*Binary Stars as Critical Tools & Tests*
*in Contemporary Astrophysics*
*Proceedings IAU Symposium No. 240, 2006*
*W.I. Hartkopf, E.F. Guinan & P. Harmanec, eds.*

doi:10.1017/S1743921307004127

# Close Binaries in the CoRoT Space Experiment

**Carla Maceroni[1] and Ignasi Ribas[2]**

[1]INAF - Osservatorio Astronomico di Roma, via Frascati 33, I-00040 Monteporzio (RM) Italy
email: maceroni@oa-roma.inaf.it

[2]CSIC - Institut d'Estudis Espacials de Catalunya, Barcelona, Spain
email: iribas@ieec.uab.es

**Abstract.** We discuss the impact that the space experiment CoRoT, whose launch is scheduled for late 2006, will have on the field of close binary.

**Keywords.** binaries:close, binaries:eclipsing, stars:late-type, stars:activity, stars: oscillation, stars: planetary systems

## 1. Introduction

CoRoT (COnvection, ROtation and planetary Transits) is a french-led international "small" space mission whose launch is scheduled for November 2006. The mission is devoted to the achievement of two parallel "core programs", astroseismology and extra-solar planet search, wich require the same type of observations, i.e. high accuracy photometry and long continuous monitoring of targets †.

CoRoT will provide high accuracy ($10^{-3}$ – $10^{-4}$) lightcurves of more than hundred thousand stars. The observations will be performed in two modes, both characterized by continuous monitoring of a preselected field: Long and Short Runs lasting, respectively, $150^{\mathrm{d}}$ and $30^{\mathrm{d}}$. The expected duty cycle is of ~94%.

Many selected binary systems will be observed in the Additional Programme (AP), i.e., research programs outside the core programs. Moreover, about a thousand new binaries are expected as by-product of the exoplanet search and hundreds of them will have extremely accurate light curves.

The exoplanet targets have apparent magnitude in the interval $11.5 > V > 16.5$, and a typical sampling of 8 min. Besides, targets brighter than $V = 15$ will have as well some color information (thanks to a prism that will separate the blue and red part of the spectra with a resolution $\sim 4$). These will be as well the characteristics of most CoRoT binaries.

Table 1 and Figure 1 (see Maceroni & Ribas 2006) show an estimate of the expected number of binaries per CoRoT Exo-field, by means of the Besançon Galaxy model (Robin *et al.* 2003). The constraints are: spectral type G-M and luminosity class V-IV (as the Exoplanet search will privilege late-type dwarfs), within the magnitude range $V$=10.5–15.5. Eclipsing binaries are assumed to be 0.5–1% of all monitored stars (as suggested by surveys as Vulcan, STARE, OGLE).The results in Table 1 shall be multiplied by a minimum number of five Long Runs and ten Short Runs.

† complete information on the mission is available at `http://corot.oamp.fr`

**Table 1.** Expected binaries per 3.4 square degree exoplanet field in the Summer (centered at $\alpha = 6^{\rm h}50^{\rm m}; \delta = 0°$) and Winter ($\alpha = 18^{\rm h}50^{\rm m}; \delta = 0°$) pointing directions

| Spectral type | expected EB number |
|---|---|
| G0–G4 | 7.2 – 31.1 |
| G5–G9 | 3.2 – 10.5 |
| K0–K4 | 2.9 – 11.9 |
| K5–K9 | 0.35 – 0.8 |
| M0–M4 | 0.09 – 0.17 |

## 2. Close binaries related scientific programs

The community involved in CoRoT and AP on binaries has assumed the (informal) organization of a 'Binary Thematic Team' (BTT) ‡, coordinated by the authors. The BTT has been granted several scientific programs (two applications for data of known binaries and archival data) for the first CoRoT runs (2006/2007) which are aimed to (Maceroni & Ribas 2006 for details):

• derive basic stellar parameters (masses, radii) for *well-behaved* systems, i.e., preferentially detached binaries. Exquisite, better than 1% accuracy is expected,

• study second-order effects in the light curves (limb and gravity darkening),

• study the manifestations of stellar activity in late-type components by eclipse tomography, and derive information on rotational period and differential rotation (from spot migration), and

• perform astroseismology in suitable eclipsing binaries.

