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Delu

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Recenzja rozprawy doktorskiej Sachu Sanjayana
Review of the PhD dissertation presented by Sachu Sanjayan

Kepler photometry of two open clusters NGC 6791 and NGC 6819

The PhD thesis presented by Sachu Sanjayan consists of five chapters, the last four of which are four articles published in refereed journals in years 2022–2023: one article in *Monthly Notices of the Royal Astronomical Society* and three articles in *Acta Astronomica*. All four articles were prepared in collaboration. In the case of three of the four papers, Sachu Sanjayan is the first author, while in one case he is the second author after his supervisor, Prof. Andrzej Baran. The four publications have been cited ten times by the end of May 2024.

The thesis is focused on searches for variable stars, in particular for pulsating hot subdwarfs, in two Galactic open clusters intensively monitored during the original *Kepler* space mission in years 2009 – 2013. The first chapter is an introduction to the topic of hot subdwarfs, stellar pulsations, and star clusters. It also describes the spectroscopic data collected in ground-based observatories and publicly available astrometric data from *Gaia* space mission. In this chapter, we can find a summary of all obtained results. The attached bibliography consists of 111 articles.

In my opinion, among the most important results presented in the thesis are:

- the thorough analysis of the unique photometric *Kepler* data for the two Galactic open clusters, NGC 6791 and NGC 6819,
- confirmation of the presence of three hot subdwarfs in NGC 6791 and the absence of such pulsators in NGC 6819,
- the attempt to derive precise stellar parameters of four pulsating subdwarfs (two cluster members and two field stars) using state-of-the-art evolutionary models,

The author presents detailed results of the modeling and lists obtained discrepancies, which are important for future asteroseismic studies. Based on the spectroscopic observations, he provides hints on binary nature of the cluster subdwarfs.

I would like to note that the text of the thesis is written in good English.

I have several comments to Chapter I (Introduction).

In the first paragraph in Section 1.3 (page 8), the author starts the description of 'Hot subdwarfs in star clusters' with open clusters. However, in the next paragraph of this subsection, cluster NGC 6752 is mentioned without explanation that it is classified as a globular cluster. In the third paragraph, the acronym 'GCs' appears for the first time without expansion.

An incorrect plural unit is used in Subsection 1.3 on page 9: 5 Gyrs -> 5 Gyr

There is no scale shown in both images presented in Figure 1.2.

The acronym 'sdBV' in the title of Subsection 1.5 is not explained.

The following sentence in Subsection 1.5 (page 11) does not sound good:
We successfully identified ... eight unidentified pulsators in NGC 6819.

Further in the text, it would be good to provide the aperture size of the Nordic Optical Telescope for a comparison with the Apache Point Observatory 3.5-m telescope.

In Subsection 1.5, the author considers the age of the clusters NGC 6791 and NGC 6819 in terms of hot subdwarf populations. It would be worth to remind the age values at this point.

Below, I provide my remarks to the published articles.

In Paper I, there are no citations to *Gaia* and *Kepler* missions.

In none of the articles, the author mentioned on RUWE parameter, which informs about the quality of *Gaia* astrometric solution and which is critical in the determination of the membership status for individual stars in the cluster field.

Finally, I have a question regarding to Paper III and Paper IV. What was the reason to determine effective temperature (T_{eff}) and surface gravity ($\log g$) for objects recognized as binary stars? There are two stars in the systems hence the fits lead to spurious values.

To summary, the PhD candidate Sachu Sanjayan presented a dissertation in which he analyze a large set of astronomical data and conduct sophisticated modeling of the structure and evolution of still poorly understood hot subdwarfs. In concluding the above review, I declare that the dissertation meets the requirements of the Polish "Act on academic degrees and academic title". It also meets the usual requirements of the astronomical community. I propose the dissertation to be publicly defended.

Konkludując powyższą recenzję stwierdzam, że rozprawa spełnia wymagania „Ustawy o stopniach naukowych”. Spełnia także zwyczajowe wymagania środowiska astronomicznego. Wnoszę o dopuszczenie jej do publicznej obrony.

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