B

STARE observations for COROT[1]

This second Appendix summarizes the detection of new variable stars in the celestial regions accessible to the COROT telescope. The wide field of view of the STARE telescope allows a fast identification of variable stars. Some of these might be chosen to serve as secondary targets on the asteroseismic COROT CCDs, for its 150 d long runs, after the launch of the space mission expected for June 2006.

B.1 Introduction

THE european COROT (COnvection, ROtation and planetary Transits) space mission (Baglin et al. 2002) consists of a telescope with a pupil surface of 590 cm^2 (diameter ∼25 cm), planned for launch in June 2006, that will stare for long runs (∼150 days) at several pointings in two celestial regions: the galactic anti-center ($\alpha = 6^h 50^m, \delta = 0°$) and the galactic center ($\alpha = 18^h 50^m, \delta = 0°$). Each of the accessible zones for the telescope has a radius of 10°. Two CCD's with a total field of view of $\sim 2.8° \times 1.4°$ will be devoted to look at no more than 10 bright stars during each run, with magnitudes 5.7<V<9.5, with the aim of detecting solar-like oscillations, but also to study the pulsational behavior of different types of stars at several evolutionary stages. In this *asteroseismic* mode, one target is labelled as *primary*, while the other ∼9 are considered as *secondary* targets, for scheduling and planning

[1]Several of the results presented in this Appendix have been published in Alonso et al. (2003b), Poretti et al. (2003), Martín et al. (2004) and Poretti et al. (2005). I summarize in this appendix the STARE contribution to those works.

purposes. These objects are observed in a defocussed mode, to increase the number of collected photons, to minimize the intra-pixel and inter-pixels sensivity variations of the detectors, and thus to achieve noise levels at the order of 10^{-6} in flux after 5 days of observations. At least one δScuti star will be a primary target.

Two different CCD's will be situated after a prism, and photometry of at least ~30000 stars (throughout the whole mission, a maximum of 12000 stars will be observed at each long run) with low resolution color information will be used for the search of transiting objects, aimed at the detection of the first telluric planets. In this *exoplanetary* mode, the magnitude range of the surveyed stars will be $11<V<16$, (only those with $V<15$ will have color information) and the specifications are to achieve 10^{-4} noise levels for a 15.5 magnitude star after an integration time of 1 hour.

B.1.1 Motivation

The wide field of view of the STARE telescope implies that the objects accessible at all the possible orientations of the COROT CCDs around a primary target are within its reach. Thus, it was used as a tool to detect new variable objects of interest to serve as secondary targets around the primary targets on the asteroseismic CCDs. Two different philosophies were adopted in the center and anti-center directions, as the necessities were not the same in both cases.

B.2 Observations: Anti-center

In the case of the targets located at the anti-center direction, the request was to find suitable secondary targets around already fixed potential primary targets. The goal was to map the lower part of the instability strip, and the ideal COROT targets should be located between the ZAMS (Zero-Age Main Sequence) and the TAMS (Terminal-Age Main Sequence). The reason is that evolved stars show too dense frequency spectra that are very difficult to model. A total of six nights were spent to observe the fields around six primary targets: HD 43587 (16 March 2002), HD 45067 (17 March 2002), HD 49933+49434 (18 March 2002), HD 55057 (19 and 22 March 2002) and HD 43318 (18 Nov 2003). The observed fields and their position in the sky are plotted in Figure B.1. As the magnitude limit for the fainter stars in the asteroseismic CCDs is V=9.5, we reduced the integration time to 25 s, and we used the STARE "V" filter (see Chapter 2), for which the quantum efficiency of the CCD is lower. With this configuration, a total of 500-600 stars in each STARE field have $V<9.5$, and 500-700 images were obtained in each field.

