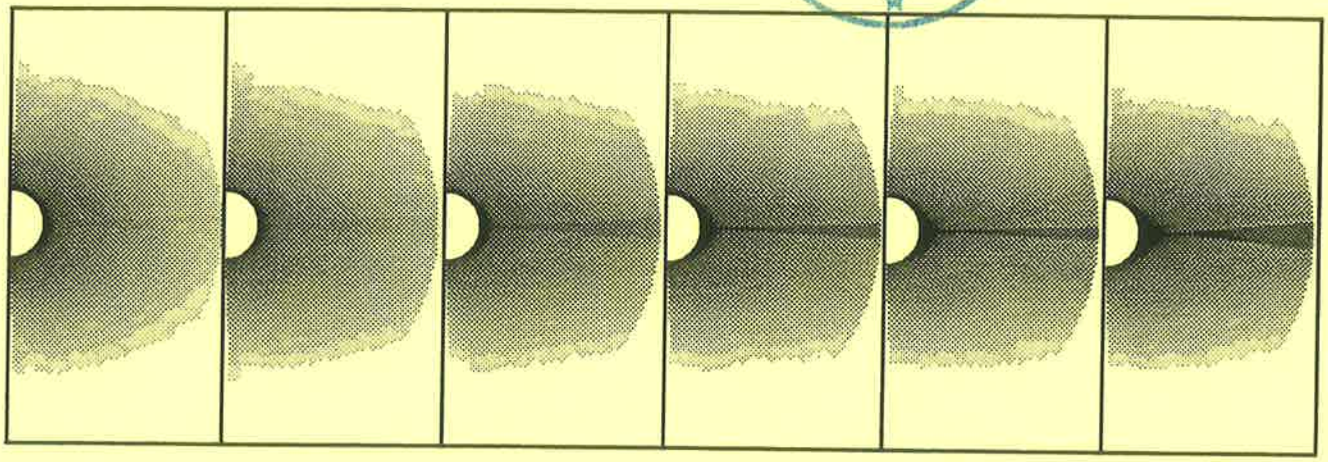
ISSN 0296-3140



Be STAR NEWSLETTER

NUMBER 30
September 1995

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Contents

The Be Star Newsletter is produced at and financially supported by
the Georgia State University Department of Physics and Astronomy.
The electronic version is available on
the World Wide Web (`http://chara.gsu.edu/BeNews/intro.html`)
or by anonymous ftp (`ftp chara.gsu.edu, cd BeNews`).

1. EDITORIAL

We are happy to send you the 30th issue of the *Be Star Newsletter.* We continue to make the *Newsletter* available in three forms: paper, plain ASCII text that is sent to e-mail subscribers and also available via anonymous ftp, and our version on the World Wide Web (WWW). We continue to receive positive feedback on our electronic *Newsletter* on the WWW and expect that it will continue evolve. We are of course eager to hear your suggestions for improvement and are especially interested in your opinions on whether we should continue to offer the e-mail version in plain ASCII text or perhaps switch to a pure LaTeX format.

In Issue No. 30 we are pleased to publish the first summary of the UV polarimetric observations on hot stars that were obtained with the Wisconsin Ultraviolet Photo-Polarimeter Experiment (WUPPE) on board the *Astro* Observatory payload flown on the space shuttle *Columbia* in 1995 March. Also included in this large issue are reports on recent activity in μ Cen, 66 Oph, and HD 161711. Contributions discussing the geometry of shell phases, pulsation modes in the "λ Eri" stars, and further discussion on the radial velocity variations in λ Eri itself are also a part of Issue No. 30. In our section "What's Happening?" we include announcements of several campaigns on Be stars and other newsworthy information of interest to the B star community. The usual"Preprints Received", "Bibliography" (note the new style), and information on forthcoming "Meetings" are also a part of Issue No. 30. As usual we would like to thank those who sent contributions and helped compile the bibliography.

We anticipate that Issue No. 31 will go to press around the first of February 1996. In order to insure that your contribution will appear, please send copies to the editor-in-chief and technical editor by:

January 15, 1996.

We recommend that communications be sent by electronic mail (HYADES::PETERS, gjpeters@mucen.usc.edu, gies@chara.gsu.edu) and prefer that contributions and abstracts of submitted papers be sent as LaTeX files. Beginning with Issue No. 32, we will require that abstracts be submitted as LaTeX files and we will supply a template for their preparation. If it is not possible to transmit your contribution electronically, we request that it be submitted in a camera-ready condition (see papers in the current issue for style). Contributions may also be sent by FAX (telephone number: 213-740-6342), but this is not recommended for papers that are longer than a half page or those that contain figures due to the degradation of the resolution. We prefer that illustrations be sent by E-mail as a PostScript or encapsulated PostScript file. If this is not possible, please send dark, clear copies of the figures by regular mail. References should by typed in the newer, simpler style recently adopted by the *Astrophysical Journal* and other major astronomical publications.

I would like to wish you, in advance, a productive fall and happy holiday season and New Year. I am looking forward to receiving your contributions in the months to come.

Gerrie Peters, Editor-in-Chief

2. WORKING GROUP MATTERS

2.1. Working Group News

Myron A. Smith
Working Group Chairman
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First, Joe Cassinelli and I would like to arrange a regional meeting of members of the classical Be and Be-X-ray communities next year for one day. This would be a very informal gathering that would coincide with the American Astronomical Society meeting at the same time and place in Madison, Wisconsin. Joe will set aside appropriate space for a meeting, but it will not be a part of the AAS meeting per se. (We would be delighted to welcome non-North American astronomers, but they should be aware that they would have to register for attendance of the AAS meeting separately.) The Wisconsin AAS meeting will take place between Sunday, June 9 and Thursday, June 13, 1996. Our meeting would be held on either Friday, June 14, or Saturday, June 15, 1996. Should you be interested, please contact me (Myron Smith) at `beiau@iuegtc.gsfc.nasa.gov`.

Second, I want to remind you that the post of Scientific Editor of the Be Star Newsletter will be open at the end of the year as the current term expires. The current editor is of course Dr. Gerrie Peters. Gerrie has indicated that she would like to serve for a new term, and we should be thankful that there will indeed be an outstanding candidate for the new term of 1996-1998. At this time I would like to start to invite other willing candidates as well. Should anyone be interested, please contact me, or any of the other B Star Organizing Committee members.

Third, as you may be aware, at the last IAU General Assembly in August, 1994, the IAU approved a plan whereby the old Commissions would be phased out in favor of a new structure in which a web of working groups would grow and interconnect within IAU Divisions. This past winter the Division of Variable Stars and Close Binary Stars, to which we will want to belong, elected its Division chairman, Dr. Yoji Kondo of the USA (`kondo@stars.gsfc.nasa.gov`). Because this process has just started, I have continued with my plan. which will fit in well with the new IAU structure, to request that our Working Group be affiliated with more than the original parent Commissions on Stellar Spectra and Variable Stars. Therefore, I have requested an affiliation with the commissions on Theory of Stellar Atmospheres (C36) and Close Binary Stars (C42). I am now awaiting a replies from Lawrence Cram and Marcello Rodono on this petition.

Proceeding to topical liaisons, I have circulated an invitation for several X-ray astronomers who study X-ray Be binaries and High Mass X-ray Binaries to join our Working Group, and several have asked to be put on the distribution list of the Chair and Newsletter Editors. With the advent of ISO, I am inviting interested members of the OC and others to solicit interested researchers in the study of high mass IR- (and radio-) emitting B stars too.

In early February several of us in the WG were fortunate enough to attend the pulsation conference at Cape Town, South Africa. As Mike Jerzykiewicz recently put it, the conference organizers in Cape Town set new standards for hosting a conference that will be difficult for the rest of us to emulate – but we should try. In any case, the conference, which concerned pulsators across the HRD, was enjoyed by all participants. It seemed to me that the conference gave a little more emphasis (and certainly more results) on RP/NRP in B stars than other pulsation meetings over the last 10-15 years. For me one of the highlights was the talk by Pawel Moskalik on the theory of pulsations in B stars, based on the demonstration that the new OPAL/OP opacities are sufficient to drive radial and nonradial pulsations in B stars. The new results leave many questions unanswered, but certainly are a breath of fresh air to the observers who have had been courageous enough in the past to interpret their results. There were several interesting poster papers on B stars as well. Everyone has a favorite, and mine was one by Telting et al. on β Cephei. This paper gives evidence for rotational splitting of NRP modes consistent with a rotational period of several days. The evidence is apparently getting stronger for a magnetic dipole as well as secondary NRP modes in this star.

2.2. Jiří Horn and Karel Juza: Two Czech stellar astronomers and rare men

Within less than a year, the Stellar Department of the Astronomical Institute in Ondřejov, Czech Republic (whose astronomers traditionally study hot stars, and Be stars in particular) lost two of its most remarkable personalities: Drs. Jiří Horn and Karel Juza. Karel died on March 13, 1994, just before he could defend his Ph.D. thesis devoted to a complex study of κ Dra. Jiří passed away on December 13, 1994, at age 53. Though very different in character, they were both brilliant scientists, yet very modest, perhaps too modest men. For both of them, their way to the profession of astronomy was full of obstacles, and both of them built homes for their families with their own hands.

