ISSN 0296-3140

Be STAR NEWSLETTER

NUMBER 23

February 1991

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Produced at the European Southern Observatory

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Acknowledgements: The Be Star Newsletter is produced at and financially supported by the European Southern Observatory. We thank Pam Bristow and Hans-Jürgen Kraus for their active help in administrative and technical matters.

EDITORIAL

* * * * *

Best wishes in the new year, and I hope that 1991 brings you much happiness and success in your studies of the emission line B stars and related objects or phenomena. I am happy to send you the first of three issues of the *Be Star Newsletter* that we plan for the forthcoming year. Included are the usual Working Group Matters, Contributions, What's Active/Inactive?, Observations ... Theoretical Support Wanted/Available, Preprints Received, and Bibliography. I extend my thanks to all of my colleagues who contributed to this issue and especially those who helped with the compilation of the bibliography. If we overlooked one of your papers, or made a clerical or printing error, please let me know about it and I will correct the omission/error in the next issue.

Our series of invited contributions continues in this issue with a summary by Myron Smith of some historical highlights in the recent quest to confirm whether or not there is a connection between Be activity and nonradial pulsations. An update specifically on the NRP-photometric variability connection appeared in the last issue of the *Newsletter*, and of course was extensively discussed and debated during the Workshop on *Rapid Variability of OB-Stars: Nature and Diagnostic Value* held in Garching, Germany in 1990 October. The possible link between NRP and the mass loss must have been mentioned in over half of the papers on Be stars in the 1980s, and the NRP scenario was indeed the landmark model of the last decade. But just how important is NRP alone, and *who might the other players be?* Multiwavelength observations with new detectors in the 1990s may once again mold our perception of these incredibly active stars.

It has become apparent to me that several individuals or groups have been monitoring the same stars in different spectral regions with a variety of instruments now for a number of years. Many individuals/groups are not aware of other's unpublished data. Therefore it might be useful to the community for those of you who are undertaking long-term monitoring projects to announce your efforts and the stars that are most frequently being observed in the *Newsletter*. So I invite contributions for a possible new section in the *Newsletter* called "What's Happening?". Short notes of this nature were frequently published in the early days of the *Newsletter*, and I would like to again include such material.

Since we expect to publish the next issue of the *Newsletter* about a month before the IAU General Assembly in Buenos Aires, contributions for Issue N° 24 should be received by:

May 15, 1991

Lengthy contributions should be submitted in a camera-ready format (see papers in the current issue or Issue N° 14, p. 3 for style), but for short communications I especially recommend Electronic Mail (SPAN-CYGNUS::PETERS, 5546::GPETERS, ASTRON::GPETERS), Fax (telephone number: 213-740-6342), or telex (4720490 USC LSA). Please note that our Fax number has been changed and that the Internet address given in previous issues of the *Newsletter* currently is inoperative. In addition my telephone number has been changed to: 213-740-6336.

Again, I wish you a productive and happy year and look forward to receiving your contributions for the June issue. I thank Nancy Wu for her assistance with some of the typing and the European Southern Observatory for their continued financial support.

Gerrie Peters, Editor

WORKING GROUP MATTERS

* * * * *

The ESO workshop on variable OB stars held Oct. 15-18, 1990 in Garching had the nice side effect that for the first time since the IAU General Assembly in Baltimore, all members of the Organizing Committee of our Working Group (L.A. Balona, J. Dachs, V. Doazan, J.M. Marlborough, J.R. Percy, G.J. Peters, and the undersigned) were assembled at the same place. We used this rare opportunity for two lunch meetings to which we also invited A.G. Hearn as the representative of IAU Commission ?? (Stellar Atmospheres) which is one of the commissions sponsoring our Working Group. The following is a brief summary of the discussions we had.

Gerrie Peters expressed her willingness to continue as the editor of the Be Star Newsletter. This was gratefully accepted by the other members of the Organizing Committee. The technical production and distribution of the Newsletter have now for five years taken place at the European Southern Observatory. It would perhaps be appropriate if at some stage another institute/group could engage in this activity. But this was not seen by the Organizing Committe as a very pressing issue.