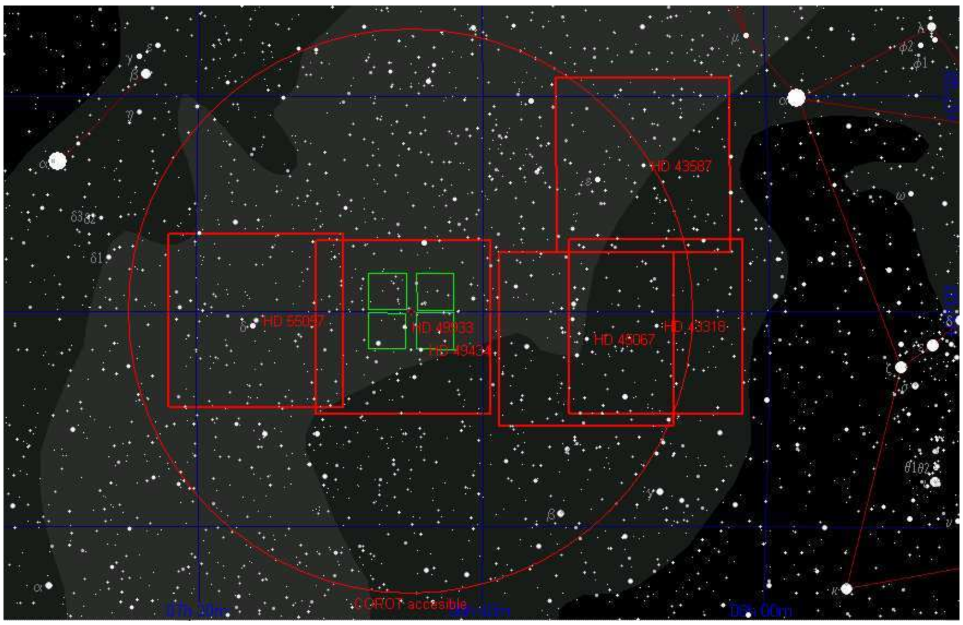

FIGURE B.1— Location of the COROT primary targets and the 5 STARE pointings in the anti-center direction. In green, the size of the COROT CCDs is plotted; the two CCDs on the left side will be devoted to asteroseismology, while the two on the right are used for exoplanet transit search. The circle marks the accessible sky for COROT on this region.

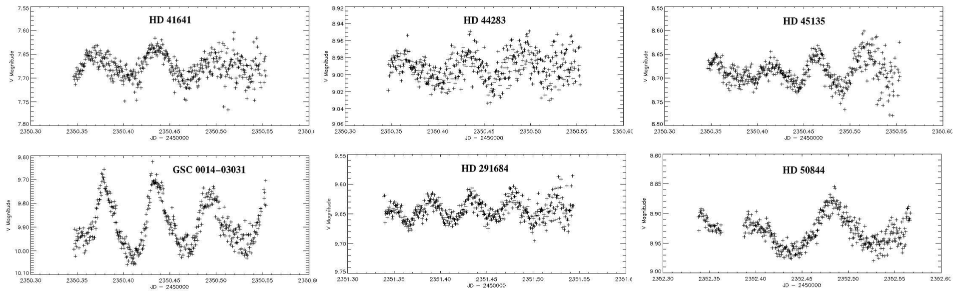

FIGURE B.2— Light curves of six stars found to be variable in the STARE images. Magnitude scale is instrumental V.

B.2.1 Results

A total of 38 clear variables have been discovered with the STARE observations in this exercise. They are listed in Table B.1. 11 of them meet all the conditions to be observed as secondary targets on the asteroseismic CCDs, and the rest are fainter than the V<9.5 limit (18) or too far from the primary targets (9). Possible future changes in the primary target choices might include some of the stars located too far from the current primary targets, and thus these have been included in the Table. A sample plot of six of the variable stars is given on Figure B.2.

B.3 Observations: Center

The observations in the center direction were conducted to try to detect new variables in the open cluster NGC 6633. If a star belongs to a known cluster, then parameters such as the age and the metallicity are better constrained, which might help in the inversion of the pulsation frequencies to study the interior of those stars. Several studies of δScuti stars have been preformed on the basis of this idea (e.g. Belmonte et al. 1994). A multi-site campaign coordinated by S. Martin in summer 2002 was intended to detect new variable stars and to confirm several doubtful candidates. The STARE telescope was used on the nights of July 13, 15 and 16 2002. The parameters for the observations were identical as those performed in the anti-center direction.

