Photometry of $\delta$ Sct and Related Stars: the Results of AD Arietis

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Abstract This paper reports on the preliminary photometric results of $\delta$ Sct and related stars. The photometry was obtained using high-speed photometers designed for the Whole Earth Telescope campaign and the STEPHI project. The typical accuracy from magnitude differences between reference stars is about 0.005 mag. The observing log is given in detail.

Key words: techniques: photometric — stars: variables: $\delta$ Scuti — stars: individual: IP Vir, YZ Boo

1 INTRODUCTION

In 1996, we started a project to obtain Johnson $V$ and Strömgren $uvby\beta$ photometry for the poorly studied variables of “pulsational interest.” We used the three-channel high-speed photometer designed for the Whole Earth Telescope campaign and the four-channel photoelectric photometer dedicated to the STEPHI project. The typical accuracy from magnitude differences between reference stars is about 0.005 mag. The observing log is given in detail.

2 OBSERVATIONS

The photometry of three $\delta$ Sct stars AD Arietis, IP Virginis and YZ Bootis was performed from 2000 February 26 to 2001 January 31 with the three photometers mounted on the 85-cm telescope at the Xinglong Station of BAO. The typical accuracy from magnitude differences between reference stars is about 0.005 mag. The observing log is given in detail.

3 DATA REDUCTION

The time-series, i.e. pairs of Heliocentric Julian Day (HJD) versus magnitude, used for pulsation analysis can be quickly established by using an external IRAF task. The observing log is given in detail.

1 Please note the order: year, month, day
2 Now NAOC
Table 1: Please Capitalize the First Letter of Each Notional Word in Table’s Caption.

<table>
<thead>
<tr>
<th>No</th>
<th>Star</th>
<th>Photometer</th>
<th>References</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>GSC 2683-3076</td>
<td>CCD</td>
<td>Zhou et al. 2001</td>
</tr>
<tr>
<td>2</td>
<td>IP Vir</td>
<td>4-CH</td>
<td>present work</td>
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<tr>
<td>3</td>
<td>YZ Boo</td>
<td>3-CH</td>
<td>present work</td>
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3.1 Please Capitalize the First Letter of Each Notional Word in Subsection Title

3.1.1 This is a third-level section — subsection

Some applications of the routines are given in Table 1.

3.2 De-noise in the Lower Frequency Domain

To reduce the red-noise in the frequency region, we ·····

4 DATA ANALYSIS

In this part, we analyze the pulsation contents for the three stars with the period-search program PERIOD98 (Breger 1990; Sperl 1998).

4.1 AD Arietis

AD Ari (=HD 14147=SAO 92873=HIP 10701, V=7.43 mag, ΔV=0.06 mag, P₀=0.2699, F0) (Kasarovets et al. 1999; Rodríguez et al. 2000) is suspected to be a candidate of γ Doradus-type pulsating variables exhibiting both p- and g-modes in terms of its long period and late spectral type. You can cite a figure like "as shown in Figure 1" or like (Fig. 2).

4.2 IP Virginis

IP Vir (α = 14h40m08s.0, δ = 00°01′45″.0, equinox=2000.0) was reported by Landolt (1990) to be a δ Scut-type variable ·····

4.2.1 Wavelet Analysis

Universally, Lebesgue integration

\[ \int_{-\infty}^{\infty} |h(t)|^p dt < \infty, \quad 1 \leq p < \infty \] (1)

presents a measurable function of \( L^p(\mathbb{R}) \). Use Equation (1) to cite an equation, and you can also cite an equation like (Eq. 2). A function \( \psi \in L^2(\mathbb{R}) \) is called an orthogonal wavelet if

\[ \langle \psi_{j,k}, \psi_{l,m} \rangle = \delta_{j,l} \cdot \delta_{k,m}, \quad j, k, l, m \in \mathbb{Z} \] (2)

\( \delta_{j,k} \) is Kronecker sign and for any \( f(x) \in L^2(\mathbb{R}) \)

\[ f(x) = \sum_{j,k=-\infty}^{\infty} C_{j,k} \psi_{j,k}(x) \] (3)
This is wavelet series representation of $f(x)$. The most simplest example of an orthogonal wavelet is Haar function:

$$
\psi_{H}(x) \equiv \begin{cases} 
1 & 0 \leq x < 0.5 \\
-1 & 0.5 \leq x < 1 \\
0 & x < 0, \ x \geq 1.
\end{cases}
$$

Additionally, a Mexican hat is also a wavelet.

Similar to Fourier series, wavelet coefficients $C_{j,k}$ is given as

$$
C_{j,k} = \langle f, \psi_{j,k} \rangle = \int_{-\infty}^{\infty} f(x)\psi_{j,k}(x) \, dx
$$
and we have

\[(W_\psi f)(b, a) \equiv |a|^{-1/2} \int_{-\infty}^{\infty} f(t)\psi(\frac{t - b}{a}), \quad a, b, f \in L^2(\mathbb{R}), \quad a \neq 0\] (6)

If \(\psi, \hat{\psi}\) satisfy the window function condition, then \(\hat{\psi}(0) = 0\) or follows \(\int_{-\infty}^{\infty} \psi(t)dt = 0\). Mother wavelet \(\psi(x)\) oscillates and decays, preferably rapidly. The oscillation property is expressed mathematically by insisting that wavelets integrate to zero. Wavelet functions are constrained, by definition, to be zero outside of a small interval. This is what makes the WT able to operate on a finite set of data, a property which formally called “compact support”. Compact support means that a basic wavelet like Harr wavelet vanishes outside of a finite interval. If a mother wavelet is zero outside of some interval—compactly supported, then it is the “fastest” decay of all. This is the reason why we name \(\psi\) “wavelet”.

5 DISCUSSION

I would like to give my discussion on the results elsewhere.

6 CONCLUSIONS

The preliminary photometric results on the ······ are reported along with an introduction to the user-compiled IRAF task ······

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Appendix A: THIS SHOWS THE USE OF APPENDIX

A postscript file is actually an ASCII text file (you may even edit it). However, you need to transfer a PDF file or any compressed or packaged file in binary mode when using FTP.

Appendix B: WHAT IS SCI?

SCI is the abbreviation of Science Citation Index system powered by the Institute for Scientific Information (ISI). For details please visit http://apps.isiknowledge.com.

References

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Sperl M., 1998, Comm. in Asteroseismology, 111, 1 (Univ. of Vienna)