The majority of the present members are already serving their second (or third) three-year period on the Organizing Committee. The Working Group does not have any written by-laws. But it was generally felt that after two terms it should be time for a change. It would make sense to me if in addition to this very healthy rule the editor of the Newsletter always were automatically a member of the Organizing Committee. After further consultation with the Organizing Committee I will probably return to this matter in the next issue of the Newsletter.

An important topic of our discussion was, of course, the question of a new meeting on Be stars at the IAU level. My invitation in the previous issue of the Newsletter for suggestions on this subject had zero response. But within the Organizing Committee there was unanimous support of this idea, albeit at different levels of enthusiasm. ROSAT, radio observations, rapid photometric and spectroscopic variability, monitoring from space of mass loss phenomena, polarimetry, a renewed interest in the structure of Hα emission profiles, etc. can all be expected to yield new results (in many cases have done so already) which deserve to be reflected upon collectively by the Be star communicated. Perhaps the most attractive point is that none of these topics is any way specific to Be stars. The Organizing Committee therefore decided to plan the agenda of the envisaged meeting in such a way as to make attractive for many more scientist than 'just' Be freaks. The definition of a draft program is now underway.

As good luck had it, the Organizing Committee was at the same time informed by a workshop participant of the very kind and attractive offer by his home institute to host the meeting in question. The Organizing Committee gratefully took note of this suggestion and will almost certainly accept it. The most likely date would be in the late (northern) summer of 1993. The *Be Star Newsletter* will keep you informed on further developments. Any suggestions to me concerning the program are still welcome.

Finally, Luis Balona explained his proposal for the subject and format of the meeting of the Working Group at the IAU General Assembly in Buenos Aires. The Organizing Committee welcomed his suggestions, and Luis offered to provide a short write-up of his idea for inclusion in the *Be Star Newsletter*. You will find it reproduced on page 27 of this issue. Luis has volunteered to organize the scientific part of that meeting. It would only be fair to express your appreciation of his initiative by sending him any further suggestions you may have in order to make this meeting a success.

Dietrich Baade

* * * * *

A BRIEF HISTORY OF THE "NRP-Be" CONNECTION[1]

Myron A. Smith, National Science Foundation, Washington, D.C.

Although suspected for several years in sharp-lined "53 Per" and some β Cephei stars, nonradial pulsations (NRP) were first detected as moving bumps in absorption profiles of metallic lines by Walker, Yang, and Fahlman (*Ap.J.*, **233**, 199, 1979) and diagnosed as high-degree NRP modes by Vogt and Penrod (*Ap.J.*, **275**, 661, 1983) in the rapidly rotating O9.5e star ζ Oph. Even before the latter discovery Dietrich Baade (*Astr.Ap.*, **105**, 65, 1982) and Tom Bolton (*Be Stars*, ed. M. Jaschek (Dordrecht: Reidel), p. 181, 1982) had suggested that there may be a causal relationship between NRP and the spasmodic mass loss episodes identified with "Be activity". Don Penrod surveyed some 22 stars for his Ph.D. thesis, finding that possibly all but one exhibit line profile variations consistent with the NRP "degree" $\ell = 2$, as well as a high degree mode. His results, confirmed by Baade later in the Southern hemisphere, seemed to suggest that among rapid rotators low degree modes are present only in Be stars and not in Bn stars. Penrod also found, as had Bolton before him for λ Eri, that for three Be stars the Hα emission status seems to be anticorrelated with NRP amplitude. More precisely, over the 1983 and 1984 seasons he found a consistent lag in the "recovery" of the apparent NRP pulsation amplitude behind the time of peak Hα emission.

By 1984 the idea seemed an attractive one that the Be phenomenon is caused by, or at least coincident with, NRP in rapidly rotating B stars. So, many of us began pursuing various observational tests. Several investigators have demonstrated (see Percy's article in the previous *Newsletter*) that for some Be stars photometric variations give the same period as line profile variations, and that these are likely to be associated with low degree modes. In contrast, the short period "high degree" modes have not been detected. This behavior, the detectability of low degree but not high degree modes in the photometry, is a point in favor of the NRP model because it predicts that light and radial velocity variations would quickly diminish in integrated starlight with increasing NRP degree. On the other hand, high-degree modes have increased visibility in rotationally broadened line profiles. Nonetheless, doubts have been since expressed about the reality of NRP in Be stars. However, (as discussed below) because the NRP-Be link seems weaker today anyway, these doubts will not be discussed herein.

