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CoRoT: pioneer space mission for exoplanet transit search

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Abstract. Led by the CNES space agency the CoRoT mission is born from a joint effort of France, Austria, Belgium, Brazil, Germany, Spain and ESA. In orbit around the Earth, CoRoT started its first observations in February 2007 and is, now, regularly producing ten thousand light-curves with a very high accuracy. Performances are better than expected and some Hot Jupiters have already been detected in the raw data. Once the fully corrected data will be delivered, much smaller transits should be detected giving access to the hot Neptunes and the big Terrestrial planet families. We briefly describes the status of the mission, the inflight performance and the ground based program follow up strategy. We also present some preliminary results issued from a first analysis of the data.

Keywords. instrumentation: photometers, planets and satellites: formation, stars: binaries: eclipsing, stars: variables: delta Scuti, stars: variables: other

1. Introduction

This paper presents an overview of the CoRoT mission (see also Baglin *et al.* 2006) and its status. A detailed description can be found in a pre-launch book (CoRoT 2006) and in a post-launch paper (Auvergne *et al.* 2008, *in preparation*) that describes how the instrument is actually working and its present in flight performances. CoRoT, which stands for COnvection ROtation and planetary Transits, is an experiment dedicated to stellar seismology and search for extrasolar planets. It was developed as a minisatellite CNES mission, i.e. a mission of intermediate size and low cost. It was preselected in 1994 for a phase A competitive study. However, political and financial difficulties have postponed the final decision, which was taken in October 2000. In between, the studies continued and a much richer scientific mission has been prepared with an extended exoplanet program and a much larger scientific community from the european countries.

CoRoT was launched December 27th from Baikonour and placed in orbit around the Earth at an altitude of 900km. Now, the satellite is collecting data that are downloaded to the Earth at a regular rate. A number of technical challenges have been taken up successfully : (i) a pointing stability of 0.5 arcsecond (the payload being in control loop with the platform), (ii) a very efficient protection against straylight thanks to a baffle whose rejection factor is better than 10^{-12}, (iii) a thermal stability better than 0.05C over 1 hour, (iv) the management of a cooperation with many international partners.

2. The scientific objectives

The CoRoT mission has two scientific programs, both requiring long and uninterrupted sequences of observations with a very high photometric accuracy. The first one is devoted to understanding the physics of stars and their evolution. The second is devoted to the discovery of other planetary systems and to the study of the way they form. During the observations, the telescope is pointing in fixed direction and the two scientific objectives are working simultaneously on adjacent parts of the sky. These two programs define the so called Core Program of the mission that splits into a central program organized around long observation runs of 150 days and an exploratory program based on short observation runs of 20-30 days. The exploratory program follows the requirements of the seismology program in order to get a reasonable coverage of the HR diagram. The short runs are also used by the exoplanet search program to enlarge the sample of Hot Jupiter planets.

2.1. *The seismology program*

Helioseismology has proved to be a powerful tool to probe Sun's interior, leading to identify many parameters of solar physics with an accuracy better than 0.1% down to the core, and even contributing to rethink the theory of the neutrinos. The observation from space of other stars than the Sun (with a precision and over time scales out of reach from the ground) was necessary to test different physical conditions and improve the modeling of the internal structure and evolution of stars. The light curve integrated over a stellar disk can bring accurate information on the modes and makes it possible to determine: the radius of the core, the deep limits of the convective external layers, the rotation profile inside the star, the angular momentum transport.

A good frequency resolution is necessary to discriminate a significant number of modes, to reveal the frequency splitting and rebuild the line profiles. The number of targets is of the order of 10 per run. The targets are chosen among F and G stars (supposed to have

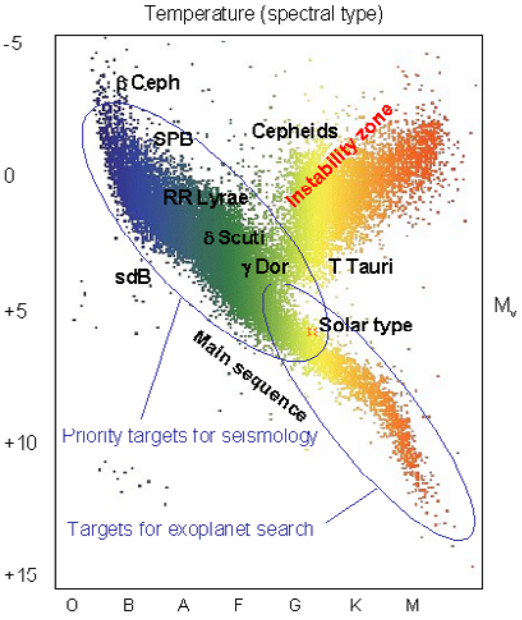

Figure 1. HR diagram reporting the various families of targets that CoRoT will observe (after Boisnard & Auvergne 2006)

