Strange and low amplitude Cepheid candidates in the CoRoT observations

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Introduction

Recent advancements in large-scale photometric surveys and space photometric missions made possible the discoveries of new types of variable stars, as well as offered the potential to test theoretical predictions at a new level of data continuity and accuracy.

One of the possibilities is to find low amplitude variable stars. On the one hand, intrinsically low amplitude pulsating stars are well known (nonradial pulsators like B-type stars, SPB, Delta Sct, gamma Doradus, pulsating white dwarfs, etc). On the other hand, according to more recent theoretical developments, radially pulsating, classical variables may come in low amplitude flavors, too.

We initiated a CoRoT Additional Program to find and analyze ultra-low amplitude (ULA) classical variables (Cepheid, RR Lyrae) in the CoRoT data. Well inside the classical instability strip (IS) one does not anticipate low amplitude variables. However, near or at the IS edges genuine low amplitude classical variables may be found. These stars may be:

- radially pulsating stars entering or leaving the IS, therefore exhibiting low amplitude (Buchler & Kolláth 2002), or
- pulsating in a high-order radial overtone (strange) mode which is confined to the outer atmosphere of the star (Buchler et al. 1997), again showing lower-than-normal pulsational amplitude.

So far several ULA candidates were published (all found in the LMC). Buchler et al. (2005) discovered 7 ULA and 2 strange Cepheid candidates using the MACHO and OGLE observations. Soszynski et al. (2008) mention 23 possible ULA Cepheids found in the OGLE-III data, lying in the vicinity of Cepheids in the color-magnitude and period-luminosity diagram. Buchler et al. (2009) uncovered an additional ~30 stars, some appears to be multiperiodic. Among them there may be low amplitude Pop II. Cepheids or RV Tauri stars.

Sample and selection criteria

We used the CoRoT IRa01 (initial run in the Galactic anticenter direction) and LRc01 (first long run in the Galactic center direction) data and selected low amplitude Cepheid candidates based on the automated supervised classification performed by the CoRoT team (Debosscher et al. 2009). A new class (LAPV: low-amplitude pulsating variables) was defined to accommodate low amplitude Cepheids. However, it turned out that low amplitude variables of different nature (eclipsing binaries, low amplitude pulsators, blends, etc.) show similar light curve characteristics. It is therefore not easy to separate them without accurate color information. As a consequence, we had to deal with hundreds of light curves. These were all low amplitude variables (amplitudes typically less than 0.01^m), the sample did not contain any normal amplitude Cepheid. The selection mechanism we applied consisted of the following steps:

- Fourier-analysis, only stars with one significant frequency (plus possible harmonics) were retained.
- Light curves showing frequencies close to (but not equal to) the 1:2 ratio were rejected, these are likely rotationally modulated or spotted variables.
- We eliminated obvious blends based on the DSS images using the CDS database.
- 2MASS JHK color indices were checked to match those of Cepheid and RR Lyrae variables.

