

Analysis Report on roAp Candidate HD 113414

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November 21, 2023

Abstract

Presenting results for the field roAp candidate HD 113414 (TIC 1727745). The data shown below was taken by the Cerro Tololo Inter-American Observatory. Being classified as an F7/F8 type star with an estimated absolute magnitude, temperature, and metallicity of $M = 7.22$, $T_{eff} = 6150K$, and $Fe/H = 0.04$, respectively [1]. From known artifacts, the star was declared not to be chemically peculiar, due to the color indexes and $H\beta$ index of the star [1]. From TESS observations [1], HD 113414 was found to have a rotational period of 3.172 ± 0.001 d. With a pulsation frequency and amplitude of 2.29116 ± 0.00004 mHz and 0.035 ± 0.006 mmag, respectively.

Keywords: *chemically peculiar – stars: oscillations – techniques: photometric – stars: variables – stars: magnetic fields*

1 Methods and Results

The data taken with the Cerro Tololo Inter-American Observatory, which is a part of the SARA national observatory, was processed via AstroImageJ. Using the CCD Data Processor tool to calibrate the images, ridding them of systematic noise. From these, differential photometry (multi-aperture photometry) was performed. Getting the counts from the images and plotting the respective light curves and relative flux curves. From the data produced, the flux error and time were exported, plotting a time series (Flux vs. Time) from that data (*referencing Fig. 1*).

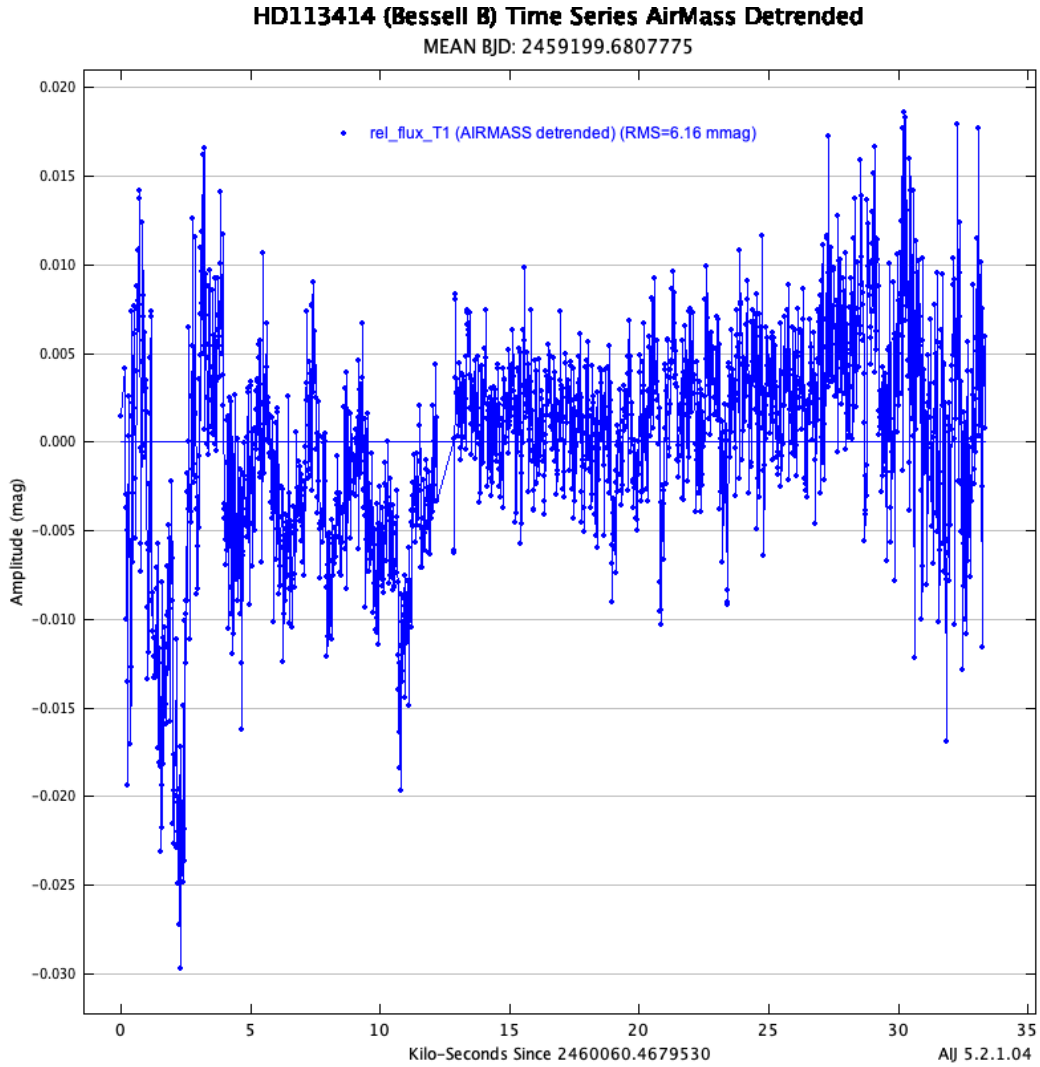


Fig. 1 Airmass-Detrended Time Series with axes Amplitude vs. Kilo-Seconds of HD 113414

Period04, which is used for analyzing variable star light curves, performed Fourier analysis to select amplified frequencies from the time series. This makes an amplitude spectrum (*which can be seen in Fig. 2*) which is plotted over the Nyquist frequency range of 2-2.5mHz. The principle pulsation frequency of HD 113414 was found to be 2.295264 ± 0.004212 mHz, which lies in the roAP frequency range. The uncertainty of the principle frequency is in the range of the pulsation frequency found in Holdsworth's paper [1]. The amplitude found from the Fourier analysis is 0.7657 ± 0.1951 mmag, which is much larger than expected. Though large, this amplitude fits in the range for a roAp, which has rather large pulsation amplitudes.