Jiří Horn was not allowed to study at the Charles University of Prague since his parents were considered "political suspects" by the communists ruling the country. Fortunately enough, Mirek Plavec, now a professor at UCLA and at that time a leader of the Ondřejov group of the Stellar Department, accepted Jiří as his research assistant and later recommended him for the study at the University.

Jiří Horn had always been full of energy and a source of ever pertinent humour, sometimes tough but never injuring. He was probably the cleverest of all of us but he had no ambition to demonstrate his knowledge publicly. He was very efficient in work, remarkably productive, but with little interest in publishing. Actually, I am only aware of one single paper which he himself published alone. He was an excellent team worker, however, and a notably skillful programmer as well. Most of us still use his fine, user-friendly programs, day and night, since he had also developed the control program for spectral observations with the coudé spectrograph of the 2-m telescope. His energy was simply unbelievable. He was helping his wife with their three children to the extent that he seldom slept even after his duties at the telescope, and his feeling of responsibility for all family members was extraordinary.

He became a Deputy of the Head of the Department and participated very actively in the development of spectral observations with electronic detectors.

Karel Juza, born 1951, graduated from the Faculty of Mathematics and Physics after defending a M.Sc. thesis in astronomy. However, there were no professional positions available for astronomers in Czechoslovakia at that time. He therefore accepted a position as night assistant at the Skalnaté Pleso Observatory, and for many years he travelled frequently between Prague (where he himself built an apartment as a member of a building cooperative) and High Tatras in Slovakia, a magnificent mountain setting in which the Skalnaté Pleso Observatory is located. He was also there at the time of the Tschernobyl disaster when a spring rain splashed this area with radioactive debris.

Still at Skalnaté Pleso, he started his postgraduate study which he continued later in Ondřejov. When he eventually joined the Ondřejov Stellar Department, it was again as a night assistant. Soon afterwards, however, he finally obtained a research position there.

Besides the preparation of his Ph.D. thesis, he did an enormous job of transferring a huge archive of many thousands of UBV observations of Be stars secured at Hvar from punched paper cards into magnetic media, and he participated in a new, improved reduction of these data on personal computers.

Very attentive, always willing to help, a man with a remarkable sense of dry humour, loving husband and father of two daughters, he watched with a growing uneasiness the coming split of Czechoslovakia. His wife was born in Eastern Slovakia, and the time indeed came when they had to use an international train to visit her parents.

Karel rushed to meet the deadline for finishing his thesis. The promise of a more quiet time in his life was so close when the insidious disease struck. He fought for two long months ...

Both Jiří and Karel had acted as unifying elements for the whole department, and all of us shall miss them both for the rest of our lives.

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3. CONTRIBUTIONS

3.1. New WUPPE/Astro-2 Observations of Hot Stars

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Abstract

During the 16 day Astro-2 mission aboard the space shuttle Endeavour (STS-67) in March 1995, new ultraviolet spectro-polarimetric observations of a number of hot stars were obtained by the Wisconsin Ultraviolet Photo-Polarimeter Experiment (WUPPE). Contemporaneous optical spectropolarimetry was also obtained for many of these objects from the Pine Bluff Observatory (PBO) providing complete spectropolarimetric coverage from 1450Å to 1.05 μm. Objects observed included Oe/Be stars, OB supergiants, massive pre-main-sequence stars, luminous blue variables, and Wolf-Rayet stars. The new WUPPE observations have more than tripled the available ultraviolet spectropolarimetric data on these stars. Combined with a large database of prior optical observations from PBO and with the WUPPE data from the Astro-1 mission, we now have an excellent sample of data with which to begin detailed modeling of the circumstellar environments of hot stars. Since the new WUPPE data are so recent, they are still being carefully calibrated and reduced, and so we cannot yet draw firm conclusions from the data; however, we can present a summary of the observations that were obtained.

1. Instrumentation

1.1 WUPPE

The Wisconsin Ultraviolet Photo-Polarimeter Experiment (WUPPE) is a 0.5-m telescope and spectropolarimeter. It obtains simultaneous spectra and polarization measurements from 1450 to 3400Å, with a resolution of about 8Å. WUPPE is part of the Astro Observatory space shuttle payload, which consists of three ultraviolet telescopes (WUPPE; the Hopkins Ultraviolet Telescope, or HUT; and the Ultraviolet Imaging Telescope, or UIT). Observations with WUPPE were made during the 16 day Astro-2 mission on the space shuttle Endeavour (STS-67) in March 1995. Previous observations were made during the 8 day Astro-1 mission aboard the space shuttle Columbia (STS-35) in December 1990. In a number of cases, the hot stars were also co-observed with the IUE satellite to provide higher spectral resolution information.

1.2 PBO

The University of Wisconsin's Pine Bluff Observatory (PBO) is a 0.9-m telescope with a dedicated optical spectropolarimeter attached. It has been in continuous operation for 6 years, obtaining optical support observations for WUPPE and conducting optical polarization survey programs. Observing is carried out by a team of undergraduate students along with UW faculty and staff. Recent upgrades to the PBO equipment include a CCD detector, which has greatly improved the efficiency of the instrument and has extended the wavelength range from 3400Å out to 1.05μm, allowing spectropolarimetric observations to be obtained across the Paschen jump.

2. Observations

2.1 Oe/Be Stars

Our intent was to expand the sample obtained on Astro-1 to include a range of spectral types, inclination angles, and rotation velocities, in order to have adequate data for physical modeling of the circumstellar disks (see Figure 1 for a graphical representation of the coverage we actually obtained). Data were obtained for 14 stars, covering spectral types from O7 to B9.5, and $v \sin i$ values from 25 to 400 km/s. Data are still in the process of being calibrated, so only a summary of the observations can be presented here.

The Oe/Be stars observed with WUPPE/Astro-2 were the following (spectral types and $v \sin i$ values were taken from Slettebak 1982):

- ζ Tau - reobservation of Astro-1 object; B1 IV e-sh, $v \sin i = 220$
- ϕ Per - B1.5 V e-sh, $v \sin i = 400$, binary
- ψ Per - B5 III e-sh, $v \sin i = 280$, binary
- 48 Lib - B3 IV e-sh, $v \sin i = 400$
- χ Oph - B1.5 V e, $v \sin i = 140$
- 59 Cyg - B1 V e, $v \sin i = 260$
- EW Lac - B3 IV: e-sh, $v \sin i = 300$
- 28 Tau (Pleione) - B8 V e-sh, $v \sin i = 320$
- FR CMa - B1.5 V e, $v \sin i = 200$
- 48 Per - B4 V e, $v \sin i = 200$
- ξ Per - O7 e, $v \sin i = 216$
- HD 93521 - O9 V p, $v \sin i = 400$
- 51 Oph - possible HAeBe star; B 9.5 IV e, $v \sin i = 220$
- AE Aur (HUT target) - O9.5 V e, $v \sin i = 25$

2.2 OB Supergiants & Luminous Blue Variables

The primary object selected for observation in this class was the luminous blue variable (LBV) P Cygni. The observations were designed to search for UV and optical polarimetric variability on several timescales as a follow-up to results found from Astro-1 and from monitoring programs at PBO. WUPPE obtained 3 UV observations of P Cyg during the Astro-2 mission, on 1995 March 3, 8, and 12. In support,

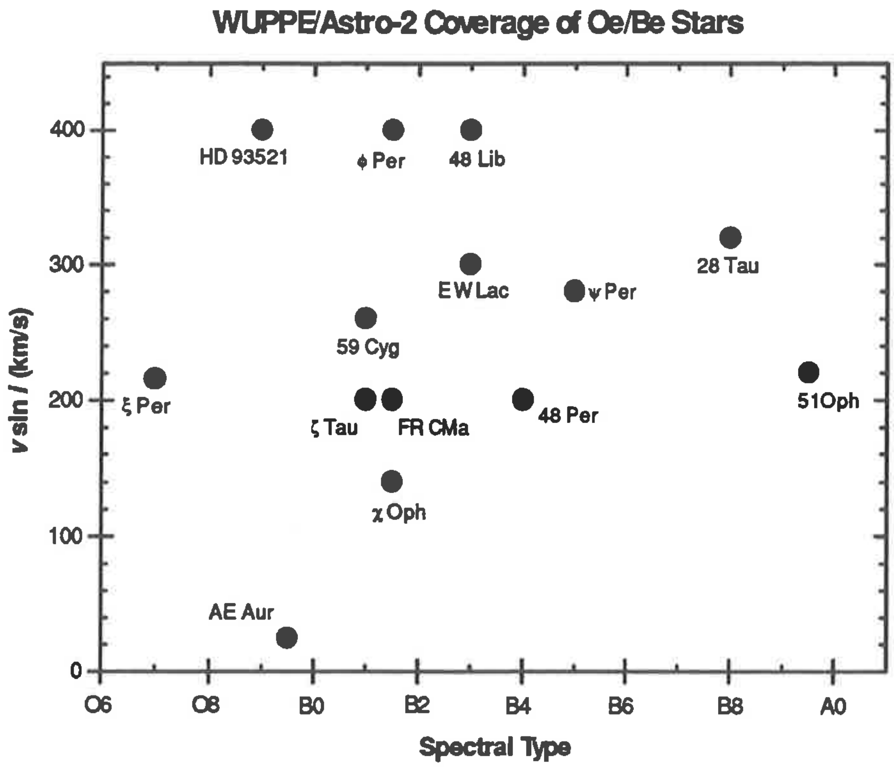

Figure 1. The range of spectral types and v sin i values for Oe/Be stars observed with WUPPE on Astro-2.