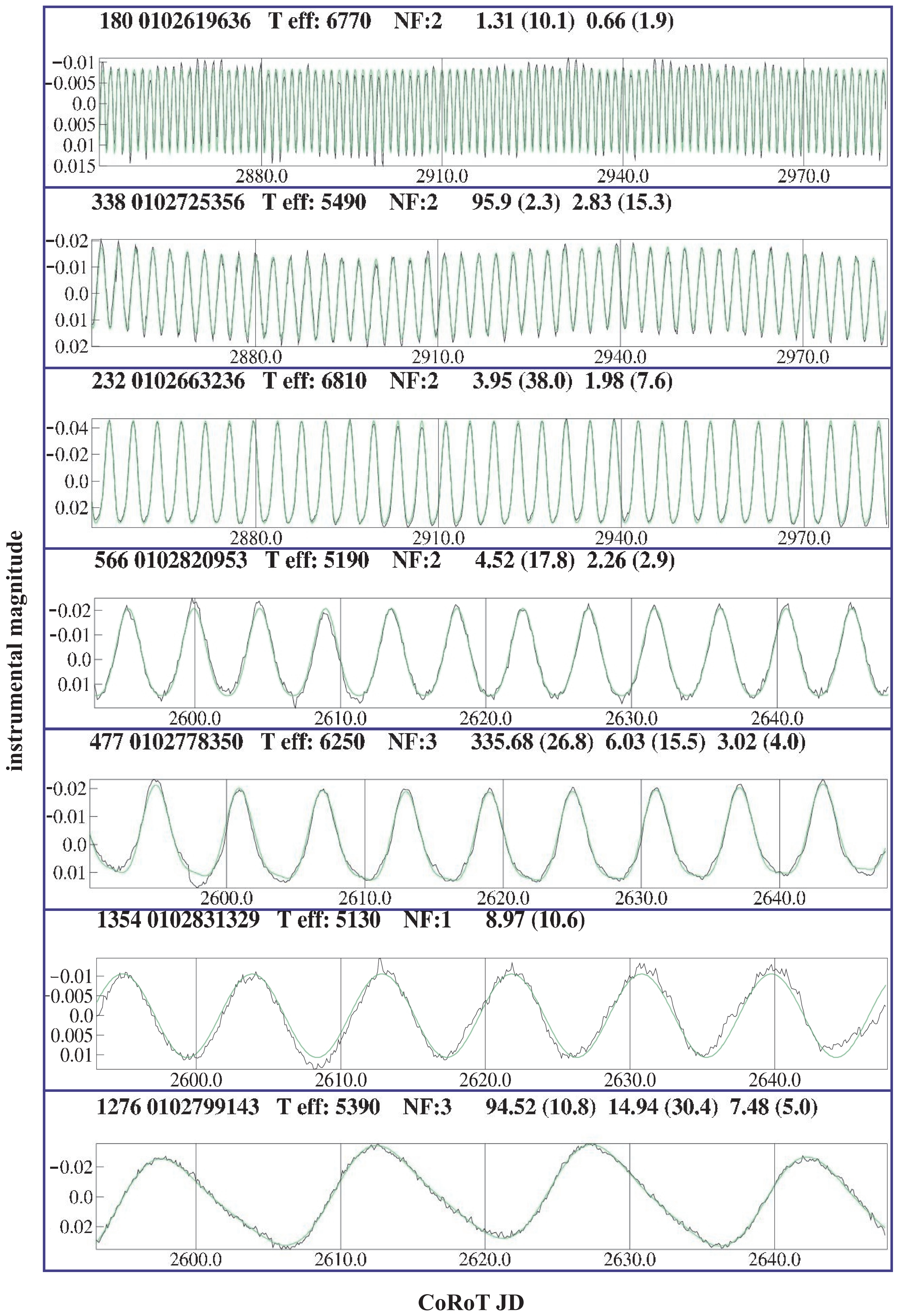

Fig. 1. Light curve examples ordered by increasing period. The numbers show ID, Corot ID, effective temperature, number of the fitted frequencies, period(s) (days) and amplitude(s) (mmag, in brackets). The black curve is the observed light variation, while the green curve shows the Fourier-fit.

Results

After applying the selection criteria, we were left with ~70 low amplitude Cepheid candidates. We present in **Fig. 1.** a sample from our low amplitude Cepheid candidates ordered by increasing period. Note the different intervals covered by observations.

Fig. 2. shows the normal and strange Cepheid Instability Strip based on linear models applying a $\log L = 3.56 \log M + 0.79$ mass-luminosity relation. All the models were computed using the Florida-Budapest code (Kolláth et al. 2002 and references therein) assuming Galactic metallicity (Z=0.02, X=0.75). Our models were transformed to the J-H color index - period plane using Kurucz atmosphere models.

The distribution of ULA candidates are seemingly random around the classical Cepheid Instability Strip. This is maybe due to contamination of blends and other impostors. However, clear clustering is evident at the 'strange' region close to the blue edge of the IS. Some other stars can be in the phase of entering or leaving the IS with low amplitude near both the red and blue edges.

The amplitude of some candidates may be decreased by one or more close stellar companions lying in the same direction by coincidence. To be able to rule out the blending scenario, reliable colors, high-resolution imaging and preferably a spectrum will be necessary.