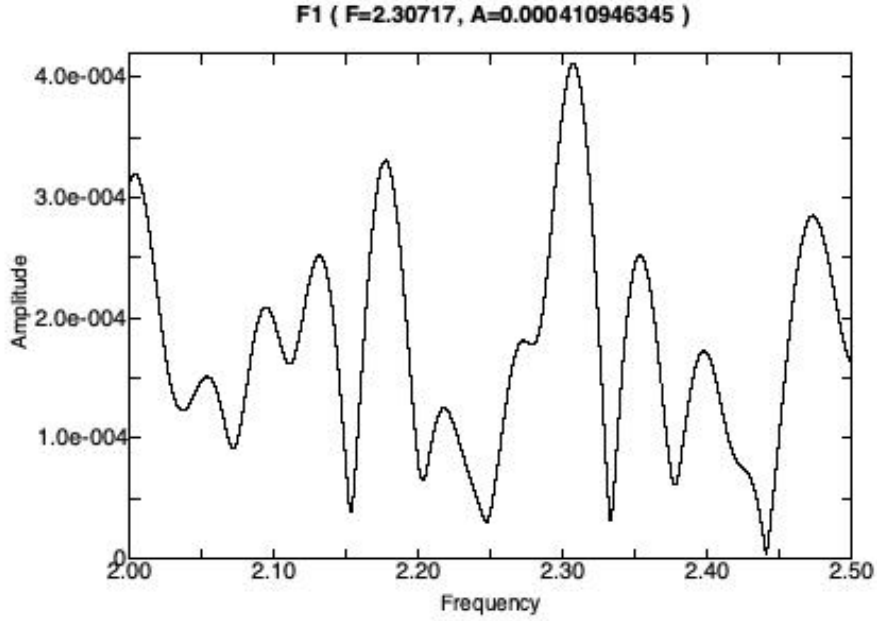


Fig. 2 Amplitude Spectrum of HD 13414 showing the Pulsation Principal Frequency

In the Nyquist frequency range from 0 mHz to 3 mHz, at 0.016205 ± 0.0006415 mHz, there is an artifact with a large amplitude of 3.9315 ± 0.15256 mmag shown in Fig. 3. This artifact is not shown in the papers being referenced, concluding that this is most likely due to aliasing or another systematic error.

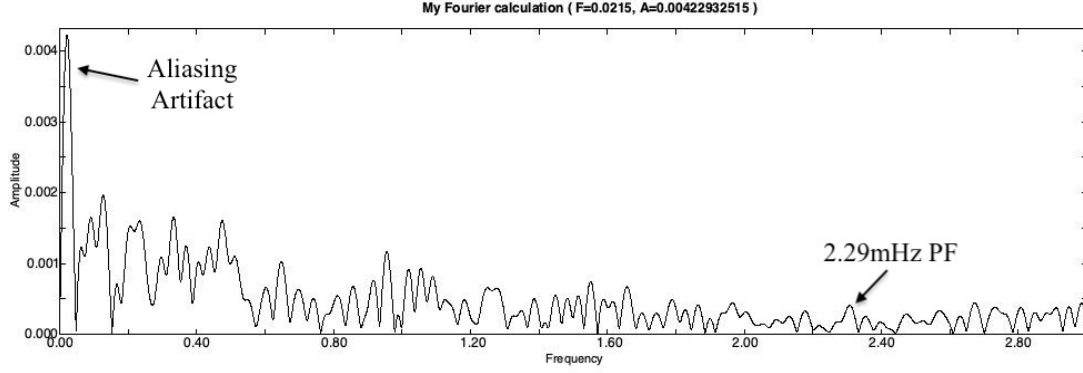


Fig. 3 Amplitude Spectrum of HD 13414 with the Principal Frequency (PF) and the artifact

2 Conclusion

The Holdsworth paper [1], states HD 113414 is not chemically peculiar, not fitting in the rapidly oscillating Ap-type star category. Due to its pulsation frequencies found from this data and prior research, we can confidently classify HD 113414 as a rapidly oscillating A-type star. This can be put in the category of roA stars, not roAp stars. Even though the Holdsworth TESS observations paper clearly states this non-peculiarity. They mark it as a roAp candidate, not roA. This is relatively confusing and should be clarified. Could HD 113414 possibly have been misclassified and is chemically peculiar, or is this just a simple syntax mistake?

References

- [1] D L Holdsworth and et al. Cunha. [TESS cycle 1 observations of roAp stars](#). *Monthly Notices of the Royal Astronomical Society*, 506(1):1073–1110, May 2021.