PBO also obtained 3 optical observations, all within 24 hours of the WUPPE observations. Quick look data reduction shows that variability was detected in both the optical and UV.

Other objects in this class included AG Carinae, which was observed as a follow-up to HST spectropolarimetry (these data will require more careful calibration before results can be discussed) and κ Cas and α Cam, which were observed as follow-ups to Astro-1 results (these stars are also used as interstellar probes; they are dominated by interstellar polarization, but some intrinsic polarization is present).

2.3 Herbig Ae/Be (HAeBe)

In this class, many objects were too faint for WUPPE to observe. However, the following four brighter stars were observed:

- HD50138 - This star is believed to be similar to HD45677, which was observed on Astro-1 and showed evidence for bipolar flows. It is thought to be nearly edge-on. Quick look data reduction does not show evidence for the polarimetric position angle flip that would be the signature of bipolar geometry; however, further analysis is required. Excellent supporting data were also obtained with IUE, PBO, and the University of Toledo's Ritter Observatory.

- AB Aur - This star was observed as the test case for the near pole-on HAeBe stars.

- HD163296 - This star is thought to be seen at mid-latitudes. Quick look reduction shows evidence for a possible polarimetric position angle flip between optical and UV, which may indicate a bipolar geometry. Accreting gas was detected in the contemporaneous IUE observations (Grady 1995).
- HD200775 - This is the central star of the reflection nebula NGC7023. The WUPPE observation consists of a spectrum only, as the observation was too short to complete all the polarimetric filter pairs.

2.4 Wolf-Rayet Stars

Observations of four WR stars, 3 of which had 4 observations each, were obtained as part of a Guest Investigator (GI) program (PI: R. Schulte-Ladbeck). For details about the observations, see Schulte-Ladbeck (1995). The stars observed for this program included:

- HD50896 (EZ CMa, or WR6; observed at 4 different phases)
- HD191765 (WR134; 4 observations)
- HD96548 (WR40; 4 observations)
- HD93131 (WR24; 1 observation)

In addition to the GI program, several observations were made of HD5980, a WR star undergoing an apparent LBV outburst, and some serendipitous observations were made by offsetting from HUT cluster targets. Near the end of the mission, WUPPE was defocused in order to observe γ^2 Velorum, a WR binary system which would normally be too bright for WUPPE to observe; because of the unusual nature of the observation, the data will require careful calibration before results can be interpreted.

2.5 Serendipitous Observations

Adding to the planned WUPPE science programs for hot stars, we also obtained data on some early OB supergiants in clusters as serendipitous co-pointed observations from a HUT GI program (PI: N. Walborn). WUPPE data on these HUT targets will be used as part of the WUPPE polarization program on OB supergiants. Also, numerous OB supergiants and OB main sequence stars observed as part of interstellar medium program (Anderson et al. 1995) can be used as comparisons for Oe/Be stars.

3. The Oe/Be Stars: Plans for Analysis

3.1 What the WUPPE & PBO data can tell us about Oe/Be stars

With the new data obtained on Astro-2, we now have an excellent cross section of observations of Oe/Be stars across spectral types and $v \sin i$ values. This will allow us to test specific models, such as the wind-compressed disk (WCD) model (Bjorkman & Cassinelli 1993), with a range of parameters. We can compare model effects on continuum polarization with known effects of spectral line blanketing to investigate the properties of the disk material. We have already begun to develop models using Monte Carlo methods to include multiple scattering effects (Wood & Bjorkman 1995b), which show that thin disk models can reproduce the observed levels of continuum polarization. For example, fits to the PBO data on ζ Tau show that a disk with a 3° half- opening angle is consistent with both the polarization wavelength dependence and the 12μm IR excess (Wood & Bjorkman 1995b). In addition, the combination of WUPPE and PBO data provides good constraints on model parameters across the entire UV and optical wavelength range. For example, we can use Balmer & Paschen continuum polarization plus Balmer & Paschen jumps in polarization to determine disk density and geometrical thickness, and modeling of the Fe line blanketing of the UV polarization will provide an estimate of the disk temperature.

Quick look reduction of the WUPPE data already shows that in cases of extreme shell stars, where spectral line blanketing due to the shell material is strong, the entire Balmer continuum polarization is depressed, strengthening the case for post-scattering attenuation due to the disk (Wood & Bjorkman 1995a). This has implications for what modelling geometries can be assumed for the disk material (thickness and extent of the disk). These results confirm and expand the results from Astro-1 (Bjorkman et al. 1991; 1993). The new WUPPE data will also allow us to investigate whether gravity darkening effects can be seen in the continuum polarization (Bjorkman & Bjorkman 1994).

The WUPPE and PBO data have been obtained, calibrated, and reduced through the efforts of many people. We wish to thank all the members of the WUPPE and PBO science teams. We also thank the crew of STS-67 and the NASA support team for a very successful and productive Astro-2 mission. We thank Carol Grady for obtaining the contemporaneous IUE data. WUPPE has been supported through NASA contract NAS5-26777 with the University of Wisconsin.

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3.2. Rapid Changes in the Spectrum of HD 161711

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The moderately-high latitude star HD 161711 (V=8.28, b=+31°) is classified as a type A in the Henry Draper Catalogue but as B8 by Balz (1956). Its spectrum appears in common with all other northern HD and somewhat fainter stars, on 10° objective prism plates taken with CWRU's Burrell Schmidt now located on Kitt Peak; in fact, the object is on two plates taken almost exactly four days apart, on July 22 and 26, 1992. Inspection of these has revealed a very substantial change in the blue-violet spectrum of the star.

On the first plate, which is rather light, the spectrum is that of a star of about type B8: the $H\beta$, $H\gamma$, and $H\delta$ lines are quite strong and moderately sharp, with $H\beta$ being perhaps somewhat weaker than normal. But on the second plate there is clear evidence of sharp emission in $H\beta$, shifted a bit longward of the line center, and in $H\gamma$ and probably also in $H\delta$. This plate shows the higher members of the Balmer series as very broad and shallow.

This speedy transformation from a non-Be to an emission object is seldom seen. Reference to the Simbad database, however, indicates that HD 161711 has already been suspected of having emission: Abt (1984) has classified it as B9Vne? No further details are given, and I know of no other spectroscopic observations. Strömgren photometry has been discussed and published by Olsen (1980, 1983).

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3.3. Recent Activity in μ Cen

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The well-known Be star μ Cen, which had a strong $H\alpha$ emission in the early 70's (Peters 1979), lost most of this emission in the 70's and showed only in occasional outbursts weak $H\alpha$ emission with pronounced V/R-variations since then. The spectroscopic history of μ Cen until 1991 has been summarized by Hanuschik et al. (1993).

We have monitored μ Cen with HEROS, a fiber-linked echelle spectrograph attached to the ESO 50-cm telescope from Feb. 5 to Jun. 3, 1995 with a gap of two weeks in April. The spectrograph has two channels which are fed by a beam-splitter. With this

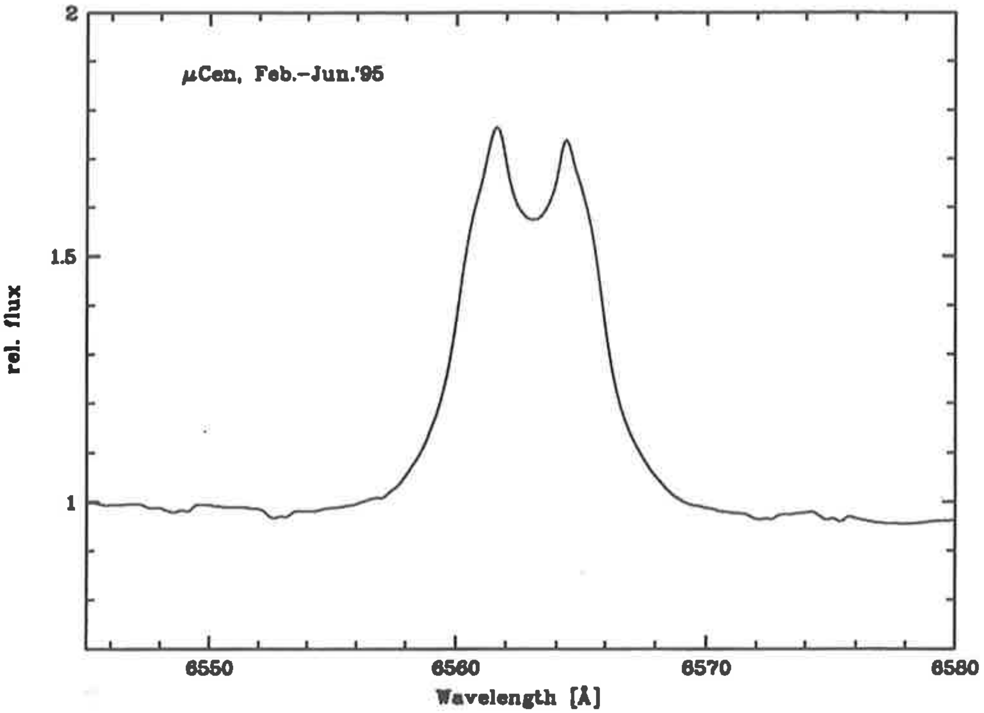

FIGURE 1. Mean Hα profile obtained in Feb.-Jun.'95

set-up, the wavelength ranges from 3500 – 5500 Å and 5700 – 9000 Å are covered in one exposure with a resolution of about 20 000. One spectrum per night was obtained and only a few nights were lost due to bad weather. In this short note we report the first results about the Hα line of this monitoring.