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solar like pulsations) but also among more classical pulsators as delta Scuti, gamma Dor and beta Ceph stars known as variables from the ground with only a small number of modes. During the long runs (150 days) the frequency resolution reaches 0.1 Hz in the Fourier space (central program). During the exploratory program the observation runs are shorter (20-30 days) and the aim is to widen the sample of target spectral types for a better coverage of the HR diagram (Fig. 1). This should be sufficient to produce statistical data about the excitation of the oscillating modes (see e.g. Michel *et al.* 2006).

2.2. *The exoplanet program*

The CoRoT planet finding program aims at detecting extrasolar planets when they transit in front of the disk of their parent stars. For the exoplanet channel the global design of the instrument is the same than for the seismology channel; the only difference is a smaller defocus and a longer integration time. Small flux variations down to 7.10^{-4} can be seen with CoRoT on a star of magnitude 15.5 in a one hour integration time. On the same duration, smaller variations are accessible to stars brighter than $m_V \simeq 12$, the magnitude at which saturation problems appear on the CCD.

The exoplanet program is performed during long runs of 150 days (180 days at maximum) but the data acquired during the short runs (20-30 days) are also used to search for short period planets. To detect a planet in complete confidence, the phase must stay coherent over three successive transits, so planets detected during a long run will have periods less than 50-60 days whereas those detected during a short run will have periods less than 10-15 days.

In order to partly overcome this limitation, a dispersion device has been implemented on the exoplanet channel, a few centimeters in front of the CCDs, providing a three-color signal that helps to discriminate planetary transits (achromatic events) from stellar "noise" (highly chromatic variations due to temperature variations at the surface of the star). Studies have shown that using this three-color information can improve transit detection for stars much more active than the Sun and also when the light curves contain less than three successive transits. Further, as the image of a star on the CCD surface is divided into three distinct regions, the three-color bands correspond to a spatial information that can be used to discriminate false candidates (due to background eclipsing binaries) from transit events on the target star.

During the nominal lifetime of the mission, CoRoT will observe some 60,000 stars during 5 long runs of 150 days and nearly some 60,000 stars during 5 short runs of 30 days. So, in total, some 120,000 light curves should be available to search for planet with periods less than 10 days and 60,000 light curves to search for planets with periods that range from 10 days to 50 days. With its photometric precision, mainly limited by the photon noise, CoRoT should detect big terrestrial planets 2-3 times bigger than the Earth (Barge *et al.* 2006)

The planet finding program also includes in-depth analyses of the data looking at: (i) transit timing variations due to an hypothetical non-transiting outer planet; (ii) peculiar transits due to planets in binary systems or to planets with rings or big moons; (iii) signatures of exoplanetary atmospheres. This program includes a complete characterization of the detected planets to get their orbital motion, masses, mean density and also to learn more about their composition and internal structure. The determination of planet radius from transit depth also depends on the precision the star radius is known. In a more general way, an optimal scientific return of the mission requires to characterize at best the planet and its host star. This is possible via the organization of a well co-ordinated program of follow-up and complementary observations like prepared by the CoRoT Exoplanet Science Team. CoRoT is expected to detect and characterize a large

large number of transiting planets that will help to constraint the models and to improve our understanding the way planets form.

2.3. *Additional programs*

Additional programs allows the astronomical community to propose observations devoted to specific target fields to address scientific cases different from the core program, as for example stellar activity (surface magnetism), binary systems, pulsating stars beyond the instability strip and possibly search for Kuiper belt objects (KBO), etc ... In the case of exoplanetary science, the search for the modulation of the star flux by the light reflected by an orbiting planet was selected as a specific additional program. The target is HD52265, a star known to host a planet from Doppler measurements, and that will benefit from the very high photometric accuracy available on the seismology CCDs. The additional programs have, however, a lower priority with respect to the seismology/exoplanet core program.

Figure 2. The CoRoT instrument on the Proteus platform

3. Organization and partners

CoRoT is a french national-lead program with a new type of collaboration with ESA. CNES is the prime contractor for the mission, the payload development is driven by a team with people from CNES and CNRS laboratories (LESIA in Meudon, LAM in Marseille and IAS in Orsay) and including European partners (Austria, Belgium, ESA and Germany). Alcatel Alenia space was responsible for the platform and the integration of the satellite. The ground segment is developed within the same frame of cooperation between CNES, CNRS laboratories (OMP in Toulouse) and international partners (Brasil and Spain). The satellite mission and control centers are located at the Toulouse Space center.