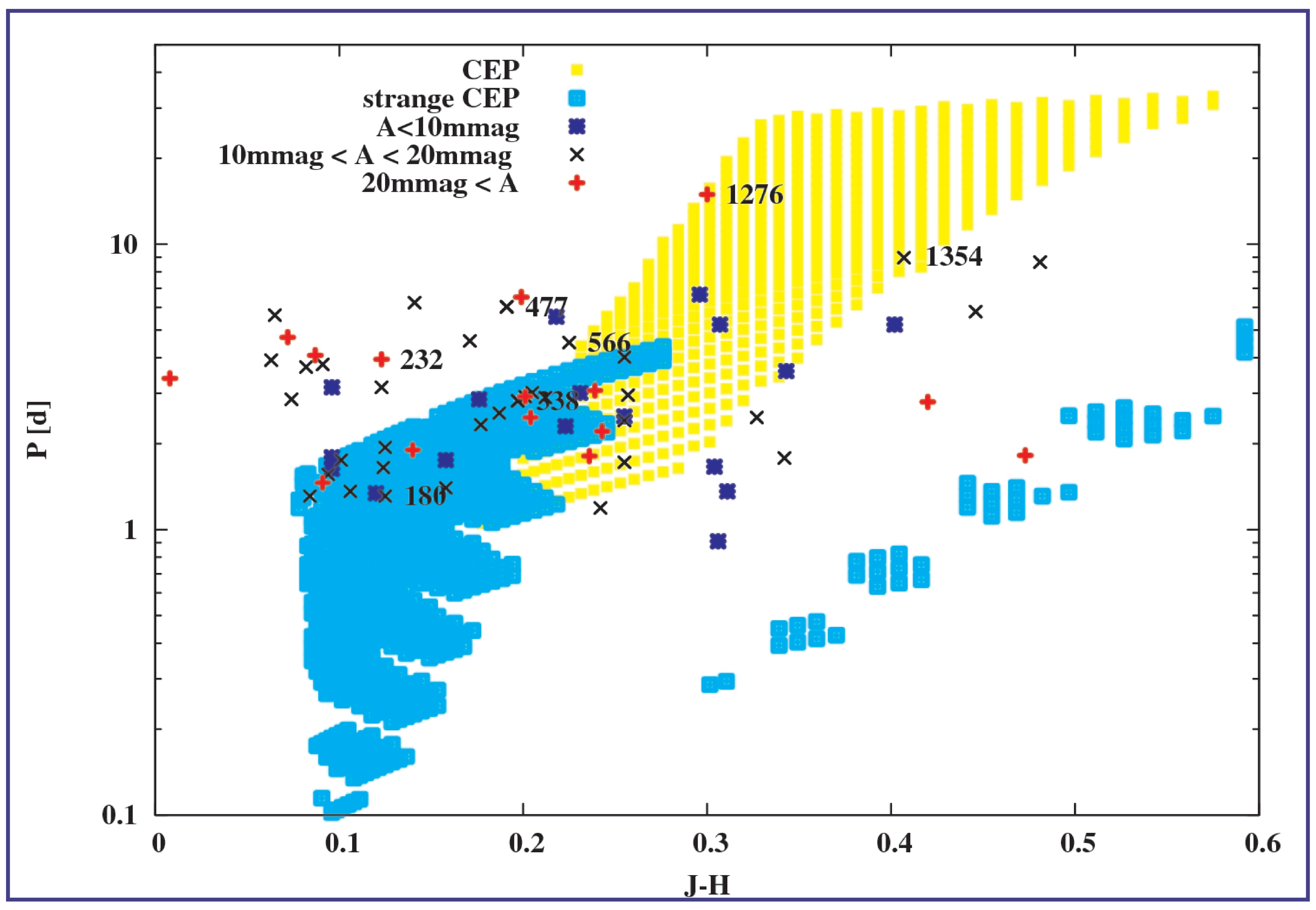

Fig. 2. Period vs. J-H 2MASS color index of the CoRoT ULA Cepheid candidates. Yellow and blue regions denote normal and strange Cepheid models, respectively. Blue, black and red symbols represent low amplitude Cepheid candidates of different amplitude range. Stars shown in Fig. 1. are labelled.

References

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