We found rather strong and symmetric double-peak emission in Hα, about as strong as in the 1984 outburst reported by Peters (1986), with a maximum intensity of 2.0 × continuum level. The emission profile shows clear night-to-night variations with a timescale of about 10 days but no qualitative variations in profile. The mean profile of the 96 spectra is shown in Fig. 1. A time series of the individual spectra, divided by this mean spectrum, is shown in Fig. 2. In Fig. 3 the equivalent width of Hα as function of time (integrated from 6545 to 6580 Å) is shown. The variations in equivalent width are more pronounced than in peak intensity due to variable broad wings of Hα. These wings reach about ±400 km sec^{-1}.

Since the emission had a similar strength already in Mar. 1993 (private communication from Geraldine Peters), it appears that μ Cen is building up again its strong envelope from the 70's. Further observations of these "secular" changes could add to our understanding of long-term changes in Be stars.

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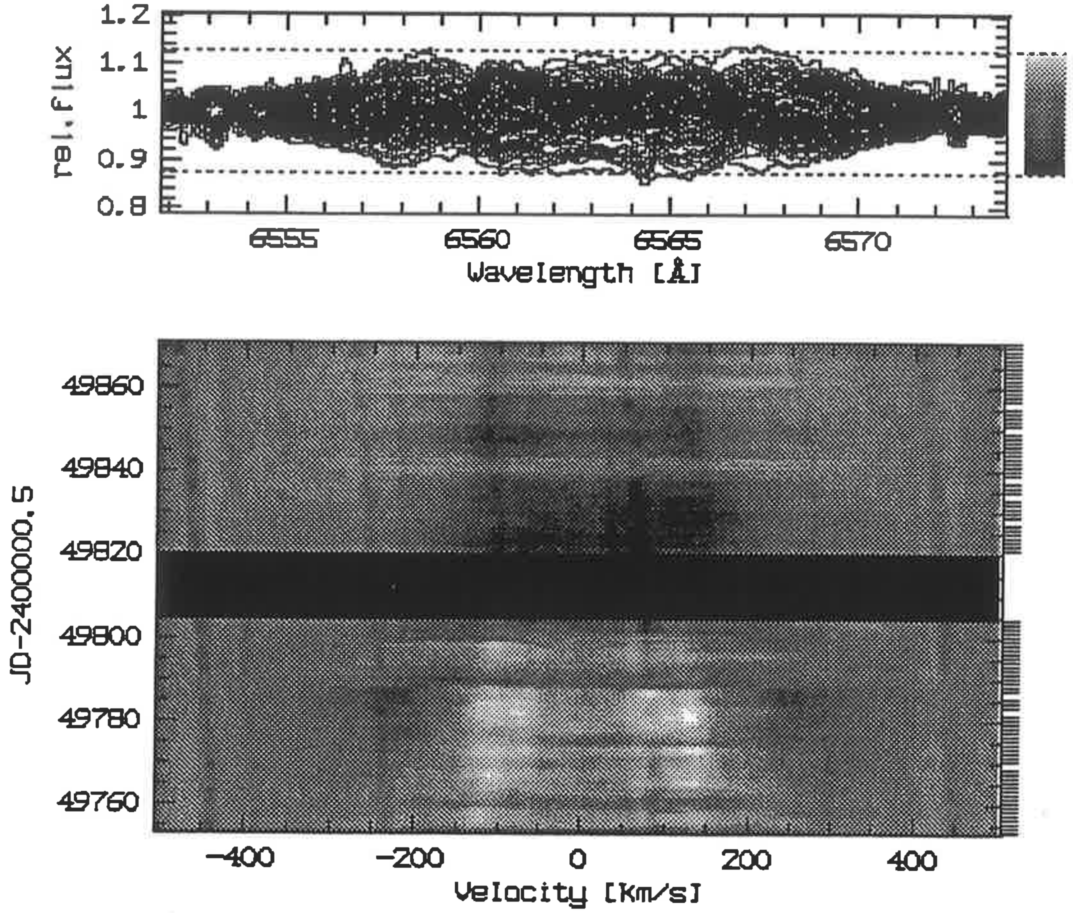

FIGURE 2. Time-series spectrum of μ Cen around the Hα line. The spectra have been divided by the mean spectrum shown in Fig. 1. In the box above all quotient spectra are plotted. On the right-hand side of this box, the look-up table is given. Note the narrowing of the broad emission wings during the first half of the observing run.

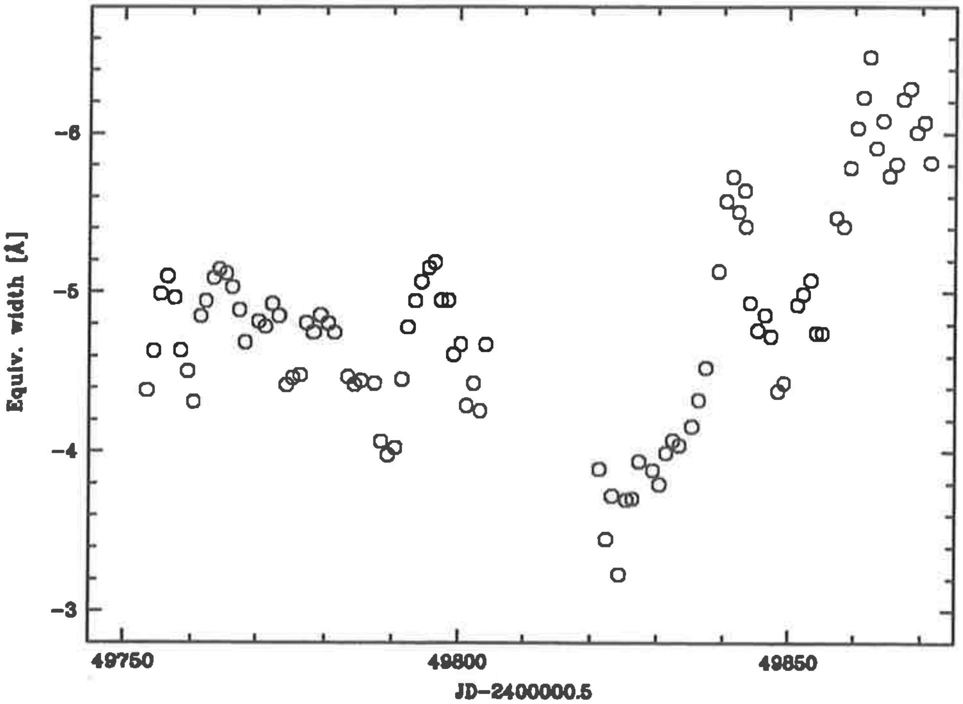

FIGURE 3. Variations of the equivalent width of Hα from Feb. to Jun.'95. Note that the larger equivalent width at the end of the run compared to the beginning is due to the broad emission wings while the peak intensity was similar.

3.4. Observation of a $V = R$ transition in 66 Oph

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As part of our long-term spectroscopic monitoring programme of Be stars at high resolution[1], we have repeatedly observed the interesting equatorial Be star 66 Oph = HR 6712 (B2 IV-Ve, $v \sin i = 240$ km s^{-1}). We have mainly investigated the Hα and the Fe II λ5317 emission line. Our data shown here cover the epoch 1993–1994 and have been measured at ESO's 1.4m Coudé Auxiliary Telescope (observers: Hanuschik, Hummel), at the 2.2m telescope at the German-Spanish Observatory DSAZ on Calar Alto/Spain (observers: Hummel, Vrancken), and at the 2.0m Ondřejov telescope (observer: Štefl). Resolution $R = \lambda/\Delta\lambda$ has been around 50000 except for the Ondřejov data (15000).

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[1] Based on observations obtained at the European Southern Observatory, La Silla, Chile; at the German-Spanish Observatory DSAZ, Calar Alto, Spain; and at the Ondřejov Observatory, Czech Rep.

