High-Amplitude γ Doradus pulsators in the *Kepler* data

Ádám SÓDOR, Emese PLACHY, Zsófia BOGNÁR

Konkoly Observatory, HUN-REN CSFK CSI, Budapest, Hungary

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1. Previous Study and Motivation

The amplitude of γ Doradus (GDOR) pulsations is not an abundantly studied subject. Not long ago, the brightness variations of GDORs were considered to be generally low-amplitude – on the mmag–0.01 mag level.

Paunzen et al. (2020) identified 15 High-Amplitude GDOR pulsators (HAGDORs) in the field*. They concluded that HAGDORs do not constitute a separate group, but they are merely the highest-ampliutde members of the GDOR pulsators.

To investigate the subject further, we started a systematic search for HAGDORs both in the *Kepler* data (this study), and in TESS (Plachy, Sódor & Bognár, in prep.)

* Paunzen et al. (2020) defined HAGDORs as GDORs with peak-to-peak (p-p) brightness-variation exceeding 0.1 mag in Johnson V band.

2. Classification

We identified **3226** GDOR stars **in the complete original *Kepler* data**, of which **1752** (54%) are hybrid GDOR-DSCT (δ Scuti) variables and **1474** (46%) are GDORs only*. And while we were at it, we also identified an additional **598** pure DSCT pulsators with no GDOR component in their light variations*.

Although the light variation amplitude of pulsators in the *Kepler* passband is somewhat lower than in Johnson V, we used a conservative limit of at least 0.1 p-p mag to consider a GDOR as high-amplitude one.

* with possible additional eclipse, rotational or other non-pulsational light variations.

3. Findings

We found **96** HAGDORs among the 3226 *Kepler* GDORs (3%).

We found that:

- All the HAGDORs belong to the **ASYM** group of Balona et al. (2011), as Fig. 3 shows, meaning that the highest-amplitude pulsations feature sudden, short, excessive brightenings (Fig. 1a.)
- About half of the HAGDORs are **frequency-group** stars, showing quasi-equidistant peak-clusters in their periodograms (Fig. 1b.; see Kurtz et al., 2015)
- Some of them are **episodic**, showing only a couple of high-amplitude episodes during the 4-year-long *Kepler* observations (Fig. 1c-d.)
- There is **no fast rotating GDOR with high amplitude** (Fig. 2.)
- **There are no HAGDOR-DSCT hybrids**, with one single exception.

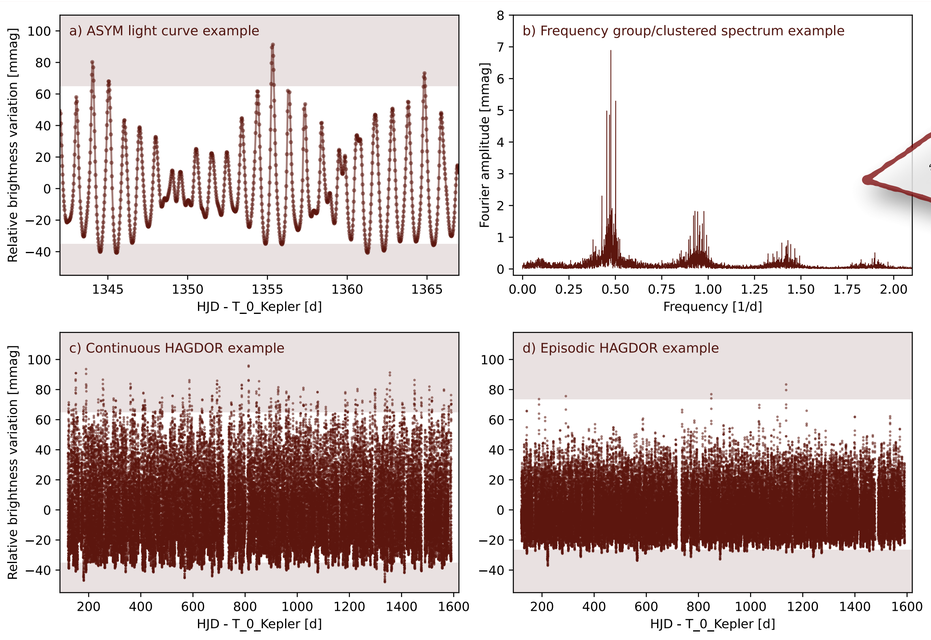

Fig. 1. **HAGDOR light curve and spectrum examples.**

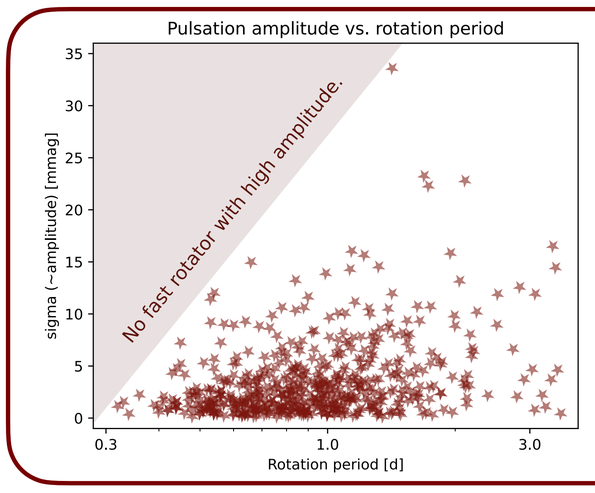

Fig. 2.