The attractiveness of NRP stemmed mainly from the large amounts of energy tied up in them. According to "classical" g^+-mode eigenfunctions they could comprise some 0.3% of the star's gravitational binding energy. Thus if a way could be found to liberate some of this energy suddenly, e.g. through the switching from a high- to a low-energy NRP mode, it seemed possible that NRP could eject material into a disk. Work done by Hiroyasu Ando indicated that NRP might be effective in transporting angular momentum from a deep NRP-exciting region of the star to the mode damping region near the surface. This spawned the hope that material might indeed be ejected into an equatorial circumstellar structure because of the equatorial confinement of energy in the sectorial ($|m| = \pm 1$) NRP modes that seem to be observed in B stars. Finally, it was pointed out that Be stars become an appreciable fraction of the B star population above $V \sin i$ values of about 150 km s^{-1}. According to a still-incomplete sample, this is the approximate value of a fuzzy $V \sin i$ "demarcation" value above which NRP modes tend to be retrograde (with respect to rotation) and below which modes are prograde. The correspondence of this "demarcation velocity" with that for which Be stars make an appearance lent further hope that a particular kind of mode (retrograde, $\ell = 2$) was important in the development of "the" Be phenomenon. Three years later, Lee and Saio (*P.A.S.J.*, **224**, 513; 225, 643, 1987) announced a successful reinvestigation of Osaki's of "oscillatory convection" model for the excitation of NRP in rotating B stars. They claimed (and have since developed this

[1]One of a series of invited contributions currently appearing in the *Be Star Newsletter*.

claim further) that this mechanism excites NRP and overcomes envelope damping in B stars. The necessary ingredients are a convective core, rotation, and resonances of organized convection cells with g^+ modes in the whole star. The late 1980's was the "high water mark" for a putative causal connection between NRP and Be activity. It was particularly nice that a mechanism had been proposed which, though short on details, did *not* require Be stars to be rotating near their critical velocities, as indeed present observations indicate.

However, throughout this period NRP proponents acknowledged that "the Be phenomenon" is probably not a single one. At the 1986 Boulder IAU Colloquium on Be stars, practically all participants voted "aye" to Mirek Plavec's straw poll question: "are there at least three explanations for Be stars?" Even if one makes this stipulation (along with the stipulation that a few astronomers hedge on the existence of NRP in Be stars at all), it was recognized early on that there were problems with any NRP-Be connection. First, at the same meeting Osaki put forward an NRP theory in which the internal transfer of angular momentum followed. However, it led to the prediction that Be stars should show prograde modes, not retrograde modes as generally interpreted by spectroscopists. In addition, the question can be raised: if NRP $\ell = 2$ modes are responsible for Be stars, why are not other, more slowly rotating B stars with these modes (53 Per, some β Cephei) episodic mass losers as well?

To follow up on an original suggestion of an emission-NRP anticorrelation Bolton and Štefl (*Angular Momentum and Mass Loss for Hot stars*, ed. Willson and Stalio (Dordrecht: Kluwer), 1990), and Smith (*Ap.J.Suppl.*, 71, 357, 1989) have independently monitored λ Eri (B2e, a single star) for several years. [This was Penrod's best case for an NRP-Be correlation.] Neither group found a continued correlation, whether in radial velocity or line profile behavior. Thus, more extensive data have simply removed the strongest observational case for a link here. In addition, monitoring observations of Be stars suggest that mass loss events are apt to occur extremely rapidly, and our esteemed Editor's observation of 12-min. variations in the He I 6678Å profile of μ Cen (Peters, *Ap.J.*, 301, L61, 1986) makes this case dramatically. An interesting by-product of Smith's monitoring campaign of this same He I line in λ Eri is the discovery of frequent, rapidly developing "spectral transients" at unpredictable intervals. Similar features have been reported by Yang *et al.* in γ Cas (*Publ.A.S.P.*, 100, 233, 1988). Although the causes of these features are unknown, the fact that they can occur even when the 6678Å line is opaque to the underlying stellar photosphere indicates that they cannot be caused simply from NRP (e.g. through intermode beating). Of course, transients could arise in principle by NRP-generated shocks that travel through the circumstellar murk, only to deposit their energy above the ejected material. The problem with this idea is the actual numbers: the typical NRP's at the surface of λ Eri have amplitudes of $\leq$10% of the sound speed in the photosphere, making any shock mechanism difficult to support. Further, one has to go to the largest amplitude β Cephei stars (e.g. ν Eri, BW Vul) to find situations were shocks can have as dramatic effect on a line profile as in a mild-NRP, mild-Be star like λ Eri.

