Oscillating Red Giants as Corot Targets

Proposer: Joris De Ridder, Institute of Astronomy, K.U.Leuven, Celestijnenlaan 200B, B-3001 Leuven

Additional Team Members: C. Aerts, A. Noels, A. Thoul, A. Miglio, and additional BAG members

Primary Target and Science Case

The spectacular discovery of solar-like oscillations in the red giant ξ Hydrae (G7III) initiated a new branch of asteroseismology. The ξ Hya data showed a rich spectrum of oscillation modes with periods around 4 hours, which are believed to be excited by convective turbulence. Meanwhile, solar-like oscillations have been detected in several other red giants. The fact that red giants, with their huge density gradients, their hydrogen burning shells, and their extended atmospheres, are so different from main sequency stars, makes them particularly useful to test our stellar models and to improve our knowledge of this evolutionary stage. Although current ground-based datasets successfully prove the existence of multiperiodic oscillations in red giants, they are always hampered by a high noise level in the power spectrum and by aliasing due to a bad window function. Corot has the ability to make a major step forward by producing a power spectrum of a red giant of unprecedented quality. We therefore propose to observe the red giant:

1) **HD 50890** (G6III, V=6.02, α = 06 54 58.92, δ = -02 48 12.9)

during a short run of 15 days in a seismic field of the additional program. With HD50890 we chose for the brightest possible red giant in the eyes of Corot, to ensure an optimal signal-to-noise ratio. For this star, we expect to receive roughly 3.1 10^3 photons s^{-1} cm^{-2} (V passband). With the Corot detecting area of 584 cm^2, and an exposure time of 32s, this results in a (dominating) photon noise of about 130 ppm (1σ level) in the time series. After 15 days of observing with a duty cycle of 90%, the corresponding expected noise level in the amplitude spectrum is roughly 2 ppm. This is sufficiently low to also detect the somewhat lower amplitude modes as the predicted highest amplitude is somewhere between 50 and 150 ppm (Kjeldsen & Bedding, 1995, taking into account that they were wrong with a factor of 2 for ξ Hya). We also note that contaminating Mira-like oscillations are avoided by not choosing a K giant. (cf. Jorissen et al., 1997).

Secundary Targets and Science Case

From theory, we do not expect κ mechanism oscillations in stars on the main sequence between the SPB instability strip and the δ Scuti instability strip, say from spectral type B9 down to A1. However, variable stars situated in this region of the HR diagram have been discovered (e.g. Kallinger et al., 2002; and Scholz et al., 1998). They are often refered to as "Maia stars", and very little is known about them. It is, for example, unclear whether they are a separate class of variables, what the origin is of their variability, or even whether their variability is usually regular or not. We therefore propose to observe:

2) **HD 51151** (A0, V=7.89, α = 06 56 02.12, δ = -03 12 08.9)

3) **HD 50301** (A0, V=8.25, α = 06 52 28.82, δ = -03 03 49.0)

4) **HD 50698** (A0, V=9.20, α = 06 54 12.40, δ = -03 33 40.9)

5) **HD 50932** (A0, V=9.08, α = 06 55 10.43, δ = -01 48 24.9)

6) **HD 50405** (A0, V=9.32, α = 06 53 02.89, δ = -01 53 01.0)

7) **HD 50727** (B9, V=8.88, α = 06 54 23.07, δ = -01 39 25.1)

8) **HD 50280** (B9, V=9.33, α = 06 52 24.58, δ = -02 20 59.6)

9) **HD 50346** (B8, V=8.76, α = 06 52 46.73, δ = -01 42 54.2)

during the same run and in the same field of our prime target (HD 50890). Each of these targets are potential Maia candidates, and Corot can shed light on the nature of their variability. Even for the faintest target ($m_V = 9.33$), the expected noise level in the amplitude spectrum coming from photon noise in the time series is roughly 7 μmag, which is much better than in any of the current ground-based datasets.

A last target we propose to observe is the star:

10) **HD 50846** (AU Mon, V=8.43, α = 06 54 54.71, δ =-01 22 32.8)

AU Mon is a semi detached binary system which happened to be in the same field as our prime target. It is thought to consist of a B5IV star and a F9-G0 III-II companion (Vivekananda & Sarma, 1998). What makes this Algol variable special is that the eclips light variations are superposed with intrinsic brightness variations of which the origin is unknown. Ground-based photometric and spectroscopic observations already put quite stringent restrictions on the stellar parameters, and together with the high-precision measurements of Corot, this star would make a beautiful case study of an Algol variable. The orbital period is 11 days, which would be nicely covered with the requested short run.

Five Relevant publications

- Frandsen S., Carrier F., Aerts C., et al., 2002, A&A 394, L5,
  Detection of Solar-like oscillations in the G7 giant star ξ Hya
- Aerts C., Thoul A., Daszynska J., et al., 2003, Science, 300, 5627, 1926
  Asteroseismology of HD129929: Core overschooting and nonrigid rotation
- Thoul A., Aerts C., Dupret M.-A., 2003, A&A 406, 287,
  Seismic modelling of the beta Cep star EN (16) Lacertae
- De Ridder J., Kjeldsen H., Arentoft T., Claret A., 2003,
  2nd Eddington Workshop, Palermo
  The Eddington Light Curve Simulator
- Miglio A., Christensen-Dalsgaard J., di Mauro M.P., et al, 2003,
  Asteroseismology Across the HR Diagram, p. 537,
  Seismological analysis of the Helium ionization zones in low- and moderate-mass stars