In the latter case while the search for (non-radial) oscillation in binary system components is more challenging than in single stars, the advantage is that the masses, radii, inclination, and therefore the rotational velocity can be known. Also, the mutual eclipses of the components could help to identify and assign the different modes. In close binaries tidal frequencies could be excited.

A possible target for a pointed Short Run in the Seismology field is the binary IM Mon, the brightest binary in the CoRoT field of view. As the photometry of seismology target will be at a few ppm level, IM Mon could become the eclipsing system with the best ever measured light curve.

## 3. Binaries as a concern

The most serious problem for planetary transit detection in CoRoT will arise from contamination by background eclipsing binaries (BEBs).

The CoRoT exoplanet program essentially performs aperture photometry on a crowded stellar field. In spite of the definition of specific masks, conceived to limit contamination from nearby stars, a contribution of faint background objects to the light curve of the target is unavoidable. The high frequency of false alarms from BEBs was already identified from the experience of OGLE planetary transit search: only five true planets out of 177 alarms were confirmed by follow-up observations (Udalski *et al.* 2004), a result in agreement with the theoretical estimation of Brown (2003).

Blind tests have been done by Moutou, Pont, Barge *et al.* (2005) to evaluate the ability of detrending the lightcurves from instrumental and environmental biases in the specific context of CoRoT, and of eventually discriminating real planets from false alarms. A complex light curve simulator, has been realized (Auvergne, Boisnard & Buey 2003),

‡ The BTT webpage can be found at `http://thor.ieec.uab.es/binteam/`

https://doi.org/10.1017/S1743921307004127 Published online by Cambridge University Press

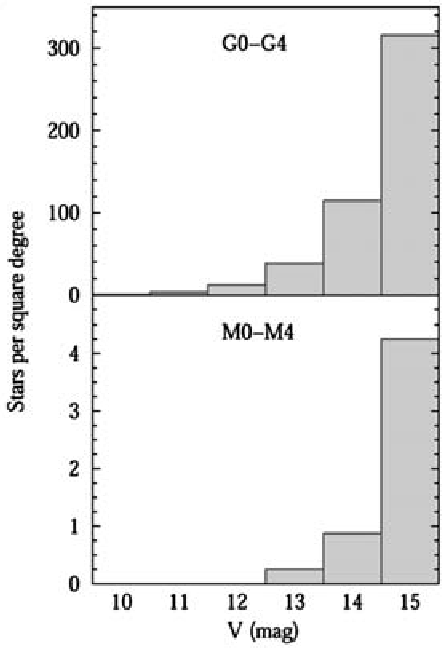


**Figure 1.** The distribution in apparent magnitude in the winter field of binaries with late-type components (and luminosity class IV-V) as obtained from the Besançon galaxy model and the hypothesis that eclipsing binaries are $\sim 0.5 - 1.0$ % of all monitored similar stars.

which includes most sources of noise and environmental perturbations. The blind test consisted in analyzing, without prior knowledge, a set of simulated CoRoT lightcurves containing signal from planets and, as well, from other stellar sources of noise, such as stellar activity and background binaries.

While BEBs were confirmed to be the major source of false alarms, many cases could be discriminated just by detailed analysis of the folded lightcurve, on the basis of color behavior of the transit and by detection of a secondary minimum. Only ∼10% of alarms will need more time and resources such as follow-up spectroscopy†.

## Acknowledgements

CM acknowledges funding of this research project by MIUR/Cofin and F-INAF programs and a grant from the IAU General Secretary.

## References

Auvergne, M., Boisnard, L., & Buey, J-T. 2003, *SPIE* 4853, 170
Brown, T. M. 2003, *ApJ* 593, L125
Maceroni, C. & Ribas, I. 2006, *astro-ph/0511171*
Moutou, C., *et al.* 2005, *A&A* 437, 355
Robin, A. C., Reylé, C., Derrière, S., & S. Picaud 2003, *A&A* 409, 523
Udalski, A., Szymanski, M. K., Kubiak, M.,Pietrzynski, G., Soszynski, I., Zebrun, K., Szewczyk, O. & Wyrzykowski, L. 2004, *AcA* 54, 313

† see the presentation of F. Pont (2006) available from the website of the 10$^{\text{th}}$ CoRoT Week: `www.obs-nice.fr/cassiopee/COROTWeek10/presentations.html`

https://doi.org/10.1017/S1743921307004127 Published online by Cambridge University Press