# CoRoT Red Giant Working Group: Sismo field

## A proposal to re observe HR 6902 (CoRoT 9540), a binary system RedG+B-type

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HR 6902 (HD 169689, HIP 90313, V2291 Oph), RA=18 25 38.79902 DEC=+08 01 55.2324, V=5.7 is a rare eclipsing binary of the Zeta Aurigae type. These are wide binaries composed by a red giant and a hot unevolved companion. Their typically large orbital periods imply no - or very weak interaction between the components. Zeta Aur binaries have composite spectra: the lines of both components, having different effective temperatures but similar luminosity, are superimposed, so that the radial velocities, and hence the absolute elements of both stars can be accurately derived. For these reason the few known Zeta Aur systems have been used as benchmark of stellar evolutionary models and, in particular, to constrain the amount of overshooting (see for instance Schroeder et al. 1997, Iwamoto & Saio 1999, Claret 2009). Citing Schroeder et al 97, **HR 6902 is defined as "well known, the most crucial system among those containing a RG".**

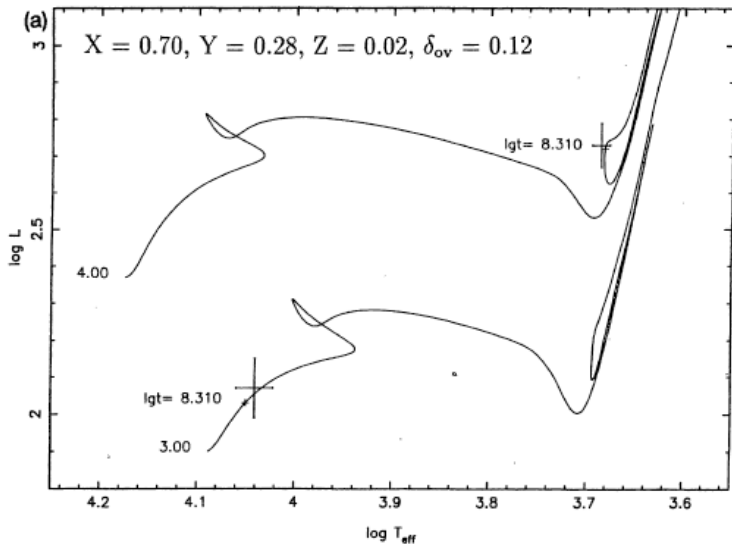


**Figure.1** HR6902: comparison of observational data and evolutionary tracks for quoted masses (age indicated by +) in the theoretical HR diagram. (From Schroeder et al. 1997

Actually, while the spectroscopic studies (Griffin & Griffin 1986, Griffin et al. 1995) are quite complete and reliable, the available photometry, before CoRoT was very scattered and made by many different non-professional observers. In spite of the object brightness, that was essentially due to the difficulty of observing the primary total eclipse (total duration ~ 8d) with a system orbital period of 385d.

Re-analysis of the extant photometry with modern synthetic light curve models has shown that the parameters originally derived by Griffin, (and in particular the radii, used in all the comparison with evolutionary models) do not fit the observations, casting doubts on the validity of the results of the previous model tests.

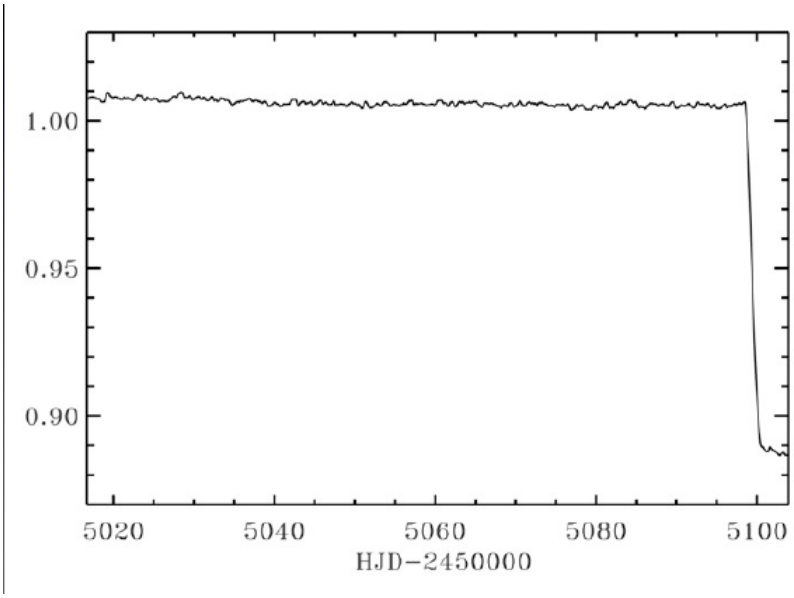


**Figure 2**. HR6902: CoRoT light curve, obtained during LRc04.

CoRoT has observed HR 6902 during LRC04, for ~ 80 days but, very unfortunately, the light curve ends in the middle of the primary eclipse, preventing a full determination of the system parameters.

