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Seismic and spectroscopic analysis of 9 bright red giant stars observed by Kepler and Gaia.

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Abstract. Space-based observatories such as CoRoT and Kepler can provide nearly uninterrupted time series for thousands red giants, allowing the extraction of seismic constraints related to global stellar properties. This can be carried over a large number of targets by combining seismic and spectroscopic constraints by using the so-called scaling relations. The combinations of asteroseismology and spectroscopy can also be used to understand extra-mixing process that occur inside red-giant stars. Therefore, it is important to characterize individual red giants using high S/N data. In this work, we conduct a detailed seismic analysis of nine bright red giant stars observed by Kepler. We extracted the period spacing of mixed modes for 7 stars. Distances estimated by seismology are compared with Hipparcos and Gaia distances.

Resumo. Observatórios espaciais como CoRoT e Kepler podem fornecer séries temporais quase ininterruptas para milhares de gigantes vermelhas, permitindo a extração de vínculos sísmicos relacionados a propriedades estelares globais. Isso pode ser repetido para a um grande número de estrelas, combinando restrições sísmicas e espectroscópicas usando as chamadas relações de escala. A combinação de asterosismologia e espectroscopia também pode ser usada para entender os processos de mistura extra que ocorrem dentro de estrelas gigantes vermelhas. Portanto, é importante caracterizar gigantes vermelhas individividualmente usando dados de alta qualidade. Neste trabalho, realizamos uma análise sísmica detalhada de nove estrelas gigantes vermelhas brilhantes observadas pelo satélite Kepler. Nós extraímos o espaçamento de períodos de modos mistos para 7 estrelas. As distâncias estimadas pela sismologia são comparadas com as distâncias medidas pelos satélites Hipparcos e Gaia.

Keywords. Asteroseismology – Stars: late-type – Stars: distances

1. Introduction

Asteroseismology of red-giant stars has proven to be a very successful tool to place tight constraints on fundamental stellar properties, including radius, mass, evolutionary state, internal rotation and age. While ideally one would conduct an analysis of individual frequencies on a star-by-star basis, the very large number of stars observed by CoRoT and Kepler makes this impractical with current analysis procedures. Most studies have so far relied on using the so-called average seismic parameters. Such parameters are related to global stellar properties and can be combined with estimations of surface temperature in the so-called scaling relations to infer masses and radii for a large sample of field stars. Scaling relations can be combined with apparent magnitudes and effective temperature to derive seismic estimation for distances. This is particularly useful for targets which cannot rely on high-precision parallaxes. It has thus become increasingly important to test the scaling relations and the seismic inferred distances by using bright giants with accurate parallaxes and robust spectroscopic estimations of surface temperature.

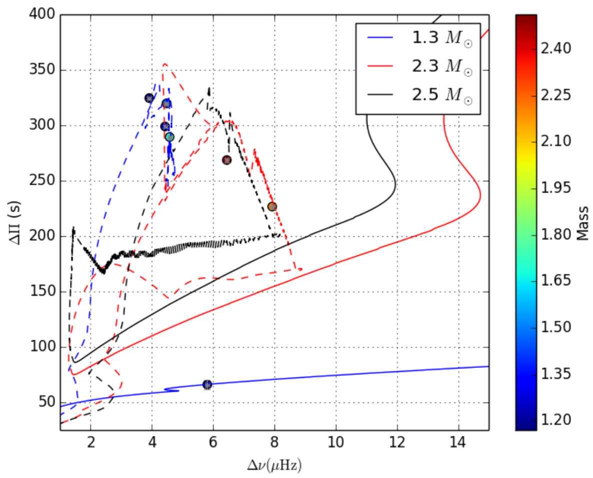

Figure 1. Period spacing (ΔΠ) versus large separation (Δν). The coloured solid lines indicate evolutionary tracks computed by the Modules for Experiments in Stellar Astrophysics (MESA) code. The models have solar composition and three different masses (1.30, 2.30 and 2.50 $M_\odot$).

2. Sample

Our sample consists of 9 bright red giant stars observed by the Kepler space telescope. The data obtained for the target stars have high signal to noise ratio (S/N > 200), allowing a detailed study with high quality seismic data.

All stars in our target sample have accurate values of parallaxes measured by Hipparcos, and 8 stars have parallaxes from Gaia.

We also measured the period spacing (ΔΠ) of mixed modes for 7 giants. Measuring period spacings allows us to clearly discriminate between red giants with similar luminosities but different evolutionary states .

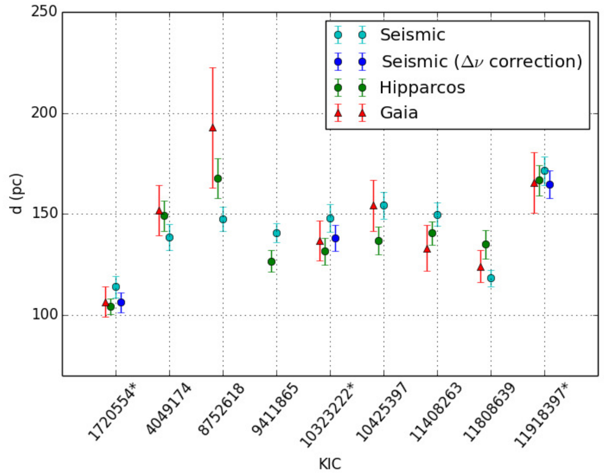

FIGURE 2. Comparison between distances obtained using three estimates: two from parallaxes, one from asteroseismology. Light blue dots are the distances determined by combining asteroseismic constraints and spectroscopic temperatures. The dark blue dots are the three RGB stars with applied corrections on $\Delta\nu$, also indicated by asterisks in the KIC numbers.

3. Results and Conclusions

Figure 1 shows the measured period spacing for 7 stars in our sample. Six stars are confirmed as clump stars ($\Delta\Pi > 200$) and one star is ascending the red giant branch ($\Delta\Pi > 50$). The other two stars are assumed to be ascending RGB stars, since they don't show a clear mixed mode patern in their power spectrum.

Figure 2 shows estimations of distance obtained by various methods. We computed estimations of distances using average seismic parameters.

From Figure 2, we see that the seismic estimations of distances have a reasonably good agreement with distances measured by Hipparcos and Gaia. We also computed corrections applied to the large separation in three RGB stars, which slightly improves the estimations of seismic distances.

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