4. The satellite

The CoRoT spacecraft is based on a recurrent Proteus platform, developed by CNES and Alcatel Alenia Space. CoRoT is the third mission to use this platform in a low Earth orbit with its associated ground control segment. The payload is made up of a telescope, a wide field camera operating in the visible, an equipment bay hosting analogical and digital electronics and a flight software in charge of the aperture photometry processings and of the fine pointing mode (see Fig. 2).

The total mass at launch is 630 kg with a payload mass of 300 kg. The satellite is 4 meter long with a mean diameter of 2 meters. The pointing accuracy of the platform is 0.5 arcsec and the capacity of the telemetry is 1.5 Gbit/day. The nominal total duration of the mission is, at least, 2.5 years but a longer lifetime is expected. The payload is made up of three subsystems called CoRoTel, CoRoTcam and CoRoTcase that we briefly describe.

4.1. *CoRoTel*

CoRoTel is an afocal telescope composed of 2 parabolic mirrors with a pupil of 27cm and a two meter long cylindrical baffle. To reach the required photometric accuracy the baffle have to stop the straylight from the Earth with an efficiency that must be better than 10^{-12}. To obtain such a high efficiency was a real challenge, of a crucial importance for the success of the mission (see Fig. 3).

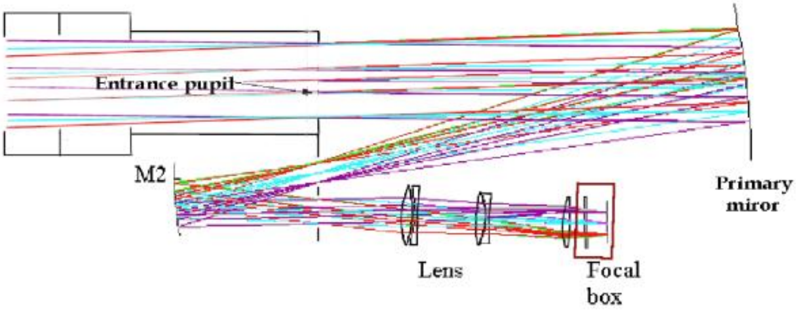


Figure 3. The optical design: the light is collected by an off-axis (afocal) parabolic system with 2 mirrors; the parallel beam at the output of the telescope is re-imaged on the focal plane by a dioptric objective.

4.2. *CoRoTcam*

This is a wide field camera composed of a dioptric objective (6 lenses) and a focal unit equipped with 4 frame transfer CCD 2048x4096. Two CCDs are devoted to the seismology program and the two others are devoted to the exoplanet program. The focusing is optimized as to spread at best the photon of the targets onto the CCDs; it is different for the two scientific objectives. In front of the 2 CCDs devoted to the exoplanets, a dispersive device (biprism) has been inserted to help discriminate planetary transits from stellar variability (see Fig. 4).

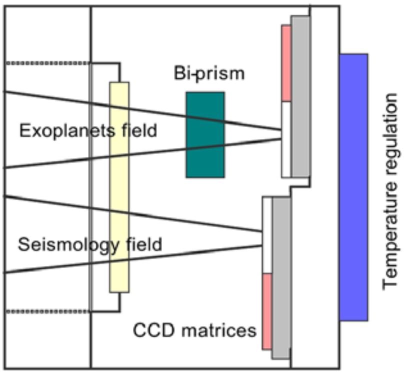


Figure 4. The two scientific channels inside the focal block

4.3. *CoRoTcase*

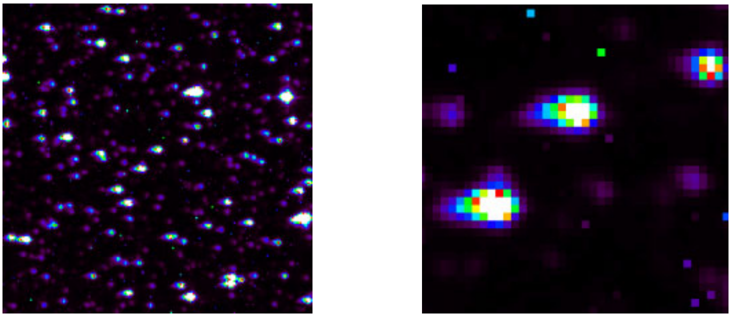
The equipment bay host analogical and digital electronics and a flight software in charge of the aperture photometry processings and the delivery of angle error measurement data to the platform (fine pointing mode). The equipment bay supports the scientific data processing electronics and instrument housekeeping electronics.