From the CoRoT data we could, however, already verify that:

1. The old parameters by Griffin (in particular the stellar radii) do not seem to fit the available curve segment
2. Non-radial pulsations of the Red Giant are detected

*A posteriori, therefore, CORoT missed the opportunity of achieving a complete study of a remarkable and pivotal binary system.*

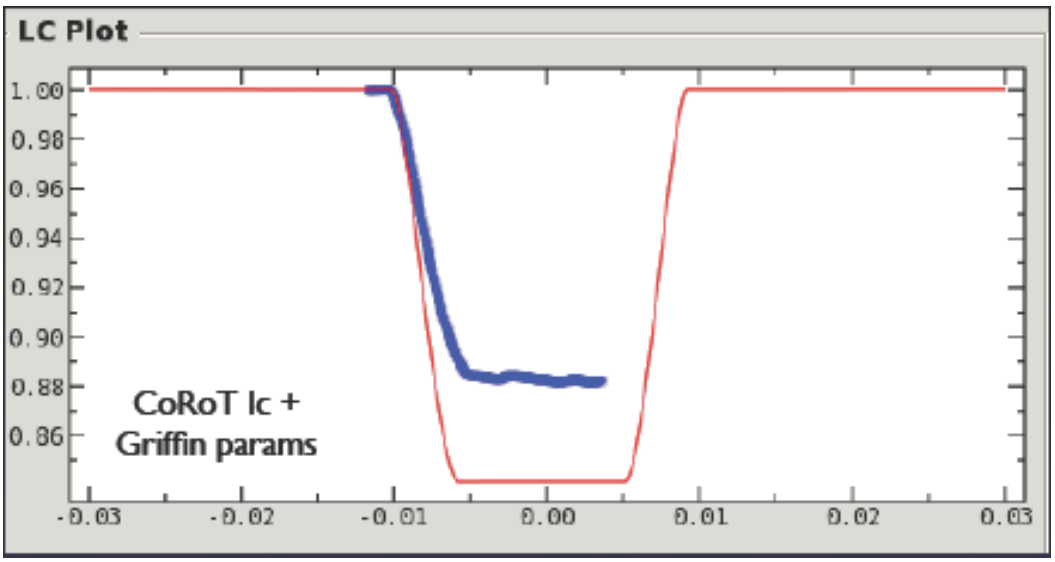


**Figure 3.** Red line: The synthetic binary light curve computed by PHOEBE with the parameters derived by Griffin (1995). Blue points: the primary eclipse in the CoRoT light curve.

Given the system ephemeris, the total eclipse, moving now from the end of Fall to Winter by 20d each year, won't be observable again for years (neither by CoRoT which observes the Center direction in Summer nor from the ground, as the system is unobservable in Winter period).
*However CoRoT could very easily observe the secondary minimum (according to our model of the light curve 0.7% deep) which will occur during the summer months for the next years (see table bellow)*

We propose therefore to re-observe the system in the seismo field, with the aim of constraining the duration of the eclipses (and hence the radii) and of combining the independent information from asteroseismic studies and binary modeling.

We stress again that this system is especially interesting because:

1. contains a pulsating red giant
2. is an EB with weak or no interaction between components
3. is AS WELL a SB2 (very rare occurrence)

Next possibility to observe the secondary minimum with CoRoT is during summer 2012. The dates of the center of secondary minimum are given in Table below, and the date for the next one is emphasized in red. Observations should cover least 5 days before and after this minima. For an asteroseismic analysis, long run of 150 (continuous or not) should be necessary as shown by preliminary study based on 80 days observations during LRc04.

Effemerides: HR 6902: (Griffin) t0=244 7788.180 P=385.0

Center of the first and secondary eclipses :

Min I (B star occultation)

| JD | date (yyyy-mm-dd hh) |
|---|---|
| 2455103.180 | 2009-09-28 16.32 |
| 2455488.180 | 2010-10-18 16.32 |
| 2455873.180 | 2011-11-07 16.32 |
| 2456258.180 | 2012-11-26 16.32 |
| 2456643.180 | 2013-12-16 16.32 |
| 2457028.180 | 2015-01-05 16.32 |
| 2457413.180 | 2016-01-25 16.32 |
| 2457798.180 | 2017-02-13 16.32 |
| 2458183.180 | 2018-03-05 16.32 |
| 2458568.180 | 2019-03-25 16.32 |
| 2458953.180 | 2020-04-13 16.32 |

Min II (B star transit on RG disc)

| JD | date (yyyy-mm-dd hh) | |
|---|---|---|
| 2455359.432 | 2010-06-11 22.37 | |
| 2455744.432 | 2011-07-01 22.37 | |
| **2456129.432** | **2012-07-20 22.37** | **Next summer CoRoT long run** |
| 2456514.432 | 2013-08-09 22.37 | |
| 2456899.432 | 2014-08-29 22.37 | |
| 2457284.432 | 2015-09-18 22.37 | |
| 2457669.432 | 2016-10-07 22.37 | |
| 2458054.432 | 2017-10-27 22.37 | |
| 2458439.432 | 2018-11-16 22.37 | |
| 2458824.432 | 2019-12-06 22.37 | |
| 2459209.432 | 2020-12-25 22.37 | |