If Be activity is not caused by NRP, by what then? Two conceivable causes that spring to mind are magnetic field dissipations (flares) and releases of energy associated with the decay of hypothesized deeply residing NRP modes, which suddenly decay into several daughter modes (parametric resonances) with short-lived large amplitudes at the surface. The latter idea is entirely *ad hoc*, and moreover violates the localness implied by the extremely rapid development of some transients (several minutes). The alternative, flare-like processes, is a long way from proven at this time, although radio observations from the binary star V760 Sco hint at the existence of magnetic fields (Stewart *et al.*, *Ap.J.*, 342, 463, 1989). However, even if another agent, such as magnetism, supplies the energy for Be mass loss, there might still be an important role for NRP. For example, convective granulation cells on the solar surface do not "cause" solar flares but they are thought to *trigger* them by destabilizing fragile magnetic configurations, leading to a dramatic conversion of magnetic to kinetic energy. Could the travelling waves of NRP serve the same role by jostling fixed configurations of a nonthermal energy supply on the surfaces of classical Be stars?

MASS OUTFLOW IN THE NEARLY PROTOPLANETARY SYSTEM BETA PICTORIS

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Previous spectral studies of circumstellar (CS) dust around the nearby, candidate protoplanetary system, β Pictoris, have detected only infalling gas. The lack of detectable mass outflow has been critical in the interpretation of the origin of the CS gas, and in our understanding of the evolutionary status of the β Pictoris system. High dispersion observations with the *International Ultraviolet Explorer (IUE)* show, in addition to infall, the presence of mass outflow in some spectra, with a maximum observed outflow velocity of -60 km s^{-1}, and a corresponding instantaneous outflow rate of 1.1×10^{-14} $M_{\odot}$ yr^{-1} or 1.1×10^{-11} Jupiter masses per year. This mass outflow rate and terminal velocity are comparable to the magnitudes of mass infall rates and terminal velocities observed from late 1986 through early 1988. The implications of these observations on our understanding of the mechanisms producing infall from the surrounding CS disk are discussed in a forthcoming paper submitted to the *Astrophysical Journal, Letters*, as are the implications for our understanding of the evolutionary status of the β Pictoris system.

The detection of outflowing material in Fe II represents not only the first direct detection of mass ejection events in a mid-A star which is close to the Main Sequence, but also direct evidence for ejection events as the source of circumstellar disk material in A stars showing shell features in their optical and UV spectra. Since β Pictoris returns to the same base state (as seen by *IUE* with limited velocity resolution and S/N), the phenomenon strongly resembles the episodic highly ionized winds seen in the UV spectra of Be stars, but shifted down in ionization. We cannot rule out something more closely resembling a late-type star phenomenon (recall, chromospheres have been detected at A7) at this time.

ARCHIVING AND DISTRIBUTION OF SPECTROSCOPIC DATA

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Dear Colleague,

Spectroscopy is a fundamental tool for the investigation of the physical conditions in astronomical objects. For a long time their spectra have been studied with photographic plates, but the results have suffered from the limited dynamical range and the difficulties involved in obtaining good quality, well calibrated spectrograms.

In more recent times, astronomical spectroscopy has benefitted from the wide use of electronic detectors which provide high quality spectroscopic data, already in digitized form, with higher S/N and a substantial dynamical range. Along with the use of powerful computers these advances have substantially changed our research emphasis to problems which require the handling of large sets of spectral data. The special impact of astronomical space projects have provided us with large and homogeneous sets of spectrograms, useful for systematic studies of many different astrophysical categories. In particular, the very large amount of data collected over many years of IUE observations is now available from the *IUE* archive and presently forms the most extensive spectroscopic data base.