5. The field of view and the photometry

In the focal plane of the instrument the four CCDs are mapping on the sky a field of view of $3.05° \times 2.8°$ and a single pixel represents 2.32 arcsec. On the two CCDs devoted to the seismology program the targets are bright stars whose magnitude ranges from 6 to 9. Each CCD contains a primary target with a magnitude of the order of 6 and a handful of stars brighter than magnitude 9. On the exoplanet CCDs the stars are fainter and much more numerous (see Fig. 5). Their magnitude ranges from 11 to 16 and their total number is limited to 12,000.

The stellar fluxes are measured as a function of time, every 32s in the seismology field and every 512s in the exoplanet field. For the exoplanet targets, the measure results from the piling up on board of 16 individual exposures of 32s obtained by aperture photometry. The apertures are in pixel unit and tailored from a reduced number (256 per CCD at maximum) of fixed patterns (or templates) that are uploaded at the beginning of a run of observation. The production of these templates results from a complex procedure that accounts for: photon noise from the targets and the background, readout noise from CCDs and electronics, jitter noise, thermoelastic breathing, variability of the background (Llebaria & Guterman 2006). This procedure is performed on ground on the full image of the CCDs that is downloaded at the very beginning of a run.

Due to the bi-prism implemented in the focal block between the dioptric objective and the plane of the detector, the image of each target star is a small spectrum whose area is about $300 arcsec^2$ on the sky. This low resolution spectrum is sufficient for a “colored photometry” obtained by splitting the aperture in three parts called “red”,“green” and “blue” according to a flux criterion based on the fraction of energy in each color channel. The separation between the red, green and blue bands is adapted for each target star. The photometry is performed on board by piling up the pixel flux in each of the colored bands and the results are transmitted to the ground. In the case of faint stars, the colored photometry is very poor and reduces to standard one band (“white”) photometry.



(a) small part of the exofield

(b) details of star images

Figure 5. Images of target stars on the exoplanet CCDs

So, in total and for each CCD, different types of windows are opened: 4500 "three-color" windows sampled at 512s; 1000 "white" windows sampled at 512s; 500 windows sampled at 32s (oversampling can be triggered from the ground); 20 "imagettes" i.e. windows of 10x15 pixels containing a single star image (all the pixels of the window are downloaded to the ground); 200 "black" windows for the correction of the background.

6. The mission constraints

As the PROTEUS platform only evolves on low Earth orbits, this puts constraints on the orientation of the satellite and on the possible observing regions. In order to observe the same direction of the sky for a long period of time (several months) without being blinded by the Sun or occulted by the Earth, the satellite must have a polar inertial orbit and a line of sight roughly perpendicular to the orbit plane (see Fig. 6).

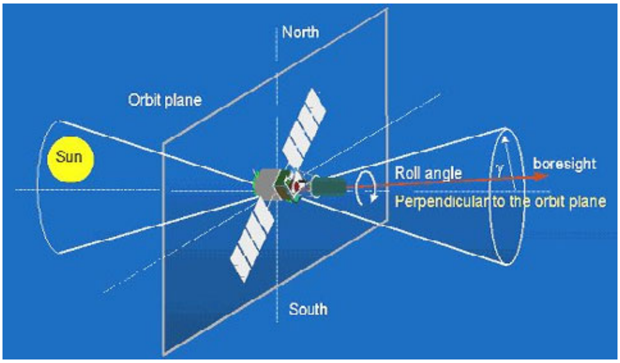


Figure 6. The observation cone and the pointing constraints.

Two reversal maneuvers are necessary once a year when the direction of the Sun is perpendicular to the line of sight. The available observing time, 180 days at maximum, is shared between long runs of 150 days and short runs of 20 to 30 days. The following scenario has been adopted: a short run of 20 days is inserted between two long runs of the central program (devoted to the seismology and the exoplanet core program). The short runs are equally shared by the exploratory program of seismology and the additional program. A dense region of the sky has been selected at the intersection between the galactic plane and the equatorial plane, defining two visibility zones (or "eyes") in the direction of the center and the anticenter of the Galaxy. Preparatory observations have permitted to find a compromise between the two scientific objectives; seismology requires a few number of well selected bright targets whereas planet search requires large number of stars with $11 < m_V < 16$ in regions of moderate star density.

