

## 1995-1998 Large-Scale Campaigns on $\lambda$ Boo Star 29 Cygni

D. E. Mkrtichian<sup>1</sup>, A. V. Kusakin<sup>2</sup>, V. A. Koval<sup>1</sup>, M. C. Akan<sup>3</sup>,  
C. Ibanoglu<sup>3</sup>, E. Paunzen<sup>4</sup>, W. W. Weiss<sup>4</sup>, P. Lopez de Coca<sup>5</sup>,  
A. Rolland<sup>5</sup>, V. Costa<sup>5</sup>, J. I. Olivares<sup>5</sup>, M. A. Hobart<sup>6</sup>, A. P. Hatzes<sup>7</sup>,  
V. P. Malanushenko<sup>8</sup>, A. Devlen<sup>3</sup>, A. Ozturk<sup>3</sup>, M. Páparó<sup>9</sup>,  
K. Krisciunas<sup>10</sup>, J. Percy<sup>11</sup>, S. Thompson<sup>11</sup>, G. Handler<sup>4,12</sup>,  
V. I. Burnashev<sup>8</sup>, A. I. Movchan<sup>1</sup>

**Abstract.** We present the main results of a photometric and spectroscopic study of the  $\lambda$  Boo star 29 Cyg carried out from 1995 – 1998.

29 Cyg was the first  $\lambda$  Boo star in which well-defined pulsations were detected (Gies & Percy 1977). It was selected by the Central Asian Network (CAN) group (Mkrtichian et al. 1998) and collaborators as a key object to investigate the pulsational characteristics of  $\lambda$  Boo stars. We intensively studied 29 Cyg during 1995 (Mkrtichian & Kusakin 1996; Paunzen & Handler 1996), 1996 (Mkrtichian et al. 1998), 1997 and 1998 multisite campaigns; the main results can be summarized as follows:

- We established a well-defined multiperiodicity in 29 Cyg and determined frequencies and amplitudes for nine low-degree  $\ell$  modes with amplitudes greater than 0.9 mmag. The stationary amplitude solution for the 1996–1997 V filter light curves obtained for these nine frequencies using the differential correction code (Andronov 1994) is given in Table 1. We found

---

<sup>1</sup>Astronomical Observatory, Odessa State University, T. G. Shevchenko Park, 65014 Odessa, Ukraine

<sup>2</sup>Sternberg State Astronomical Institute, Universitetsky prospect, 13, Moscow, 119899, Russia

<sup>3</sup>Ege University Observatory, Bornova, Izmir, Turkey

<sup>4</sup>Inst. für Astronomie der Universität Wien, Türkenschanzstrasse 17, A-1180 Wien, Austria

<sup>5</sup>Instituto de Astrofísica de Andalucía, CSIC, P.O. Box 3004, E-18080 Granada, Spain

<sup>6</sup>Facultad de Física, Universidad Veracruzana, 91000 Xalapa, Ver., Mexico

<sup>7</sup>McDonald Observatory, University of Texas at Austin, Austin, TX 78712

<sup>8</sup>Crimean Astrophysical Observatory, Nauchny, Crimea, Ukraine

<sup>9</sup>Konkoly Observatory, P.O. Box 67, H-1525, Budapest, Hungary

<sup>10</sup>Astronomy Department, University of Washington, Box 351580, Seattle, Washington 98195, USA

<sup>11</sup>Erindale College, University of Toronto, Mississauga, Ontario, Canada L5L 1C6

<sup>12</sup>South African Astronomical Observatory, P.O. Box 9, Observatory 7935, South Africa

long-term and short-term variability of amplitudes for all of these modes in 29 Cyg – the first time this has been done for a  $\lambda$  Boo star.

- For the first time for  $\lambda$  Boo stars we have detected pulsational multiperiodic radial velocity variations.
- Based on spectroscopic radial velocity and line-profile data we found that both low- and high-degree nonradial modes are excited.
- Based on multicolor  $W, B, V, R$  photometry we determined the amplitude–wavelength dependence for low-degree modes in 29 Cyg.
- The photometric behavior of 29 Cyg is similar to the pulsational characteristics of  $\delta$  Scuti stars.

Table 1. Nine-frequency solution for the 29 Cyg 1996–1997  $V$ -data.

Designation	Frequency (c/d)	$\pm\sigma_f$ (c/d)	Semi-ampl. (mmag)	$\pm\sigma_a$ (mmag)
$f_1$	37.425904	0.000005	10.72	0.06
$f_2$	34.720723	0.000012	4.80	0.06
$f_3$	29.775771	0.000020	2.82	0.06
$f_4$	25.188602	0.000024	2.41	0.06
$f_5$	27.503653	0.000035	1.63	0.06
$f_6$	28.159113	0.000050	1.14	0.06
$f_7$	25.459053	0.000056	1.04	0.06
$f_8$	34.911538	0.000058	0.95	0.06
$f_9$	32.626003	0.000059	0.93	0.06

**Acknowledgments.** This work was partially supported by CRDF grants UP2-317 and FWF S7303-AST.

## References

- Andronov, I. L. 1994, *Odessa Astronomical Publications*, 7, 1, 49
- Gies, D. R. & Percy, J. R. 1977, *AJ*, 82, 166
- Kusakin, A. V. & Mkrtichian, D. E. 1996, *IBVS*, No. 4314
- Mkrtichian, D. E., Kusakin, A. V., Janiashvili, E. B., Lominadze, J. G., Kuratov, K., Kornilov, V. G., Dorokhov, N. I., & Mukhamednazarov, S. 1998, *Contrib. Astron. Obs. Skalnaté Pleso*, 27, 238
- Mkrtichian, D. E., Kusakin, A. V., Malanushenko, V. P., Papparó, M., Akan, M. C., Percy, J. R., Thompson, S., Krisciunas, K., Burnashev, V. I., Ibanoglu, C., Pekunlu, R., Devlen, A., Ozturk, A., & Koval, V. A. 1998, *Contrib. Astron. Obs. Skalnaté Pleso*, 27, 476
- Paunzen, E. & Handler, H. 1996, *IBVS*, No. 4318