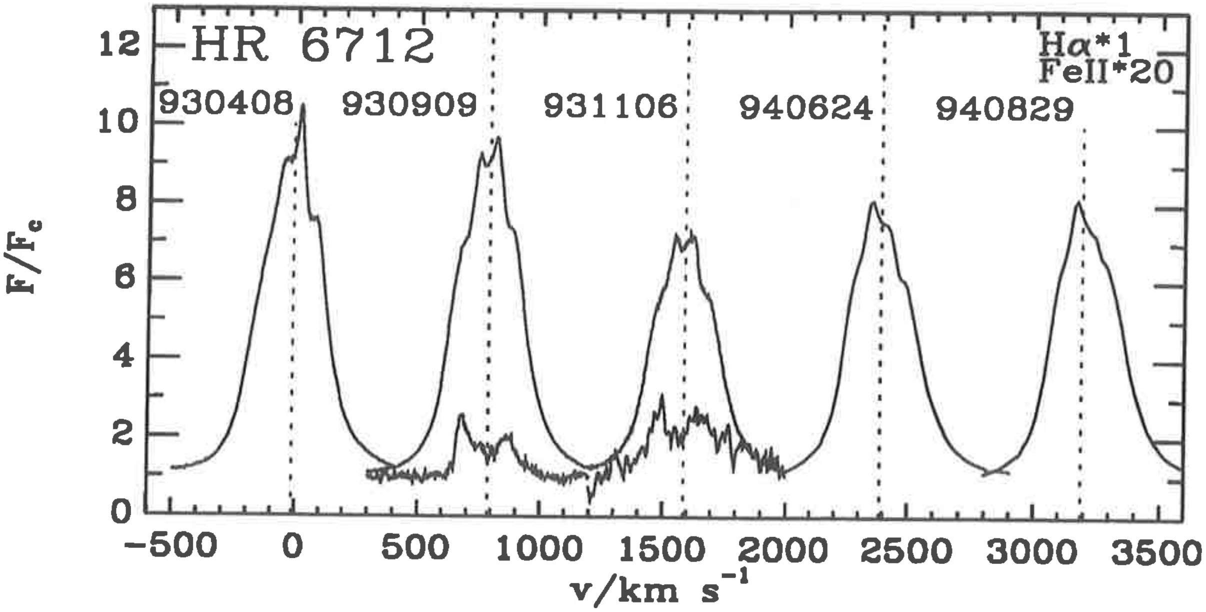

FIGURE 1. Comparison of the 1993 and 1994 Hα and Fe II emission line profiles of 66 Oph, demonstrating the $V < R \rightarrow V > R$ transition in November 1993. Fe II lines are shown on a flux scale expanded by a factor of 20. Radial velocity scale is heliocentric

In 1988, 66 Oph showed a sudden onset of cyclic V/R variability, after at least 15 years of symmetric double-peak structure ($V \approx R$) (see Hanuschik et al. 1995, A&A, in press). Its present full V/R cycle time is only 5 years, rather short if compared to other such Be stars which have typical cycle duration of about 10 years. With this cycle time, the first $V = R$ transition must have occurred in early-1991, but escaped detection. In 1993, we have been fortunate enough to observe the second $V = R$ transition (see Fig. 1).

This transition occurred in November 1993 and appears to have lasted only a few months, as a comparison of our data from September 1993 (Hα: $R > V$), November 1993 ($R = V$), and June 1994 ($V > R$) clearly shows. This duration is only a small fraction of the full cycle time. Such time behaviour agrees well with the expectation that the slope of the V/R evolution is sinusoidal, with much longer periods of V/R asymmetry than with $V = R$.

An interesting observation is that shortly before the $V = R$ transition, Hα and Fe II profiles showed slightly opposite V/R behaviour: in September 1993, $R > V$ in Hα, and $V > R$ in Fe II. This may be partly due to the fact that in a certain critical parameter range, the V/R ratios in the Hα and the Fe II line may show opposite sign, due to the superposition of different line broadening mechanisms (causing the winebottle-type inflections and the profile peaks). Alternatively, this may be indicative of a certain time lag between the $V = R$ transition in both lines due to very different optical depth and therefore different contributing disk regions.

A very pronounced decrease in equivalent width occurred in November 1993 (from 59Å to 45Å in two months), after the star had shown a stable value of 59 Å for almost half a year before. Almost 8 months later, W_α was again observed at higher values (50Å), remaining constant thereafter for at least two months. Such rather strong disk variability seems to be uncommon in this star. If it is physically related to the $V = R$ transition, then this observation may be interpreted as result of the relatively small velocity gradient (averaged across the whole emitting disk) at the moment of symmetry ($V = R$), as compared to the situation shortly before and after the transition when the velocity gradient becomes larger again.

New, not yet reduced spectra from Oct. 29, 1994, and March 8, 1995, show a continuation of the trend of increasing V/R ratio.

We strongly encourage observers to continue to monitor this interesting Be star at high spectral resolution, in order to follow up its V/R behaviour and to furthermore document its emission strength variability pattern.

3.5. A simple and natural explanation for shell events

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Circumstellar Be envelopes are cylindrical, thin, rotating structures, i.e., disks. For Keplerian disks in fully-developed hydrostatic equilibrium, the density law has the well-known form

$$N(r,z) = N(r) \cdot \exp\left\{-\frac{z^2}{2h^2(r)}\right\} \tag{1}$$

(e.g., Pringle 1981, ARA&A 19,137). The scale height $h(r)$ is given by $h(r)/r = c_s/v_K(r_*) \cdot r^{1/2}$, with the isothermal sound speed c_s and the Keplerian velocity at $r = r_*$, $v_K(r_*)$. For values typical of Be stars, $M_\star = 10M_\odot$, $R_\star = 7R_\odot$, and $c_s = 12.7$ km s^{-1}, we obtain $h(r) = 2.44 \cdot 10^{-2} r^{3/2}$.

Such hydrostatic disks are concave in shape: for a power law dependence of density in the equatorial plane, $N(r, z = 0) = N_0(r/r_*)^{-n}$, the exponential slope in vertical direction produces density contours which have concave shape for a certain range in radius (i.e. $\mathrm{d}Z/\mathrm{d}R \propto R^{1/2}$, see Fig. 1). There is a small *critical* inclination range in which a chance exists that with increasing disk radius, column depth in the disk suddenly becomes large enough to produce a shell line.

This occurs because lines of sight then may intersect the disk twice: the first time very close to the star, the second time far away from the star. In cases when the column depth collected within the first intersection is too low to cause shell absorption (= *Be phase*), an increase of disk radius towards the second intersection area may produce a *shell phase*.

Numerical calculations for shell line absorption in such disks (Hanuschik, in preparation) show that this specific effect is to be expected only around a certain critical value of inclination angle, $i_1 \approx 70° \pm 5°$. If the actual value of i is smaller, an enlargement of r_d even by large factors is not capable to bring any appreciable amount of absorbing material into the lines of sight. At larger i, shell absorption may occur already in the region close to the star. In Fig. 2, an example illustrates the shell effect at $i = 70°$.

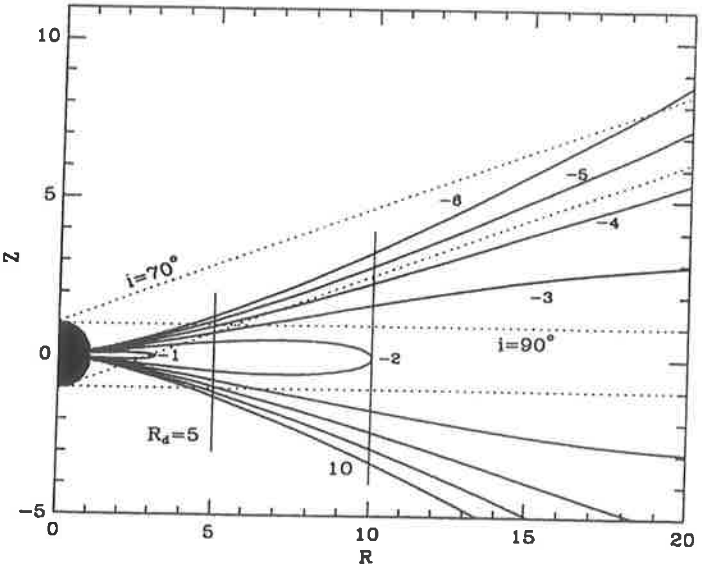

FIGURE 1. Sketch of the shell effect in a concave ($h \propto r^{3/2}$) disk. Density contours for the density law in Eq. (1) (with $n = 2$) are shown for the cases $N/N_0 = 10^{-1...-6}$. Dotted lines indicate the range of shell absorption for $i = 90°$ and $i = 70°$, resp. For the latter case, shell absorption becomes a sensitive function of outer disk radius R_d.

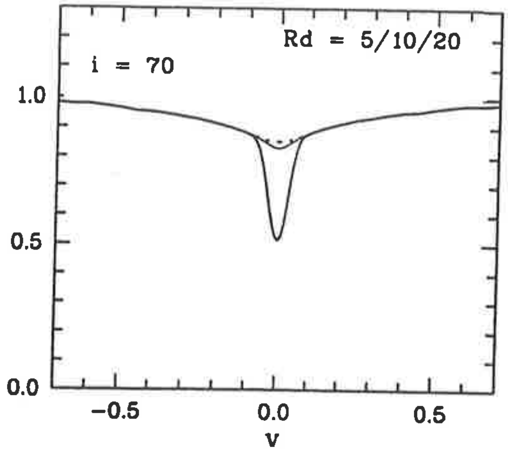

FIGURE 2. Calculated hydrogen shell line profiles for a Keplerian velocity field, the density law of Eq. (1), inclination angle 70° and outer disk radii $r_\mathrm{d} = 5$ (broken line), 10 (thin solid line), $20r_*$ (thick solid line).

