AMBER+FINITO+UT Science Demonstration Proposal

Sizing red giants with AMBER, asteroseismic modelling of COROT data.

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Abstract:

We propose to use AMBER to measure angular diameters of red giants and combine them with COROT asteroseismic data that we have privileged access to. The combination of independent techniques provides a mean to constrain fundamental stellar parameters, allowing the testing of stellar models. The constraints provided by interferometric angular diameters are significantly better than those currently available. We will be able to infer more accurately the mass and evolutionary status of these stars, providing an important input for the theory of stellar interiors

Scientific Case:

Our team has privileged access to the high-quality red giant time series that has become available from the asteroseismic space mission COROT. Our prime target, HD181907, is the Corot giant with the best S/N power spectrum at the present moment. The data mentioned revealed important and unprecedented oscillatory properties about this red giant star, resulting in the discovery that HD181907 is a non radial oscillator similarly to our sun (Fig.1). These new results represent great advances in the understanding of solar-like oscillations in red giant stars, as it definitively proves and confirms the existence of this kind of non radial modes in such stars. The interferometric angular diameter measurements become extremely essential as this will allow us to constrain the mass of this star with great precision, giving us the opportunity to infer the internal structure in a way that has not been possible before.

A precise estimate of the stellar radius estimate is a precious constraint for the study of red giant stars structure. The reason for this is due to the red giant branch in the HR diagram being nearly vertical, meaning that even a small variation of the effective temperature implies a drastic alteration in the position of a red giant star in the HR diagram. Subsequently, a radius estimate can restrict the location of these stars in the HR diagram significantly.

Different observational techniques provide access to independent measurements which are crucial to increase the precision of the estimated parameters. Creevy et al. (2007, ApJ, 659, 616) showed that a precise measurement of interferometric radius is extremely important for a precise determination of the stellar mass in a way that would never be obtained with the seismic time series alone. Together, asteroseismology and interferometry have allowed refinement of the estimates of other physical parameters such as the effective temperature, the luminosity, and the metallicity. For instance, the measured stellar diameter allowed Kervella at al.(2004, A& A413, 251) to reduce significantly the error bar on the luminosity of Procyon A. Furthermore, it allowed to refine valuable constraints on the theoretical models of β Hyi (North et al. 2007, MNRS), δ Eri, ξ Hya and η Boo (Thevenin et al. 2005, A & A, 436, 253) reducing the uncertainties in the HR diagram.

Moreover, the mass estimate is very sensitive to the adopted mixing length parameters, as generally a solar value is adopted. Such estimates could help solving the long pending problem of mixing length parameter value in an environment very different from the sun's. Using observational constraints available at the time in a seismic analysis, Brown et al. (1994) were able to increase the precision of the estimated parameters of the α Cen binary system, e.g. the precision of the estimated mixing length increased of a factor of two (see also Miglio & Montalbán 2005, A&A, 441,615)

Calibration strategy:

HD175679, HD181907 and Hd50890 are COROT's asteroseismic targets. Our team is composed by experts in working interferometric data, asteroseismic data, and red giants modelling. We will use the high precision interferometric and asteroseismic measurements to test our internal structure modelling. We would like to obtain visibility curves along the baseline triple UT1-UT2-UT4, no special calibration is required.

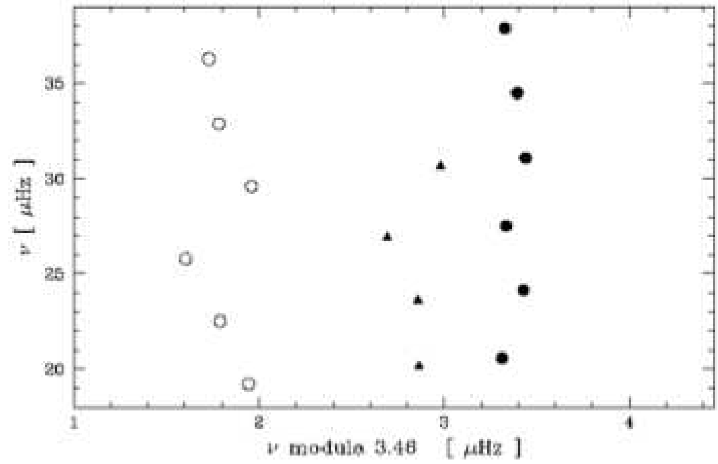

Figure 1: HD181907 echelle diagram. This diagram shows the different oscillation modes detected for this star. Solid circles correspond to the frequencies of l=0 modes, open circle to l=1 and to l=2. With much greater S/N than ground based observations we were able to clearly detect both radial and non-radial modes with similar properties of solar type oscillations.

Targets and number of visibility measurements

Target	RA	DEC	V mag	H mag	K mag	Size (mas)	Vis.	Mode	# of Vis.
HD181907	19 22 21.5451	-00 15 08.441	5.824	3.451	3.458	2	>0.5	LR	
HD175679	18 56 25.6046	+02 28 16.284	6.143	4.137	3.865	2	>0.7	LR	
HD50890	06 54 58.9172	-02 48 12.918	6.029	3.717	3.652	2	>0.5	LR	

Time Justification:
We would like to obtain visibility curves along the baseline triple UT1-UT2-UT4. The proposed objects have K magnitudes high enough for using AMBER+FINITO with UTs in low resolution. One visibility takes about 45 minutes for each object (90 minutes per calibrated point).