Abstract

The analysis of the first solar-like targets done by CoRoT has shown that the oscillation amplitudes are about 25% below the theoretical amplitudes while the convective backgrounds are up to three times higher than in the solar case (Michel et al. 2008). In such conditions, the Comb-like structure of the acoustic modes has smaller signal-to-noise ratios than initially expected complicating the characterization of individual modes. In the present work we apply the curvelet filtering to the solar-like targets already observed by CoRoT as well as a partial reconstruction of the signal from the obtained spacing of the comb-like structure of the acoustic modes. It enables us to enhance the signal-to-noise ratio of the ridges in the echelle diagrams. Finally, we study how the analysis of the p modes can be improved.

Partial reconstruction of the signal

- A possible way of enhancing the signal-to-noise ratio (SNR) of solar-like stars is to take advantage of the asymptotic properties of their p modes.
- In the Fourier spectrum of these stars, the peaks that correspond to the acoustic modes are almost equally spaced in a given frequency range.
- To increase the SNR of the periodic structures (the modes) we perform a selective filtering of the power spectrum of the power spectrum (PSPS) (see Régulo and Roca Cortés, 2002).
- The resultant PSPS is filtered in multiplying it by a window function which is 1 for all the equally spaced bins around multiples of the large separation of the p-modes (that should have been estimated before) starting at zero, while the rest of the bins are set to zero.
- The inverse Fourier Transform of this filtered PSPS produces a "recovered" power spectrum of the stellar p-modes with a higher SNR.
- This method tends to rigidify the modes towards the borders of the considered region where the modes could be less asymptotic and the large separations could change significantly with frequency.
- The "recovered" amplitudes and linewidths of the modes are modified.

Curvelet filtering

- Echelle Diagrams can help on the mode tagging.
- Used in early stages of helioseismology (Cinc et al. 1981).
- To improve the SNR Bedding et al. 2004 proposed to use it by smoothing in the vertical direction:
  - Only works well where the ridges are quasi-vertical.
  - A very good a priori of the large separation ($\Delta \nu$) is needed.
  - Only works properly in the asymptotical part.
- We propose other denoising technique based on the use of CURVELETS.
- Curvelet transforms are built to deal with curved structures of finite size in the image.
- A Curvelet transform (Candès & Donoho 1999) is a ridgelet transform (Candès 1998) but used in a localized manner.
- At a small scale any curved line can be approximated by a straight line.
- Using wavelets: Many coefficients are needed.
- Using curvelets: A few coefficients are enough.

References

- Lambert et al. 2006, A&A, 454, 1021
- Michel et al. 2000, Science, 282, 558
- Mosser et al. 2009, A&A, in preparation
- Régulo and Roca Cortés, 2002, A&A, 396, 745
- Candès 1998, Ph.D. Thesis, Stanford University
- Candès and Donoho, 1999, in Curves and Surfaces: Saint-Malo 1999, ed. Cohen, Rabut, & Schumaker, (Nashville, TN: Vanderbilt University Press)