Considering data collected with ground-based telescopes, the archival situation is decidedly worse. Not only are these data not in a uniform format, but also only limited samples of spectrograms are available through data centers, or from institutes or individuals. However, the amount of good quality spectra so far collected at the various telescopes in the world is so large as to be sufficient for many purposes.

We thus think that a concerted effort should be made now to make the observational spectroscopic material, as well as the laboratory and theoretical work, readily accessible to the whole astronomical community. For this purpose we are organizing a meeting during the next IAU GA in Buenos Aires to discuss the problem of archiving and distribution of spectroscopic data. The following aspects of the problem will be discussed:

ARCHIVING: where to create the data bases and how to organize them, the standard format of the files, how to give data errors, which information on the observation should be stored.

DISTRIBUTION: the different means (tapes, disks, cassettes, e-mail), rules, author/observer rights.

DOCUMENTATION: data center file list and observatory logbook available remotely (like *IUE*), file classification.

We would like to have your contribution and that of your colleagues to the above points well before the IAU GA in order to prepare a working scheme to be discussed during the meeting. Please circulate this note, fill in the form, and send it me at your earliest convenience.

Roberto Viotti (uvspace@irmias.earn - 40058::viotti)

(Form follows on the next page)

NAME.....E MAIL.....

ADDRESS:

1. ARE YOU INTERESTED IN THE TOPIC OF THIS MEETING?
2. ARE YOU PLANNING TO ATTEND THE GENERAL ASSEMBLY?
3. DO YOU AGREE WITH THE CONCEPT OF SPECTROSCOPIC DATA CENTERS?
4. SUGGESTED FORMAT(S) OF THE ORIGINAL DATA FILES:
5. DO YOU SUGGEST A UNIFORM SCALE OF WAVEL AND FLUX UNITS?
6. SUGGESTED UNITS:
7. WHICH INFORMATION ON THE OBSERVATION SHOULD THE FILES INCLUDE:
8. SHOULD THE ARCHIVE INCLUDE THE RECORD OF SPECTRAL PLATES?
9. FORMAT(S), UNITS, SUGGESTIONS:
10. SHOULD WE TRY TO PERSUADE OBSERVATORIES TO REDUCE THEIR ARCHIVE PLATES?
11. SHOULD ALSO EXTENSIVE LINE LISTS BE ARCHIVED?
12. DO YOU HAVE SPECTROSCOPIC DATA TO INCLUDE IN THE ARCHIVE?
13. WHICH DATA:
14. WHICH MEAN(S) DO YOU PREFER FOR THE DATA DISTRIBUTION:
15. WHICH RULES DO YOU SUGGEST FOR THE DISTRIBUTION?
16. SHOULD OBSERVATORIES HAVE AN UPDATED, REMOTELY ACCESSIBLE LOG OF ALL THE OBSERVED SPECTRA?
17. WHICH INFORMATION THE OBSERVATORY LOGBOOK AND THE DATA CENTER FILE LIST SHOULD INCLUDE?
18. COMMENTS/SUGGESTIONS:

Fill in the questionnaire and return it before February 15, 1991 to:

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ISTITUTO ASTROFISICA SPAZIALE, C.P. 67, I-00044 FRASCATI (RM), ITALY

CHARACTERISTICS OF THE LONG-TERM PHOTOMETRIC VARIATIONS OF Be STARS

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ABSTRACT

Preliminary results are presented for a 3 year program of differential BV photometry of 237 "classical" Be stars which resulted in the acquisition of 9384 magnitudes. In addition, 151 coudé spectra centered on Hα were obtained for 134 stars. 54% of the sample stars were found to be definitely or slightly photometrically variable, 46% non-variable. A typical profile was found for a variable Be star: 1) spectral type B0-3.5; 2) V range most likely 0.10-.15 magnitudes; 3) ΔV & ΔB-V opposite in direction or else with no color change; 4) Jaschek Type I, then III; 5) Hα emission, usually with a central absorption core or single emission and no underlying photospheric absorption; 6) moderate v sin i. Least likely to vary are B4-6.5 stars of Jaschek Types II & IV with low v sin i and double emission on an underlying photospheric absorption line at Hα. Stars with the largest ΔV ranges (≥ 0.2 mags.) tended to vary slowly (months to years), had larger v sin i values and Hα emission equivalent widths, as well as double or single emission profiles at Hα without photospheric absorptions. Photometric variability is suggested to be a function of the amount of material/extent of the circumstellar shell.