This rather small inclination range satisfyingly explains why the shell transitions are quite rare phenomena. At larger inclination, permanent shell absorption is to be expected (provided a circumstellar disk exists at all), and for $i \leq i_1$, no absorption phenomenon will occur.

Though more refined mechanisms for shell events cannot be excluded (e.g. variable scale height, temperature variation etc.), one should stress that this simple geometrical explanation works for isothermal disks with only one parameter allowed to vary, $r_{\rm d}$.

3.6. The double-wave λ Eri stars: A problem with mode identification

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One of the puzzling characteristics of λ Eri stars is their ability to change from a single-wave to a double-wave light curve (and vice-versa) while the period remains unchanged. The best examples of this behaviour can be found in Balona, Sterken & Manfroid (1991, MNRAS 252, 93) for stars Ahmed-1 and Ahmed-15 in NGC 3766. According to the NRP interpretation, a changeover from single-wave to double-wave implies a change of mode in which the observed frequency is exactly doubled.

If f is the observed frequency, the frequency in a frame rotating with the star, f_0, is given by:

$$f = f_0 - m\Omega,$$

where m is the azimuthal wave number, and Ω is the frequency of rotation of the star. This means that if f is doubled, so is f_0 and m. Alternatively, one may satisfy the frequency-doubling criterion yet maintain the same m value if the frequency in the co-rotating frame is not doubled but instead takes on the value:

$$f_0' = 2f_0 - m\Omega.$$

This is no longer a straightforward 2:1 resonance and there seems to be no obvious reason why this is to be preferred.

Gies (1994, IAU Symposium 165: Pulsation, Rotation and Mass Loss in Early-type stars, p.89) finds that the NRP model gives $m = -2$ for nearly every star (all those in his Table I are single-wave as far as I can tell). That means that when the changeover to double-wave occurs, the mode changes to $m = -4$. If this mode identification pertains to the majority of λ Eri stars, it also pertains to the two stars in NGC 3766 mentioned above. But a basic calculation (e.g. Dziembowski 1977, Acta Astr. 27, 203) shows that the light amplitude for a $m = -4$ mode should only be about 7 percent of the amplitude for a $m = -2$ mode. This is in conflict with observations: double-wave light curves would have such a low amplitude as to be scarcely observable. Yet it is estimated that about 50 percent of λ Eri stars exhibit double waves (Balona 1990, MNRAS 245, 92). The double waves in the two stars in NGC 3766 mentioned above are certainly visible and have amplitudes which are within a factor of two of the single wave. This agrees more with the idea that in most single-wave λ Eri stars the azimuthal spherical harmonic number is $m = -1$ and not $m = -2$.

I conclude that there is a problem in the mode identification given by Gies. Alternatively, the mode identification is correct, in which case the straightforward 2:1 resonance no longer applies.

3.7. The Radial Velocity Variation of λ Eri

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In a previous newsletter, Gies & Hahula (Be Star Newsletter **28**, 7) discuss a simulation of NRP and line profile-variability to model the Be star λ Eri. They adopt the following parameters: $R_e = 7R_\odot$, $i = 90^o$, and $v \sin i = 310$ km s^{-1}, which lead to a rotation period of 1.149 d or $\Omega = 0.870$ d^{-1}. Of course, the actual values are highly uncertain because it is very difficult to estimate the radius and angle of inclination for any particular star. The photometric and line profile variations give a period of 16.84 hrs, a frequency $f = 1.425$ d^{-1}. The frequency in the co-rotating frame is $f = -0.315$ d^{-1} for the specified mode $m = -2$. In other words, this model gives a prograde wave with a period of $P_0 = 3.175$ d for an observer rotating with the star.

It is easy to show that the velocity perturbation, $\vec{v}$, is related to the eigenfunction, $\vec{\xi}$, by:

$$\vec{v} = i(\omega + m\Omega)\vec{\xi},$$

where ω is the observed angular frequency and Ω is the angular frequency of rotation. Gies & Hahula make the mistake of putting $\Omega = 0$ in the above formula. This leads to a severe underestimate of the relative radius variation. For the mode $m = -2$, the semi-amplitude of the vertical velocity component is given by

$$A_r = (\omega + m\Omega)a_0 N_{\ell m} \sin^2\theta.$$

According to Gies & Hahula, the observed vertical velocity semi-amplitude is 0.65 km s^{-1}, for which we obtain

$$a_0 N_{\ell m} \sin^2\theta = 2.834 \times 10^4 \text{ km}.$$

It follows that the fractional radial variation at the equator is 0.58%. Gies & Hahula obtain 0.13%, the difference being due to the much smaller frequency of pulsation in the co-rotating frame. If we are to believe the ratio $dT/T = 58dR/R$, this leads to a fractional temperature variation $dT/T = 33.6\%$. Not only is such a large temperature variation unacceptable (it would lead to a light variation of several tenths of a magnitude and noticeable spectral changes during the pulsation), it predicts a "radial velocity" amplitude more than four times larger than predicted by Gies & Hahula.

All this is, of course, a purely academic exercise because the real physical parameters of λ Eri are unknown. The values given above derive from Smith, Peters & Grady (1991, ApJ 367, 302) who estimate the error in the ratio stellar mass to radius-squared of about 20%. The rotation period has a large error which propagates to a large error in the derived pulsation and temperature amplitudes. The only way of tackling this problem is to use large numbers of stars. Although the estimated radii and projected rotational velocities for each star is poorly determined, their mean properties become quite well known, subject of course to possible systematic errors. This is precisely what Balona (1990, MNRAS 245, 92) has done. I show that the ratio of the "pulsation" to rotational periods is unity with a standard error of 7%. In the example discussed above this ratio is 0.61, a difference of 9 standard deviations. The reason why Gies & Hahula ignore this fact is not stated, but it implies that the actual relative temperature amplitude is even larger than the already excessively high value above, making nonsense of the NRP model.

4. WHAT'S HAPPENING?

4.1. Forthcoming Multiwavelength Campaign on α Eridani

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The multiwavelength campaign on the bright Be star α Eri (Achernar) announced in the last issue of the *Be Star Newsletter* will be carried through during the first two weeks of September. *IUE* coverage will begin with US2 on September 7 at 07:00 UT and continue for eight contiguous shifts ending at 23:00 UT on September 9. These observations will be supported by high-resolution optical spectroscopy at Mt. Stromlo Observatory from September 6–18 and ground-based polarimetry at CTIO from September 1–15. We anticipate observing λ Eri and DU Eri as secondary targets. We encourage other observers to join our efforts, and are especially in need of optical photometry. In addition to simultaneous observations, we are also interested in the pre- and post-campaign behavior of the star.

4.2. Intensive Campaign on γ Cas

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I can't resist sharing with you the news of an award of 14 orbits of Hubble Space Telescope/GHRS time on γ Cas to Richard Robinson and myself. We have requested the observations to fall in this satellite's Continuous Viewing Zone, meaning that we hope to get nearly 24 hours of continuous integration at a cadence of about 1 second! Recently, I learned that my XTE proposal was accepted as well so we will be getting simultaneous X-ray observations along with new IUE spectra and some optical observations as well. What else we could use at this point would be rapid (serial) optical photometry. Those dates are probably (UT) 11/23-24/95, give or take a day. This will be a once in a lifetime shot to look into the connection between this star's X-ray and UV/optical activities.

4.3. Announcement of an *IUE* Campaign on ω Orionis

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To investigate the origin of the Discrete Absorption Components (DACs) in the wind of the B2 IIIe star ω Ori, we have been granted 144 hours of *IUE* time during the 19th (and last) episode of the *IUE* Guest Observer program. The plan is to observe the star continuously for three days (~two rotation periods) at epochs of maximum and minimum mass loss. Optical photometry from Villanova University since 1982 has revealed that ω Ori undergoes outbursts quasi-periodically every 8-10 months. The *IUE* observations have not yet been officially scheduled, but the first campaign will probably occur in late December 1995 or early January 1996. Participants in this project include H. F. Henrichs, D. R. Gies, E. F. Guinan, D. McDavid, and G. J. Peters. We invite members of the community to join our campaign. We are especially in need of ground-based spectroscopic, photometric, and polarimetric observations from observing sites that have a good distribution in longitude. Since the outbursts in ω Ori are not strictly periodic, we welcome frequent updates on its emission state. We urge researchers who are involved in long-term monitoring programs of Be stars to add this object to their observing lists. In addition to simultaneous observations, we are also interested in the pre- and post-campaign behavior of the star. If you are interested in joining our efforts, please contact any of the individuals mentioned above.