So, during the nominal lifetime of the mission (at least 2.5 years), there will be a total of 5 long runs of 150 days and 5-10 short runs of 20-30 days, successively in the direction of the center or the anticenter of the Galaxy.

7. "Alarm mode" and follow up strategy

One specificity of the CoRoT exoplanet program is the "alarm mode", an operational loop between science team and command center on ground and the instrument in space (Quentin *et al.* 2006). Its goal is to optimize the science return of the mission by identifying, before the end of a run, transit candidates early in the process before the data be fully reduced. For these transit candidates, decision can be made to change the rate of the observations from one exposure in 512s to one exposure in 32s. The interest for this oversampling is two-fold: (i) to get a better coverage of the transit profile (in view to determine limb darkening and albedo); (ii) to reduce the level of noise by removing outliers from the corrupted exposures. Last but not least, another interest of this "on the stream" detection is to start follow-up operations as soon as possible.

Once transit signals are detected the goal is to secure at maximum the detections and to trigger the follow up observations necessary to completely characterize the discovered planets. Inside the CoRoT Exoplanet Science Team (CEST) the work necessary to reach this goal is shared into 5 different tasks performed in successive steps.

- *Task 1:* The first task, in direct relation with the detection procedures, is to make a detailed analysis of the light-curve and to remove the possible false alarms, for example by identifying indirect signatures of the eclipsing binaries (secondary transit, triangular shape of the primary transit, ellipsoidal modulations due to tidal effects).
- *Task 2:* It consists in using on/off photometry to test: (i) the level of variability of the background stars identified inside the target PSF, (ii) if one of the stars in the target PSF could mimic the transit observed on the target. The necessary information on the contaminating stars is found in the ExoDat preparatory database that contains all the necessary information on the field of view and the targets.
- *Task 3:* Once the transit candidate is secured, radial velocities are used to confirm the presence of a planet and to measure its mass. If accurate enough, radial velocity measurements can also be used to evidence the Rossiter-Mac-Laughlin effect that put constraints on the alignment of the star and planet rotation axes. Most of the CoRoT planet candidates will be within the reach of the SOPHIE and HARPS spectrographs.
- *Task 4:* It consists in obtaining precise stellar parameters using high resolution spectroscopy and to get a good estimate of the planet parameters.
- *Task 5:* Finally, the last task is to use space observations, like HST, FIRST, ...etc to go into deeper studies and to characterize at best all the planet parameters.

8. Summary of the in-flight performances

CoRoT is in orbit around the Earth since December 27th. The opening of the cover, on January 17th, was followed by a program of calibrations and in-orbit verifications. All the on board systems were checked, the optical performances were found to be excellent for the two scientific channels and the satellite successfully entered in fine pointing mode (the Proteus platform being fed by information from the payload). The scientific observations began on February 2nd, with a field of view in the direction of the anti-center of the Galaxy. This first run of observation lasted only 2 months and was used as a commissioning phase of the instrument.

- *Duty cycle:* Data losses occur either at the crossing of the South Atlantic Anomaly or due to random losses in high energy events. Before launch, the corresponding duty cycle was estimated of 90% . In reality losses due to random events are of the order of 2% and those due to SAA crossing are of the order of 6%; so, the resulting duty cycle is 92%, i.e. better than expected.
- *Hot or bright pixels:* The number of bright or "hot" pixels on the CCD matrices is found, however, 10 times greater than expected. This delayed the starting of the pipeline and slowed down the production of fully reduced data. Nine months after the end of the initial run data are ready and will be delivered to the Co-Is mid December 2007. A preliminary analysis of the data demonstrates the high quality of the instrument whose performances are better than expected and in very good agreement with the scientific specifications of the mission.
- *Pointing:* The actual performance in the pointing of the satellite is 0.12 pixels rms following the x axis and 0.15 pixels rms following the y axis. This corresponds on the sky to a mean value of 0.3 arcsec and is better than expected.
- *Photometric performances:* The noise level in the light curve of a star of magnitude $m_V = 15.4$ in a 1 hour integration time has been estimated to 700ppm; this value matches pretty well with the initial requirement for the instrument (700 ppm in 1 hour on a star of magnitude 15.5). In the case of a brighter star of magnitude $m_V \simeq 12.3$ the estimated noise level obtained in 1hour is 170ppm. Consequently, the noise level remains of the same order as the photon noise over all the range of magnitude.
- *Straylight:* The variations of the straylight all along the orbit of the satellite has been estimated to $0.4e^-$ (on average), a value that is significantly less than the expected value of 2-$4e^-$. This is due to the very good performance of the baffle whose rejection factor is better than 10^{-12}.