Paper presented at the June, 1990 meeting of the AAS.

Preprints are available from the author at the above address.

ORIGIN OF THE Be STAR CIRCUMSTELLAR ENVELOPE

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The prescence of emission lines in the optical spectra of Be stars is attributed to a circumstellar envelope(Struve,1931, see also Doazan,1982). The gas envelope seems to be in the form of an equatorial disk. Suggestions have been made that the gas disk originates from the fast rotating Be star, destabilized either by transport of angular momentum from inside (Apparao, Antia and Chitre,1987) or due to non-radial oscillations of the Be star (Baade,1987). It has been also suggested that the gas disk can be due to accretion from a binary companion to the Be star (Harmanec,1987; Harmanec and Kriz,1976). In this note we wish to point out that the binary model for the origin of the circumstellar disk faces difficulties in the case of x-ray emitting Be stars.

More than twenty x-ray emitting sources are identified with Be stars (van den Heuvel and Rappaport,1987). Several others have been recently discovered by HEAO-1 (Tuohy et al,1988) and the Ginga (Koyama et al,1989) satellites, but await further confirmation. The luminosity of these x-ray sources range between 10^{33} and 10^{39} ergs s^{-1} . They show pulsations with periodicities ranging between 0.069 s and 835 s. Several of them are shown to be binaries with the binary periods betwen 8.4 days and 188 days. The x-ray sources also show a variety of variations: 1) Flaring with a periodicity sometimes equal to the orbital period and sometimes with a different interval. 2) Outbursts and periods of quiescence. The high luminosity and the pulsations clearly indicate the presence of

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†On sabbatical leave from TataInstitute of Fundamental Research,Bombay,India

compact objects (neutron stars and white dwarf stars). The x-ray emission occurs when matter accretes on to the compact object from the Be star envelope. The flaring is explained in terms of the neutron star,while moving in an eccentric orbit, passes through the gas disk and accretes matter at the peri-astron. Thus in these systems matter is supplied to the companion and not the other way. Also the degenerate and compact nature(for the orbital periods concerned the compact objects are well within the Roche lobe) of the companion, precludes their supplying matter to the primary Be star to form a disk.

In order to make the model of a companion supplying matter to form a disk around the Be star viable, one has to invoke triple systems. The presence of an ordinary star filling the Roche lobe, besides the Be star and the compact star, has to be assumed. This object has to have a binary period of the order of 130 days (Harmanec,1987) in order to allow the formation of a disk around the Be star and at the same time fill the Roche lobe. Such a system with a Be star, a neutron star with an orbital period in the range 10-100 days and a mass losing star with a period of the order of 130 days is likely to be unstable. The period for the advance of the apsidal line will be in the range 250-2500days, if we use the formulation given in Batten((1973). The ephemeris of the flaring seen in the x-ray source A0535+26 (Nagase et al, 1982) with an orbital period of 111 days seems,however, to be constant over a duration of observation of about 6 yrs. Several other x-ray sources also show constancy of ephemeris for flaring.

In conclusion, the suggestion that the gas disk around a Be star arises from accretion from a companion faces difficulty in the case of x-ray emitting Be stars.

Acknowledgement: This research was done under NASA contract NAG 5-941.

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Hα OBSERVATIONS AT KITT PEAK NATIONAL OBSERVATORY

This report continues a series of updates on the variations in Hα and He I 6678 in selected Be stars of current interest to the community. Observations were made with the Coude Feed Telescope (CFT) at KPNO during 1990 August 18-23 with the TI3 CCD detector, grating B, and camera 5. The resolution for a line width of 2 pixels is 0.44 Å, and the S/N for the observations range from 100 - 200 averaged over twenty pixels. A few additional observations were made with the CFT during the KPNO *Request Night* on 1990 December 6 with the TEK2 CCD detector, grating A, and camera 5 (resolution of 0.38Å). The observations described below will be compared with those reported in previous issues of the *Be Star Newsletter (BSN)*. As in previous reports, the V/R that is quoted is I_V/I_R (not the historical $(I_V - I_{cont})/(I_R - I_{cont})$).