4.4. More on Be Star h Persei 717

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Valencia, Spain

Shortly after the publication of the Newsletter # 29 I received a communication from Dr. Andreas Kaufer commenting on a high-resolution Hα spectrum of star 717 in h Persei taken by him in September 1990. In this spectrum the Hα line is in almost pure absorption. A slight filling in is discernible when the observed profile is compared with a modeled one.

The comparison of this spectrum with my Figure 1 (Be NL, 29, 9) clearly shows that star 717 presents highly variable Hα emission characteristics. The dates of the two observations set an upper limit of 26 months to the development of the strong emission line shown in Figure 1.

Dr. Kaufer's work including the Hα profile has been published in Astronomy and Astrophysics (1994, *A&A*, 289, 740).

4.5. Polarization Activity in Omicron And

David McDavid
Limber Observatory, Pipe Creek, Texas

I have been following the current emission episode of o And with a new Glan-prism photopolarimeter on the 0.4-m telescope at Limber Observatory. During the interval in which the Hα emission began (Aug.-Sept. 1994 according to Petr Harmanec in IAU Circular No. 6082), there was no accompanying increase in polarization. The polarization remained low (0.30+/-0.10% in V) at least until early Jan. 1995, which was the last time I observed it. This is confirmed by Ryuko Hirata's polarimetry from Dodaira.

When I resumed observing o And this year (Jun. 23), the polarization was unmistakably higher (0.53+/-0.07% in V). This is by far the highest polarization I have ever measured for o And (going back to 1986 at McDonald Observatory), and it has remained constant at this level through Jul. 29. Even without removing the interstellar component (which is not well known, but probably small), the UBVRI data now show the typical wavelength dependence of the intrinsic polarization of a Be star: a peak in B, a substantial drop in U, and a steady decline through V, R, and I. The earlier wavelength dependence was almost flat. It is hard to tell if there is any significant change in the position angle because the earlier polarization was so small that the position angle was very uncertain.

Petr Harmanec has compared Ondrejov Hα spectra from Nov. 5, 1994 and Jul. 16, 1995, and comments: "The emission and shell is weaker now than in November but, in principle, the spectrum shows little change between the two dates and remains basically the same as we saw it during the whole October 1994." Thus it seems that the polarization increase lagged the onset of Hα emission by several months, although both phenomena can be considered to be part of the same ongoing active phase. A possible interpretation is that if the emission and shell features are produced in the outer region of the circumstellar envelope, while the polarization comes from the inner region, the delayed polarization increase might indicate a gradual "filling in" of the envelope. More observations, hopefully including spectropolarimetry, would certainly help to clarify the picture.

4.6. A Fortran 77 Package for Reduction, Transformation to Standard Systems, Archiving and Retrieval of Photoelectric Observations

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FAX and telephone: (42)-2-881611, Telex: 121579 astro c
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The authors make this package available to all interested colleagues upon the condition that its usage will be acknowledged in any publication based on data reduced with it, for instance, by a reference to the paper by Harmanec, Horn and Juza (1994, *A&AS*, 104, 121).

Here is how you can obtain the package:

```
ftp sunstel.asu.cas.cz (or 147.231.24.100)
login:  anonymous
password:  your e-mail address
cd pub/phot
get ...
```

A detailed instructions how to use the package can be found in file MANUAL. The whole package is also available in compressed forms created by standard programs LHA and PKZIP. In that case, you can only copy one file (PHOT.LZH or PHOT.ZIP) using the BINARY mode of ftp.

We strongly recommend you to notify us via e-mail about your becoming a user of this software. Your e-mail address will be registered and you will be notified about any future improvement or extension of the software package.

Information about upgrades for those who do not want to copy anew the whole package:

HEC22 Release 12 March 27, 1995:

1. Colour transformation coefficients H can all be set zero if desired on input and the program will calculate properly. (It was necessary to specify small non-zero values with the earlier version for numerical reasons.)
2. The built-in parameter PAS for the La Silla Observatory was set equal to 4 and the conversion program SILLA22.FOR was modified properly to give correct local time on the output of HEC22. (Everything was reduced correctly with the earlier version, only local time printed was incorrect.)

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[1] Dr. Jiri Horn died on December 13, 1994

Copy anew: HEC22.FOR, SILLA22.FOR, MANUAL

Manual release 4 May 3, 1995:

Dr. S. Stefl developed conversion program ESO5022.FOR which permits conversion of output data from the ESO 0.5-m telescope at La Silla into input data of HEC22. Copy anew: MANUAL, ESO22.FOR

4.7. Newsletters on the WWW

Steve Cranmer
Bartol Research Institute, University of Delaware, Newark, DE 19716 e-mail: cranmer@brivs2.bartol.udel.edu

Below is a listing of online newsletters from different fields of stellar astronomy.

Be stars:	`http://chara.gsu.edu/BeNews/intro.html`
Hot stars:	`http://www.inaoep.mx/~eenens/hot.html`
AGB stars:	`http://gag.observ-gr.fr/liens/agbnews.html`
del Scu stars:	`http://venus.ast.univie.ac.at/sperl_link/DSSN/DSSNHomepage.html`

The Be Star Newsletter certainly stands up in comparison, although I'm partial to the header graphics, myself ... (ed. note: produced for us by Steve and colleagues!).

Also, we at Bartol (Stan Owocki, Ken Gayley, and myself) are setting up a WWW page on our own research: "Hot Star Astrophysics at Bartol," which can be accessed at:
`http://www.bartol.udel.edu/ cranmer/hotstar_home.html`
This page is currently under construction, and really isn't "ready for prime time" yet, but I invite you to take a look. I also have some other astrophysics-related links and details of my own work in my own home page:
`http://www.bartol.udel.edu/ cranmer/cranmer_home.html`

4.8. NRP Movie on the WWW

John Telting
Astronimcal Institute, University of Amsterdam
e-mail: john@astro.uva.nl

I have produced an MPEG movie version of NRP and line profile variability for our annual science exibition here in Amsterdam. You can find them on the World Wide Web as `http://www.astro.uva.nl/anim/joop.mpg`
and
`http://www.astro.uva.nl/anim/joep.mpg` .

5. PREPRINTS RECEIVED

B[e] phenomenon extending to lower luminosities in the Magellanic Clouds

C.A. Gummersbach, F.-J. Zickgraf, and B. Wolf
A&A (in press)
e-mail: cgummers@hp2.lsw.uni-heidelberg.de
URL: http://www.lsw.uni-heidelberg.de/~cgummers/

An analysis of the four recently discovered B[e] stars Hen S 35, S 59, S 93, and S 137 in the Large Magellanic Cloud has been carried out using low-resolution IUE spectra, ESO 3.6-m CASPEC spectra, and ESO 0.5-m and 1-m *UBV* and *JHK* photometry, respectively. LTE model atmospheres have been fitted to the observed continuum energy distributions in order to derive the stellar parameters. The results are $T_{\rm eff} = 22\,000$ K, $R = 28\ {\rm R}_\odot$, and $\log L/L_\odot = 5.2$ for Hen S 35, $T_{\rm eff} = 14\,000$ K, $R = 16\ {\rm R}_\odot$, and $\log L/L_\odot = 4.0$ for Hen S 59, and $T_{\rm eff} = 13\,000$ K, $R = 26\,{\rm R}_\odot$, and $\log L/L_\odot = 4.2$ for Hen S 137.

The presence of absorption lines in the optical spectrum of the B9[e] Ib star Hen S 93 allowed an additional LTE line analysis for this star using Balmer, He I, Si II, Mg II, and Fe II lines to derive $T_{\rm eff} = 10\,000$ K, $R = 73\ {\rm R}_\odot$, $\log L/L_\odot = 4.7$, $\log g = 1.75$, $\xi = 10\ {\rm km\,s^{-1}}$, $v\ \sin i = 65\ {\rm km\,s^{-1}}$, and $M \gtrsim 14\ {\rm M}_\odot$.

Our investigation shows that the class of B[e] stars in the Magellanic Clouds extends to luminosities of about $\log L/L_\odot = 4$, i.e. much lower than those of the previously studied B[e] supergiants. This result reinforces the importance of axial symmetry in large regions of the Hertzsprung-Russell diagram.

Orbital elements of multiple spectroscopic stars

P. Hadrava
A&AS, in press

A method for simultaneous decomposition of spectra of binary and multiple stars using FFT and the solution of orbital elements by SIMPLEX-optimization is described.

The LaTeX preprint is accessible in files KOREL.TEX and KOREL.PCX by FTP at directory `/ftp/pub/fotel` at server `SUNSTEL.ASU.CAS.CZ`.

Shell lines in disks around Be stars. I. Simple approximations for Keplerian disks

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This paper investigates shell absorption lines occurring in Be star disks seen edge-on. These lines are counterparts of absorption troughs in P Cyg-type profiles for different

geometry and kinematics and offer a probe of a small portion of the circumstellar disk. This investigation concentrates on Fe lines as prototype examples for metallic shell lines, which have an extremely small thermal width (2 $\mathrm{km\,s^{-1}}$ at 10^4 K).