B.3.1 Results

A total of 7 stars brighter than V=9.5 and another 7 fainter stars were detected in the STARE observations. These are summarized in Table B.2; The stars

TABLE B.1— New variable stars discovered with STARE in the Anti-center direction.

Star	V[a]	Sp.	Ampl (mmag)[b]	Type and remarks[c]
		Potential secondary targets		
HD 43021	7.84	A0	45	δ Sct
HD 44283	9.36	F	<50	δ Sct
HD 44562	8.63	A3	20	δ Sct
HD 44872	8.40	A3	20	δ Sct
HD 45196	8.33		14	Geom.
HD 48719	9.19	A5	30	δ Sct
HD 50844	9.10	A2	80	δ Sct
HD 50870	8.88	F0	70	δ Sct
HD 55113	8.70	K5	~20	Red var.
HD 291684	9.83	A0	60	δ Sct
HD 293340	9.53	F0	40	δ Sct
		Too faint to be secondary targets		
HD 54780	10.17	A0	~220	E
HD 289732	10.8	B8	105	β Cep ?
HD 291635	10.4	B	400	E
HD 291791	10.5	F0	~80	δ Sct
HD 292402	10.10	F0	120	δ Sct
HD 292525	10.36	F2	150	δ Sct
HD 292864	10.45	A2	75	δ Sct
HD 292930	10.33	F0V	40	δ Sct
HD 292971	10.12	F2V	100	δ Sct
GSC 00142-00022	10.3		65	δ Sct
GSC 00143-00139	10.8		~120	HADS or E
GSC 00143-01718	10.3		~200	HADS or E
GSC 00144-03031	10.1		>400	HADS
GSC 04784-00830	11.5		600	E
GSC 04814-00028	11.1		~100	Red var.
		Too far to be secondary targets		
HD 41641	7.86	A5	70	δ Sct
HD 42561	8.89	A2	60	δ Sct
HD 45135	8.82	A2	100	δ Sct
HD 48866	9.0	A0	~300	E
HD 52239	9.06	A5	~30	δ Sct
HD 54331	7.94	A0	~40	Long per.
HD 292962	9.89	F0V	200	δ Sct
HD 293031	10.48	F8III	>200	E candidate
HD 293622	9.98	A	35	δ Sct

[a] Values reported in the SIMBAD and/or GAUDI (Solano et al. 2005) databases; in particular for GSC stars see GSC version 1.2

[b] Peak–to–peak amplitudes are in the V STARE instrumental system

[c]HADS stands for High Amplitude δ Sct star, E for eclipsing binary

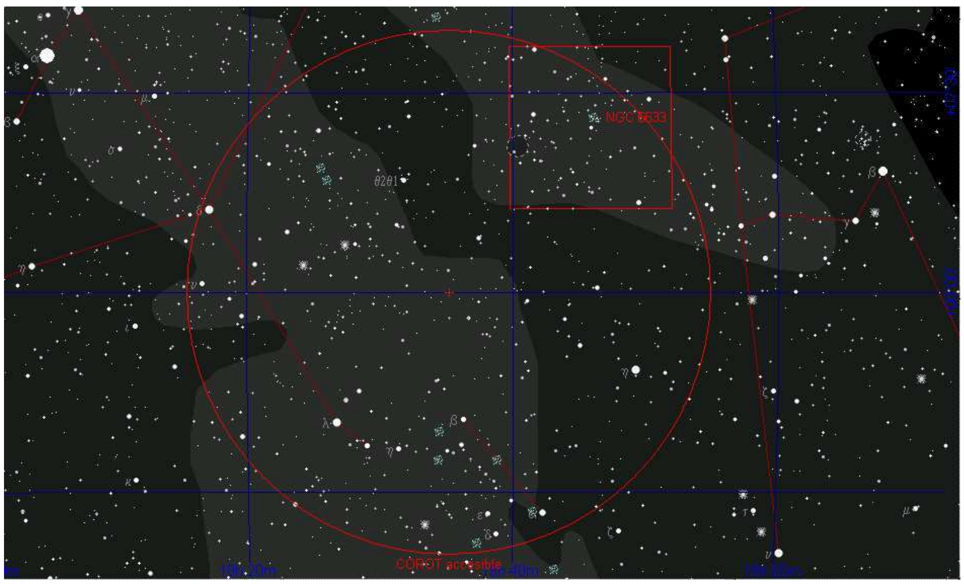

FIGURE B.3— Location of the NGC 6633 cluster in the COROT observable sky at the galactic center direction.