γ Cas - There has been a slight change in the Hα and He I 6678 emission features since my last report. Overall the Hα emission is weaker (4.0±0.1 I_{cont}). The R emission in Hα showed an increase in strength, but the V component continues to be stronger (V/R=1.10). The double emission in He I 6678 continues to show V < R (V=1.01 I_{cont}, R=1.03 I_{cont}).

28 Tau - In August the peak intensity of Hα was 5.6 I_{cont} with V/R=0.89 (a slight increase since January). He I 6678 displayed symmetrical weak absorption, consistent with the star's spectral type, and no apparent emission.

λ Eri - No Hα emission was seen in August or December (except for possible very weak filling). There was also no emission in He I 6678 (in August), but the profile showed conspicuous structure including what appeared to be a "dimple" transient. Also see the report below by M. Smith.

HR 2855 - A weak exposure taken just before sunrise at an hour angle of 4^E15 (a few degrees above the actual horizon) in August with substantial solar spectral contamination revealed a relatively weak Hα emission with V < R (R≃1.25 I_{cont}). Note that the sense of the V/R was unusual for this star. In December R continued to exceed V (V/R=0.69), but the peak intensity was a more typical 2.15 I_{cont}. The He I 6678 line continued to be strongly in emission (1.07±0.01 I_{cont}), but now displays a triangular profile skewed to the red.

χ Oph - No significant change from that reported in *BSN 22*. The peak intensity of Hα is 8.0±0.2, and structure, possibly indicative of ongoing nonradial pulsations, prevails in He I 6678.

66 Oph - Seven Hα observations in August revealed a peak intensity of 9.40±0.30 I_{cont}. The reduced emission compared to its record 10.0 I_{cont} in late March and June of this year (*BSN 22*) suggests that the wind may have faded or turned off earlier in the summer. *IUE* observations made on 1990 April 21 and September 11 (which also included *ROSAT* coverage during the all-sky-survey) showed a moderate wind (respectively the equivalent widths of the C IV wind line were 1.8, 2.0 Å, the edge velocities were -800, -900 km s^{-1}, and narrow components at -250, -200 km s^{-1} were seen). Absorption continues to be seen on the red side of the Hα emission, but now a distinct weak core is present. During the August observing run there was very interesting variability in the double He I 6678 emission. On August 19 and 22 the feature was an inverse P Cygni line with V=1.03 I_{cont} and R=1.01 I_{cont}, but an excellent exposure on August 23 revealed symmetrical emission with a peak intensity of 1.02 I_{cont}. Weak structure in the absorption line indicated the possible presence of nonradial pulsations, rarely in evidence in this star.

59 Cyg - Hα and He I 6678 have undergone no substantial changes during the past four years that this monitoring program has been in effect. In August the profile resembled the reverse of that shown in *BSN 16* (Fig. 3). Strong red-shifted He emission of 1.06 I_{cont} (no V component) was seen.

π Aqr - In August the Hα emission was strong (3.2 I_{cont}), V was *slightly* less than R, and a weak central reversal was seen. On December 6 the peak intensity was about the same but the V lobe dominated (V/R=1.1). Conspicuous variations continue to be seen in the profile of the He I 6678 emission. In August the V component (1.10 I_{cont}, FWHM=3.25Å) was stronger and sharper than the R emission (1.05 I_{cont}, FWHM=7.50Å). In December the widths of the V and R components were again equal, V=1.10 I_{cont}> R=1.06 I_{cont}, FWHM=3Å. The profile changes in Hα that have occurred during the past two years (cf. *BSN 22*) were apparently accompanied by dramatic changes in the star's polarization (Bjorkman *et al.* (*Bull.A.A.S.*, **22**, 1201, 1990). Whereas strong polarization was seen in August 1989, in August 1990, contemporaneous with the KPNO observations, no Balmer discontinuity and decreased overall polarization were reported.

o And - Weak double Hα emission (V=1.00 I_{cont}, R=1.03 I_{cont}) continues to be present. The shell core showed r_v=0.28. No emission but structure suggestive of nonradial pulsations were seen in He I 6678.