9. Observations and preliminary results

For the time being CoRoT has observed four different fields of stars. The first run of observation (IRa01) was in the direction of the Galactic anticenter and lasted 55 days. The second and the third ones were in the direction of Galactic center: a short run of 25 days followed by a long run of 150 days. The fourth one (LRa01), in the direction of the Galactic anticenter, started October 24th and is still being observed.

In total, since the beginning of the observations, CoRoT monitored 30 bright stars for the seismology program and 34,560 stars for the exoplanet search program. The data, uncorrected from the jitter and still containing residuals of the orbital effects, were analyzed by the alarm mode software. A number of transit candidates were detected in the data and the sampling rate of the targets was changed correspondingly. Then, the resulting lists of planet candidates were examined following the procedure described in section 7, the best candidates being sent to to the follow-up group for confirmation and characterization.

- *Variable stars and eclipsing binaries*

From a quick inspection of the CoRoT light curves the most striking aspect is the large number of stars with a significant level of variability. These stars are identified as eclipsing binaries or periodic pulsators with periods that ranges from days to months. Fig. 7 gives an example of a δ Scuti star of magnitude 13.8 that shows variations of 3% with double modulation.

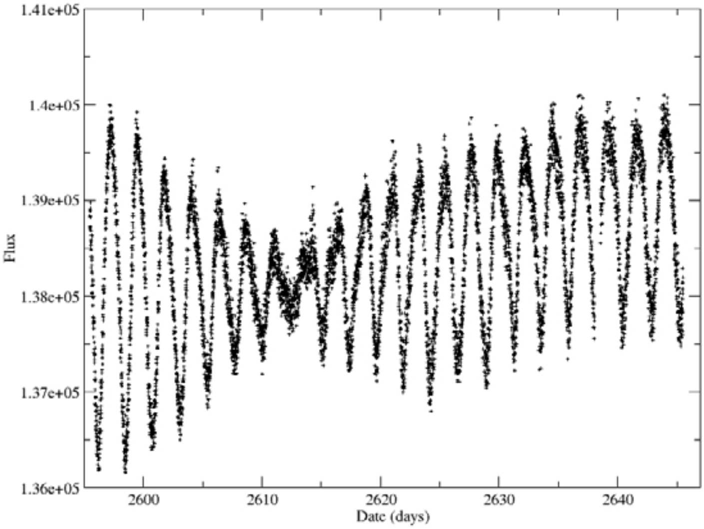


Figure 7. Example of variable stars in the CoRoT exofield

Eclipsing binaries are also frequently identified in the CoRoT field of view. They can be loose or tight systems with amplitudes that can be very large (several percents). A number of them shows clear evidence of ellipsoidal variations due to tidal interactions between the two components. An example of eclipsing binaries found by CoRoT is given in Fig. 8 with its succession of primary and secondary eclipses. This example also illustrates the possible confusion between eclipsing binaries and transiting planets when the amplitude of primary and secondary transits are nearly the same; indeed, noise may rub out the small differences between the two types of transit.

The high frequency of eclipsing binaries in the CoRoT field of view and the large extent of the CoRoT Point Spread Function (PSF) onto the sky (about 30 arcsec) are also favoring possible confusions between the periodic eclipses of a neighboring background star and the transits of a planet in front of the target star. A number of ambiguous situations can be removed with follow up observations: either on/off photometry of contaminating stars in the PSF or Doppler spectroscopy of the target.

- *The first planet detected by CoRoT*

Thanks to the alarm mode, the preliminary analysis of the data permitted to find two transit candidates during the observation of the initial run (IRa01). These two candidates were used as test cases to improve the organization and management of the necessary follow-up operations. One of them was rapidly identified as an eclipsing binary thanks to radial velocity measurements at the Tautenburg observatory. The other candidate was observed with the SOPHIE spectrograph at OHP; the first Doppler measurements gave us some positive clues about the planetary nature of the event but an additional effort was necessary to completely confirm the planet.

