

COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS

Number 3541

Konkoly Observatory
Budapest
13 November 1990
HU ISSN 0374 - 0676

**1990 Optical Elliptical Polarimetry and Centimeter Flux
Observations of the Very Active Solar-Type Star HD 129333**

A. Elliptical Polarimetry

The infant solar-type star HD 129333 has received considerable attention recently because it exhibits the highest level of chromospheric activity known for single G-type stars. An extensive account of this star has been given by Dorren and Guinan (1990).

Because of the extreme activity of HD 129333, it was placed on the Flower and Cook Observatory (University of Pennsylvania) elliptical polarimetry observing program in 1988. A complete description of the polarimeter and observational technique is presented in Elias (1990) and Elias and Dorren (1990).

A summary of the results from the 1988 and 1989 seasons (Elias and Dorren 1990) follows. Most of the observations were performed in blue light, although a few were performed in green light. The normalized Stokes parameters q , u , and v were all variable. The average linear polarization \bar{p}_L ($p_L = \sqrt{q^2 + u^2}$) was $0.12\% \pm 0.02\%$ and did not deviate significantly from this value. Most of the circular polarization (v) measures were not statistically significant, but there were two highly significant measures close to -1% . After periodogram analysis, the linear polarization parameters q and u and the position angle $\theta = \frac{1}{2} \tan^{-1} \frac{u}{q}$ exhibited periods close to 14 days; 13.95 days was deemed to be the best value. A plot of θ versus phase is shown in Figure 1.

Elias and Dorren (1990) have concluded that this 14-day variation is intrinsic to the star and not produced by the environment or the instrument. Differential saturation due to the Zeeman effect (Leroy 1962) is not considered likely as the mechanism for this variation because 1) the rotational period of the star is about 2.7 days (Dorren and Guinan 1990) and 2) the amount of linear polarization is an order-of-magnitude larger than predicted and observed for this effect by Leroy and LeBorgne (1989). A better mechanism for the observed linear polarization is scattering (Thomson, Rayleigh, or Mie) from a circumstellar envelope, with the 14-day period possibly resulting from the orbital motion of an unseen companion.

Additional HD 129333 elliptical polarimetry was obtained during the 1990

season; the results are listed in Table 1. The blue θ measures (180 degrees have been added or subtracted when necessary) have been incorporated into the Figure 1 phase plot. Although it is not possible to confirm the existence of the 14-day period observed during the 1989 season, the data from the 1990 season are not inconsistent with the ephemeris $HJD\ 2447628.802 + 13.95E$ from Elias and Dorren (1990). Further observations are necessary in order to investigate the possible binary nature of this star.

Linear polarization spectra were obtained on HJD 2447930, 2448043, and 2448105 (see Table 1). Within errors, it appears that the spectra are flat, implying Thomson scattering, although Rayleigh and Mie scattering cannot be ruled out. It is possible, however, to rule out magnetic effects because the ultraviolet linear polarization is not significantly larger than the blue linear polarization.

B. Centimeter Flux Observations

The cm observations of HD 129333 were performed using the NRAO* Very Large Array (VLA) in the A/B hybrid configuration on 1990 June 27. The observations were performed at 20, 6, 3.6 and 2 cm, each with two pairs of intermediate frequency stages (IFs; these included both right- and left-handed circular polarization). The IF bandwidths were 50 MHz except for the 20 cm IFs which had a bandwidth of 25 MHz. The primary calibrator was 3C286, and the secondary calibrators (B1950.0) were 1437+624 (20 cm) and 1435+638 (6, 3.6, and 2 cm). The visibilities were edited and calibrated at the VLA Array Operations Center (AOC) using natural weighting to maximize signal-to-noise.