TABLE B.2— Variable stars detected with STARE in the center direction.

Star	Ampl (mmag)	Type and remarks
HD 169577	20	γ Dor discovered by Martín & Rodríguez (2002)
HD 169842	~20	γ Dor candidate; member of the cluster (Catalano & Renson 1998)
HD 169959	~20	Ap variability ?
BD+06 3737	70	δ Scuti
HD 169597	<20	Low amplitude
HD 170412	<20	Low amplitude, long period (>0.2d)
HD 170451	~300	W UMa (Koppelman, West, & Price 2002)
		Too faint to be secondary targets
NGC 6633 275	>70	γ Dor discovered by Martín & Rodríguez (2002)
BD+06 7348	20	δ Scuti?
NGC 6633 89	40	δ Scuti
BD+06 3803	30	δ Scuti
BD+06 3802	100	Candidate eclipsing binary
NGC 6633 14	40	Possible non-member
NGC 6633 108	30	Possible non-member

HD 169577 and NGC 6633 275 had been observed by Martín & Rodríguez (2002) and were suspected γ Doradus pulsators. Two new variables, HD 169842 and HD 169959, both with frequencies in the γ Doradus regime, are thought to be part of the cluster (Catalano & Renson 1998), and four other variable stars were identified in the STARE light curves. One is a W UMa eclipsing system, first detected by Koppelman, West, & Price (2002), and the other three had not been previously observed to vary.

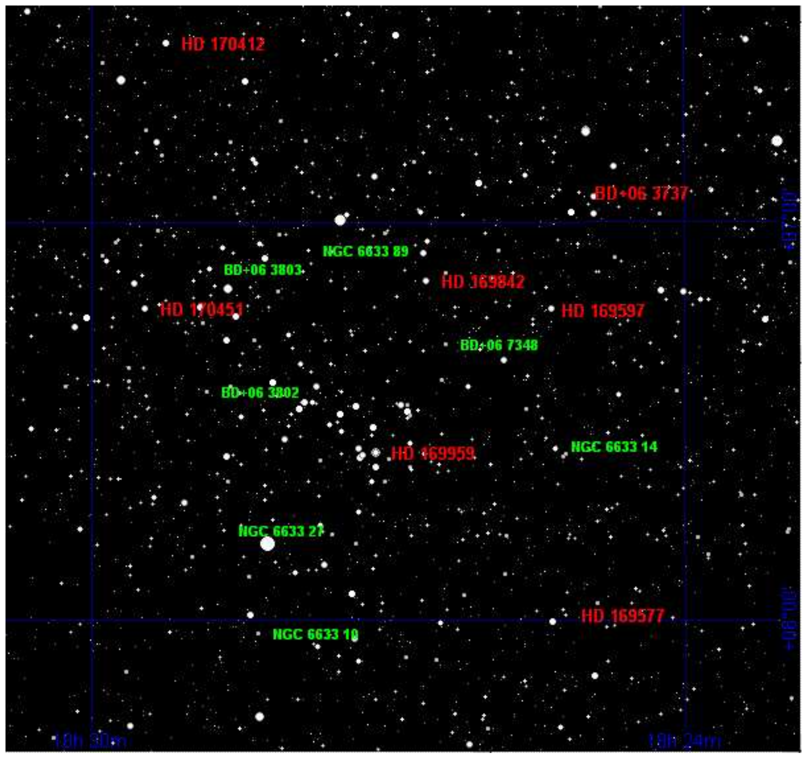

FIGURE B.4— Location of the identified variable stars in the NGC 6633 region. Red labels are for stars brighter than V = 9.5, while green labels are for fainter stars.