Thirty six transits were observed during the run which was ~55-days-long. The duration of the transits is nearly 2.4 hours and the relative precision is 2.10^{-4} in 1 hour integration time. This planet was announced in a press release and named CoRoT-Exo-1b. A rough estimate of the main planet parameters was obtained using the folded light curve (see Fig. 9) : its orbital period is 1.5 days and its radius ranges ranges from 1.5 to 1.8 R_{Jup}. The large uncertainty in the radius comes from the bad determination of the

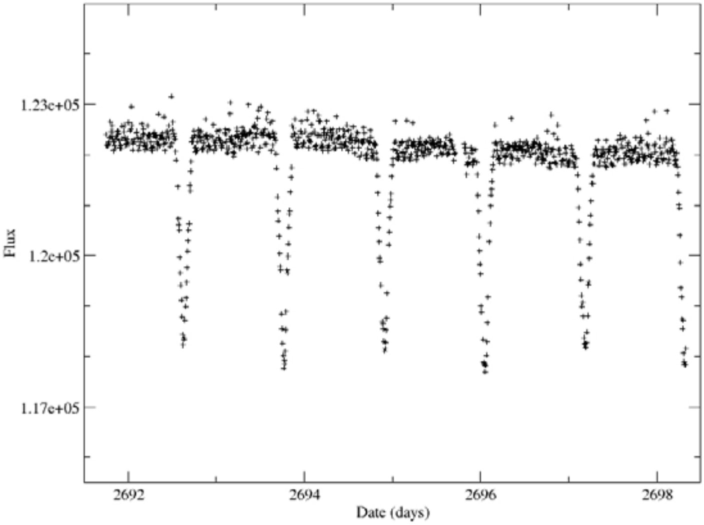


Figure 8. Example of eclipsing binaries in the CoRoT exofield

star's parameters (spectra with a good resolution and a high signal-to-noise were lacking at this moment). The best fitting of the folded light-curve is consistent with an orbital inclination of 84°.

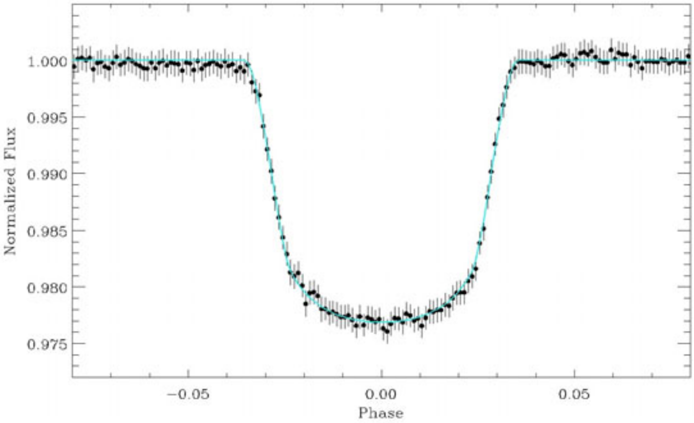


Figure 9. The transit of CoRoT-exo-1b folded at a period of 1.5 days. The bin size is 2.16 minutes and the precision $\sim 3.10^{-4}$.

With the high photometric accuracy achievable from space an interesting opportunity is to use the method of the transit timing variations to indirectly detect the presence of non-transiting outer planets. In the case of CoRoT-Exo1b we have 36 individual transits and a precision of 2.10^{-3} in 32s; so, time lags down to 20-30 sec should be accessible. The possibility to use transit timing variations to detect other planets around CoRoT-Exo-1 will be explored in a future CoRoT paper that will present the detailed analysis of the light-curve. This will be made with data fully corrected from the instrumental noises, once the last version of the pipeline will enter the production phase.

The estimation of the planet mass, based on the measurements of the SOPHIE spectrograph at Observatoire de Haute Provence, gives a value of $1.3 M_{Jup}$. Finally, with the present values of the parameters, the planet is found to orbit at some 0.04 AU from its parent star. More precise determinations of the radius and the mass of the planet will be given in a forthcoming CoRoT paper (Barge *et al.* 2008, *in preparation*).

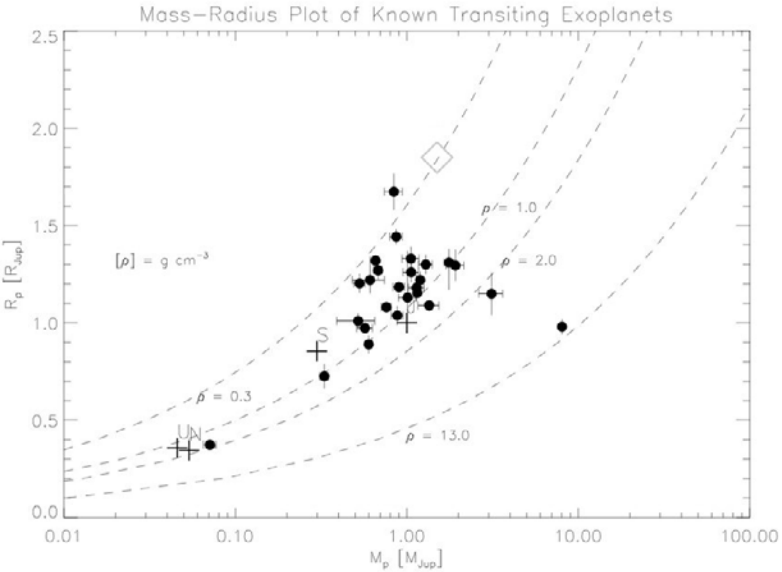


Figure 10. The mass-radius diagram: dots represent known transiting planets; crosses represent Solar system planet; the diamond corresponds to CoRoT-Exo-1b.