There is no fast rotating GDOR with high pulsation amplitude

Amplitude is measured as overall scatter of the brightnesses.

Rotation periods are calculated from core rotation frequencies given by Li et al. (2020). No correction to core-to-surface rotation ratio was applied, since Li et al. (2020) concluded that the two agree within a few per cent.

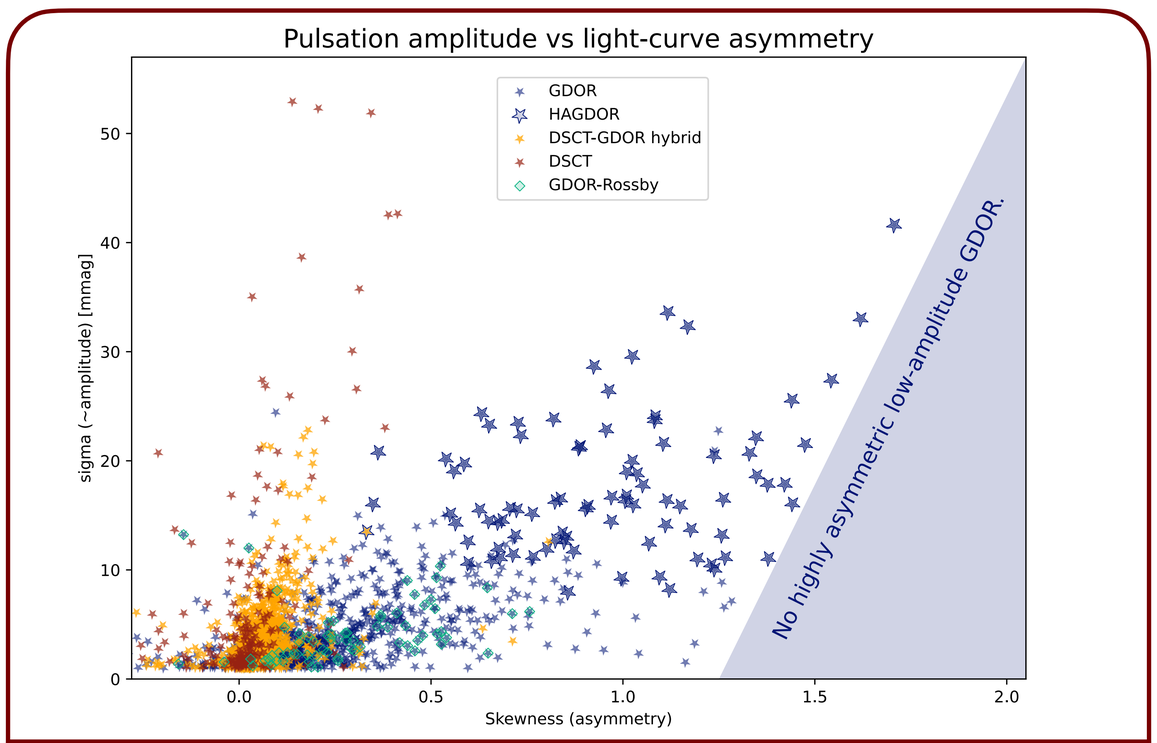

Fig. 3. ***Overall brightness scatter – a measure of pulsation amplitude – vs. skewness – a measure of asymmetry.***

Based on such a basic light-curve morphology, GDOR stars clearly constitute a distinct group, separated from DSCTs and DSCT-GDOR hybrid pulsators, while the latter two classes are quite similar by this metric.

DSCTs and DSCT-GDOR hybrids generally have more symmetric light curves.

There is no high-amplitude DSCT-GDOR hybrid pulsator.

There is no GDOR with highly asymmetric and low-amplitude light curve, which constraints geometry, that is, rotational inclination is not an important factor.

Fast rotating GDORs with Rossby modes detected by Li et al. (2019) are also indicated. These all have low pulsation amplitudes.

Note

The submitted title and abstract went like: *„Do High-Amplitude γ Doradus pulsators constitute a separate subclass?* Abstract: *Probably yes – in a sense.* Although here we argue that *most probably not – in a sense.* Such things do happen when long enough time passes between the abstract deadline and the event itself.

4. Summary

HAGDORs are regular GDORs at the high end of the pulsation-amplitude range.

HAGDORs appear to be **slow rotators**.

The HAGDOR pulsations apparently **inhibit DSCT hybrid pulsations** – or alternatively, **all hybrids are fast rotators?**

Based on light curve morphology, the GDOR pulsations in DSCT-GDOR hybrids **appear to be different** from pure GDORs.

The existence of **episodic HAGDORs** makes it more difficult to identify them by shorter observing runs.

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Ádám Sódor

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References

Balona L. A. et al. 2011, MNRAS, 415, 353
Kurtz et al., 2015, MNRAS, 450, 3015
Li G. et al. 2019, MNRAS, 487, 782
Li G. et al. 2020, MNRAS, 491, 3586
Paunzen E. et al. 2020, MNRAS, 499, 3976