLS (Christensen-Dalsgaard 2008) stellar physics codes. We calculate stellar models on the fly and search for a model that best fits the given set of observations. This results in solutions for different choices of stellar physics and provides stellar ages with more realistic uncertainties.

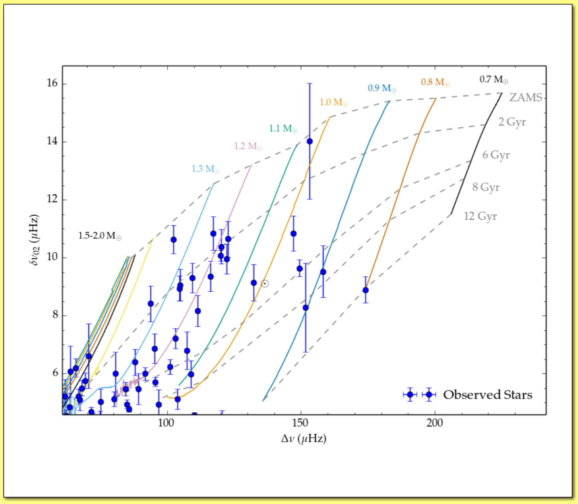


Figure: The possible spread in stellar ages can be determined using the Christensen-Dalsgaard (C-D) diagram (observational data taken from White et al. 2011).

## Red Giants in Binaries and Clusters

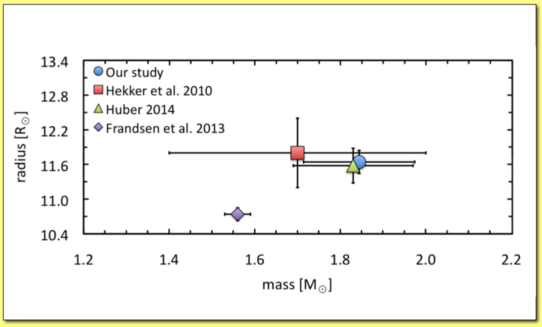


Figure: Mass and radius estimates for the red-giant star KIC 8410637 based on different methods. While the asteroseismic measurements (blue circle, red rectangle and green triangle) are in good agreement, the fundamental parameters derived from the orbital solution (violet diamond) disagree.

The fundamental parameters of red giants in binary star systems and clusters can be derived from several independent methods. Therefore, these stars are ideal benchmarks for studying stellar structure and evolution. In some cases, however, the use of two independent methods yields rather different results, as it is shown in the figure to the left. There, the estimated mass and radius from asteroseismology are not in good agreement with the results derived from the orbital solution. This discrepancy could be resolved by incorporating information from individual frequencies. In this manner, we will be able to further investigate the discrepancies that exist between different methods and derive the best global oscillation parameters possible. In addition, these direct observables can be used to better constrain stellar models and therefore provide more accurate ages of these stars.

## Multi-dimensional picture of the Milky Way

The current Milky Way forms the best test-bed for evaluating models of galactic evolution. In order to reconstruct the Milky Way history, it is important to obtain accurate and precise parameters for a set of stars with well-known selection effects.

Using the large datasets that are currently available, we will apply stochastic statistics, i.e. statistics that take the underlying stochastic processes that are important in the formation of stars into account, to perform pattern recognition. The ultimate aim is to find families of stars that are formed from the same interstellar clouds to test the current galaxy formation models and establish the relative importance of radial migration and galaxy mergers.

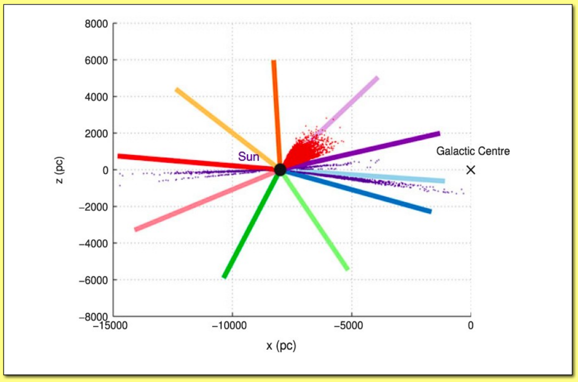


Figure: Location in the galaxy of the stars observed by CoRoT (blue dots) and *Kepler* (red dots) as well as the fields that are being targeted by K2 (lines). Figure taken from Miglio et al. 2015.

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