The new planet discovered by CoRoT has been reported on a mass-radius diagram simultaneously with all the other transiting planets discovered so far (see Fig. 10). It is located at the extreme border of the plot and detaches from all the other points. This new object seems to challenge the recent models on the physics of the hot giant planets. However, we must avoid hasty conclusions since the radius of the star is still poorly known. With an increasing number of transiting planets CoRoT will fill up this diagram with an homogeneous sample of data that will help to better constraint the models. Of course, the most interesting parts of the diagram that CoRoT should supply are, at the bottom-left, the domain of the icy giants and the domain of the big rocky terrestrials.

- *Other planet candidates*

Early transit detection with the alarm mode also permitted to identify during a single long run (LRc01) 20 planet candidates that are reported below in a list ordered following their orbital period:

– 8 candidates with $P < 5$ days
– 4 candidates with $5 < P < 10$ days
– 5 candidates with $10 < P < 27$ days
– 3 single transit events.

The variability of each target star was first checked in the database of the BEST preparatory survey. Then, we used the follow up procedure described in section 7 and triggered the following operations: (i) on/off photometry with telescopes at IAC and OHP, but also with EULER and WISE; (ii) radial velocity measurements with the spectrographs SOPHIE, FLAMES, HARPS and Tautenburg. As a result, eclipsing binaries were identified in five cases.

10. Conclusions

CoRoT is the first space survey devoted to a photometric search for extrasolar planets. The satellite, launched in December 2006, is in a low Earth orbit where the instrument is working well and all systems are nominal or better. Since February 2007, CoRoT is regularly providing 12,000 light curves with a very high photometric precision. On the total duration of the mission, CoRoT will observe in ten different directions of the sky and will produce some 120,000 light curves. The level of noise in the data is nearly equal to the photon noise, in accordance with the initial requirements of the mission. So, according to pre-launch simulations (Moutou *et al.* 2005), the detection of big and hot terrestrial planets should be within the reach of CoRoT. The number of hot pixels on the CCD matrices, which is higher than expected, slowed down the starting of the pipeline. When the release of the fully corrected data will be available (a few weeks), the detection of short-period planets smaller than Uranus will become effective.

For the time being, the preliminary analysis of the raw data performed during the alarm mode permitted to identify many variable stars and eclipsing binaries, but also a number of transit candidates. Follow up operations were triggered to secure the detected candidates and to characterize the discovered planets. One planet was found in the initial run of observation and 20 other candidates in the first long run, in the direction of the Galactic center. The first planet, CoRoT-Exo-1b, is now completely confirmed (Barge *et al.* , *in preparation*) and 15 candidates are still in the Follow Up process.

With the ground based discoveries of a number of transiting systems, the characterization of extrasolar planets just passed an important step and is leading the way to transit surveys like CoRoT and Kepler. Indeed, for such systems, mass and radius measurements can reach a precision that is only limited by the stellar parameters. This is of a crucial importance to determine the mean density of the exoplanets and to better understand their internal structure. So, the most direct impact of CoRoT will be the filling up of the mass/radius diagram with families of planets in the domains of the icy giants and the big terrestrials.

The high photometric accuracy available with CoRoT can also give access to: (i) the method of the transit timing variations (to identify non-transiting outer planets); (ii) the identification of dark spots on the surface of the stars (in possible connection with presence of a planet); (iii) the detection of tiny secondary transits due to the planet reflected light (indicative of the orbit eccentricity).

Once a transit is detected it is also interesting to search for the Rossiter-McLaughlin effect using spectroscopic measurements during the transits. This is important because this effect provides an insight on the rotation of the star and on the orientation of its spin axis with respect to the planet orbital plane.

So, CoRoT will help to learn more about the short-period planets (orbital distribution, density and structure), their possible interaction with their parent stars (planet induced stellar activity), their dynamical evolution (through tides and magnetic fields) and their formation.

To learn more on CoRoT, see the web site: http://corot.oamp.fr.

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