HD 129333 was not detected at any wavelength. The 3σ upper limits to the specific flux are as follows ($1\ Jy = 10^{-26}\ W\ m^{-2}\ Hz^{-1}$): 20 cm, 183 μJy ; 6 cm, 81 μJy ; 3.6 cm, 57 μJy ; and 2 cm, 243 μJy . These values correspond to a specific luminosity of order $10^{14}\ erg\ s^{-1}\ Hz^{-1}$ at a distance of 30 pc. These results are surprising because comparison with other chromospherically-active stars suggested estimates of the specific fluxes between 0.1 and 1.0 mJy.

* The National Astronomy Observatory is operated by Associated Universities, Inc., under cooperative agreement with the National Science Foundation.

Table 1

HD 129333 Elliptical Polarimetry - 1990

Filter	HJD	p_L (%)	θ ($^\circ$)	v (%)
<i>Red</i>				
	2447930.907	0.05(0.03)	155(14)	-0.01(0.06)
	2448043.674	0.05(0.05)	4(24)	-0.01(0.06)
	2448105.679	0.01(0.06)	21(90)	+0.03(0.08)
<i>Green</i>				
	2447930.884	0.10(0.04)	22(12)	+0.10(0.09)
	2448043.651	0.05(0.09)	119(49)	-0.01(0.02)
	2448105.657	0.09(0.03)	79(11)	-0.12(0.08)
<i>Blue</i>				
	2447930.862	0.08(0.08)	155(28)	-0.09(0.11)
	2447940.760	0.10(0.06)	76(17)	+0.14(0.09)
	2447948.707	0.09(0.05)	8(14)	-0.14(0.09)
	2447949.763	0.16(0.08)	19(14)	+0.15(0.09)
	2448043.593	0.11(0.06)	179(15)	+0.19(0.13)
	2448105.634	0.06(0.06)	36(31)	+0.03(0.10)
<i>Ultraviolet</i>				
	2447930.840	0.13(0.15)	49(31)	+0.15(0.18)
	2447949.794	0.24(0.15)	174(19)	+0.02(0.29)
	2448043.627	0.06(0.16)	94(82)	-0.14(0.32)
	2448105.611	0.13(0.14)	153(32)	+0.03(0.17)

Note: Parenthesized quantities are 1σ errors.

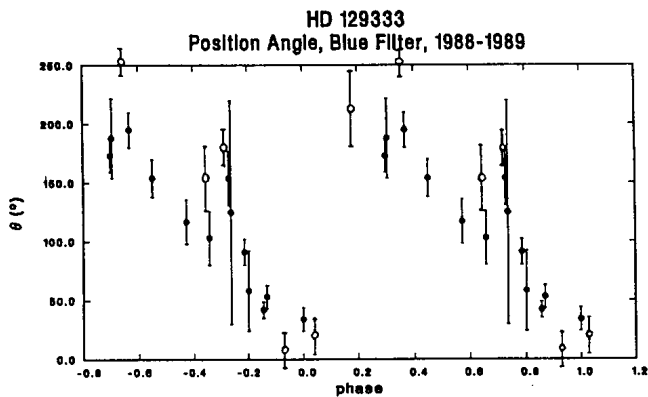


Figure 1 The filled-in circles are from the 1988 to 1989 season and the open circles are from the 1990 season. The values from the 1990 season may differ by $\pm 180^\circ$ from Table 1.

Dr. Nicholas M. Elias II
United States Naval Observatory
34th St. and Massachusetts Ave., NW
Code AD5, Building 52
Washington, DC 20392-5100

Dr. J. David Dorren
Department of Astronomy and Astrophysics
David Rittenhouse Laboratory, E1
University of Pennsylvania
Philadelphia, PA 19104-6394

References:

- Dorren, J. D. and Guinan, E. F. 1990, to be published in *Ap. J.*
Elias, N. M. 1990, *Ph.D. thesis, University of Pennsylvania.*
Elias, N. M. and Dorren, J. D., 1990, *A. J.*, 100, 818.
Leroy, J-L. 1962, *Annales d'Astrophys.*, 25, 127.
Leroy, J-L. and LeBorgne, J. F. 1989, *Astron. Astrophys.*, 223, 336.