As a simple, though not unphysical model, a purely Keplerian, isothermal disk in hydrodynamic equilibrium is adopted. The intention of this paper is to provide simple approximations for easy use. It is shown that resulting Fe shell profiles consist of a broad *kinematic* part and a narrow *thermal* core, the narrowness of which depends on the intrinsic Doppler width of the line. The outer disk radius r_d may cause, under certain circumstances, cusps at radial velocities $\pm V_\mathrm{d} = r_\mathrm{d}^{-3/2}$. These cusps can become the deepest points in the line profile, thus causing a central peak. Finally it is demonstrated that if the disk becomes turbulent, the central peak disappears, and the Fe shell profiles are identical to hydrogenic lines from non-turbulent disks.

V/R variability and global oscillations in Be star disks

R.W. Hanuschik, W. Hummel, O. Dietle and E. Sutorius
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We present high-resolution Hα and Fe II spectroscopic data on the emission line behaviour of five selected Be stars (HR 3237, δ Cen, 48 Lib, α Ara, 66 Oph), four of them showing cyclic V/R line profile variability in the period 1982–1993. With the exception of the shell star 48 Lib, these stars temporarily also show a characteristic asymmetric (*steeple-type*) profile shape in their Fe II λ5317 emission line (which we have chosen as characteristical optically thin emission line). These profiles are very similar in all three stars. In contrast, the star α Ara exhibits symmetric double-peak profiles over the whole investigated period.

Steeple-type profiles are cyclically variable in the sense that they show asymmetric line profiles for almost half a cycle, then asymmetry inversion in the second half-cycle, and re-appear with the same shape after a full cycle which lasts about 8–10 years.

We demonstrate that this characteristic steeple-type profile shape and the long-term V/R variability pattern known since long are two manifestations of the same physical phenomenon. We provide arguments in favour of the global disk oscillation scenario as causing a large-scale perturbation of the quasi-Keplerian circumstellar disk which precesses under the influence of the non-spherical gravitational potential of the central star.

Non-axisymmetric Be star circumstellar disks

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A new high resolution and high signal-to-noise ratio spectroscopic study of Hα, Fe II λ5317 and He I λ5876 emission lines of northern and equatorial Be stars is presented.

The line profiles are analyzed in order to test predictions of the recently proposed model of global disk oscillations. The Fe II and He I line profiles are used to derive the kinematics and the radial extension of the circumstellar disk-like plasma. Based on line profile derivatives, we present a new method, the separation of the inflection points (SIP), to resolve the convolved peaks of Hα winebottle-type profiles. The newly derived peak positions are used to determine Hα emission disk radii and mean optical line depths along the line of sight. We find that these improved Hα disk radii are smaller and closer to Fe II disk radii than those Hα disk radii derived from pure peak separations. We find evidence that class 2 profiles originate from quasi-Keplerian disks with a non-axisymmetric density distribution.

Hydrodynamical Simulations of Corotating Interaction Regions and Discrete Absorption Components in Rotating O-Star Winds

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submitted to *ApJ*
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We present two-dimensional hydrodynamical simulations of corotating stream structure in the wind from a rotating O star, together with resulting synthetic line profiles showing discrete absorption components (DACs). An azimuthal variation is induced by a local increase or decrease in the radiative driving force, as would arise from a bright or dark "star spot" in the equatorial plane. Since much of the emergent wind structure seems independent of the exact method of perturbation, we expect similar morphology in winds perturbed by localized magnetic fields or nonradial pulsations, as well as by either rotationally-modulated structure or transient mass ejection.

We find that bright spots with enhanced driving generate high-density, low-speed streams, while dark spots generate low-dnesity, high speed streams. Corotating interaction regions (CIRs) form where fast material collides with slow material - e.g. at the leading (trailing) edge of a stream from a dark (bright) spot, often steepening into shocks. The unperturbed supersonic wind obliquely impacts the high-density CIR and sends back a nonlinear signal which takes the form of a sharp propagating discontinuity ("kink" or "plateau") in the radial velocity gradient. These features travel inward in the co-moving frame at the radiative-acoustic characteristic speed, and thus slowly outward in the star's frame. We find that these slow kinks, rather than the CIRs themselves, are more likely to result in high-opacity DACs in the absorption troughs of unsaturated P Cygni lines. Because the hydrodynamic structure settles to a steady state in a frame corotating with the star, the more tightly-spiraled kinks sweep by an observer on a longer time scale than material moving with the wind itself. This is in general accord with observations showing slow apparent accelerations for DACs.

The Early-Type Variables

L.A. Balona
Submitted to *Ap&SS*

We review the observational status of several different kinds of intrinsic variables among the early-type stars and attempt to interpret the variations in terms of our current understanding of stellar pulsation. Four distinct types of intrinsic variable can be defined: the β Cep, 53 Per, ζ Oph, and λ Eri stars. A simple observational classification scheme, which is readily interpreted in terms of pulsation properties, is proposed. The limits of the instability strip and pulsation constants for the β Cep and 53 Per stars are discussed. Problems with the interpretation of λ Eri stars in terms of pulsation are pointed out. The observations are consistent with rotational modulation. A problem with mode identification in λ Eri stars is discussed.

Tests of the pulsation and starspot models for the periodic Be stars

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MNRAS, in press

We review the correlation between the projected rotational velocity and the periods of the periodic Be stars (λ Eri variables). By estimating radius from the spectral type and assuming that the photometric period is the same as the period of rotation, the equatorial rotational velocity can be derived. We discuss and revise the spectral type/radius calibration. The resulting distribution of equatorial velocities is not significantly different from that of a statistical deconvolution of a large number of Be stars assuming random orientation of the axes of rotation. We conclude that the photometric period is the same as the rotation period within 5 percent. It follows that the pulsation and starspot models for these stars are practically indistinguishable because the pulsational velocity is restricted to very low values. We then derive an expression for the radial velocity to light amplitude ratio. The observed ratios are much higher than predicted from the pulsation/starspot model. There are several other reasons why the pulsation/starspot model needs to be abandoned. A velocity field of unknown origin of several tens of km s^{-1} is required to explain the observations.

EUVE Spectroscopy of β Canis Majoris (B1 II-III) from 500 to 700 Å

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submitted to *ApJ*

Observations of the bright variable star β CMa (B1 II-III) made with the Extreme Ultraviolet Explorer (EUVE) are presented. We report on the continuous energy distribution, photospheric line identication, and the variability of the star, as well as the physical implications for the structure of the local interstellar medium. The star is one of the strongest EUV sources in the long wavelength spectrometer of EUVE, and one of only two early-type stars whose photospheric continuum was detected by the EUVE spectrometers. This paper is primarily concerned with the portion of the spectrum that lies between the neutral helium ionization edge at 504Å and an effective cutoff by interstellar absorption near 700Å. As in our EUV analysis of the B2 II star ϵ CMa, we found that line-blanketed model atmospheres are not capable of predicting an energy distribution which matches observations in all wavelength regions. Consequently, we derived two set of basic parameters for the star ($T_{\rm eff} = 24,800$K, $\log g = 3.7$; and $T_{\rm eff} = 23,250$K, $\log g = 3.5$), depending whether we accept the measured angular diameter, or require an exact agreement between models and the observed visual flux. For the higher $T_{\rm eff}$ model, the predicted EUV flux is in agreement with observations, while for the lower $T_{\rm eff}$ the star's EUV continuum is about 5 times brighter than the predictions. In either case, the star does not show the order of magnitude EUV excess that was seen in ϵ CMa. The EUVE data also provide information concerning the low density interstellar medium in the direction of β CMa. We derive a neutral hydrogen column density of $\approx 2 \times 10^{18}$ cm^{-2} and estimate a lower limit for the neutral helium column density of 1.4×10^{18} cm^{-2}. The EUVE spectrum shows many strong photospheric absorption features, similar to that of ϵ CMa. Evidence for a stellar wind is seen in the O V 630 Å absorption feature.

There is special interest in β CMa because it is among the brightest of the β Cephei class of variables. The pulsations in this class of star manifest themselves primarily as periodic effective temperature changes. We find that the semi-amplitude of the change is 108^{+31}_{-32} K for the primary period. This result is consistent with that derived from an analysis of the UV continuum by Beeckmans & Burger (1977), but our error bars are significantly smaller. The general agreement implies that the pulsations do propagate between the layers where the optical and UV continua are formed and the layers where the EUV continuum forms, which is about six density scale heights higher in static models. The possibility that some pulsational energy deposition could occur within the outer photosphere is discussed. Our observations, taken over two time intervals separated by 70 days, resulted in the detection of the beat phenomenon owing to the three oscillation periods of β CMa.

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7. MEETINGS

- 21-24 November 1995
  Colliding Winds in Binary Stars (Celebrating Dr. Jorge Sahade's 80th. birthday), La Plata, Argentina. Contact: Virpi Niemela, Observatorio Astronomico de La Plata, 1900 La Plata, Argentina.
  E-mail: `winds@fcaglp.fcaglp.unlp.edu.ar`.

- 14 or 15 June 1996
  WG sponsored informal meeting following the AAS meeting in Madison, Wisconsin (see Section 2.1 of this issue).

- 16-20 June 1997
  A Half Century of Stellar Pulsation Interpretations - A Tribute to Arthur N. Cox, Los Alamos, NM. Contact: Joyce A. Guzik, Los Alamos National Laboratory.
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