Gerrie Peters

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THE LAMBDA ERIDANI (B2e) WATCH

Paul Avellar and Myron Smith, who have been monitoring this star at high spectral resolution for several years now, report that during this season the star has been "quiescent" as ever. Its Hα and He I 6678Å lines have shown no recent emission, either in the core or wings. The strength of the He I line is strong, suggesting that any putative chromosphere is weak at this time. Ron Polidan and Myron have found that several "*dimple transients*" in the He I line were followed several minutes later by a temporary weakening of the UV C IV and N V resonance lines in *IUE* data.

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REQUEST FOR OBSERVATIONS TO SUPPORT A MULTIWAVELENGTH CAMPAIGN ON η CENTAURI

From March 28 - April 1 we will conduct a multiwavelength campaign on the southern Be star η Cen. This star has been displaying some spectacular photometric and spectroscopic variations lately. Cuypers, Balona, and Marang (*Astr.Ap.Suppl.*, **81**, 151, 1989) found that the optical photometric variations were best fit with a *triple-wave* light curve with a period of 1.927 days and a full range in brightness of 0.1 mag! Data in the *IUE* archives reveal large fluctuations in the strength of the C IV wind line (EWs 2-3 Å), and large profile variations have been observed in the optical spectrum (Baade, *Astr.Ap.*, **124**, 283, 1983; Dachs *et al.*, *Astr.Ap.Suppl.*, **63**, 87, 1986).

To investigate the cause for the striking variability in η Cen and compare short-term modulations in mass loss with those observed in previous campaign stars (which display single or double-wave light curves with smaller amplitudes) we will obtain 64 hours of continuous coverage of the activity with *IUE* (eight contiguous shifts). The *IUE* observations are scheduled to begin with US2 (19:00 UT) on March 29, 1991. We will also secure a limited amount of data on the secondary targets μ Cen, χ Oph, and 48 Lib.

Some of the participants in the project are D. R. Gies, H. F. Henrichs, D. McDavid, J. R. Percy, G. J. Peters, and M. A. Smith, and we invite interested observers to join our effort. We plan simultaneous *IUE* and ground-based spectroscopic, photometric, and polarimetric observations. If you are interested in participating in this campaign, please contact either John Percy, Department of Astronomy, University of Toronto, Toronto, Ontario M5S 1A1; Canada (photometric observations) or Gerrie Peters, Space Sciences Center, University of Southern California, Los Angeles, CA 90089-1341; USA (spectroscopic observations).

* *

REQUEST FOR INFORMATION ON Be STARS OBSERVED DURING THE ASTRO-1 MISSION

The *Astro-1* mission was successfully launched aboard the space shuttle Columbia on 2 December 1990. Although there were numerous problems encountered during the mission with shuttle and pointing systems, all the instruments performed beautifully and some good scientific observations were obtained. The duration of the mission was 9 days (shortened by one day due to shuttle problems and bad weather forecasts for the landing site).

Due to all the problems, the WUPPE observations obtained were significantly fewer than were originally planned. However, observations of three Be stars were made: ζ Tau, π Aqr (two observations), and P Car (a very short observation). The data on ζ Tau and π Aqr look quite good, and are very interesting. The WUPPE team is currently in the process of calibrating the data and results will be forthcoming.

We are quite interested in knowing what ground-based support observations may have been made for WUPPE/*Astro-1*. If you were able to observe any Be stars near the time of the mission, I would appreciate knowing of your observations. Please let me know (by e-mail, fax, telephone, or mail) what types of observations were made, which objects were observed, and when the observations were made. The support observations will be important for interpreting and understanding the WUPPE observations.

Thank you for your interest and support. We hope to have interesting results to present at the Seattle meeting of the AAS, and I will try to prepare some information for the next issue of this newsletter.

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LAST CALL FOR OBSERVATIONS OF PREVIOUS CAMPAIGN STARS

We are just about finished with the analysis of multiwavelength data from our earlier campaigns. Included are the following stars and approximate observation dates: o And (1987 August), λ Eri and ω Ori (1987 November), ϵ Cap (1988 September), and 28 Cyg (1989 September). If you supported any of these efforts (even if you were able to obtain only 1-2 spectra or photometric observations), or if you have contemporaneous unpublished data that you would be willing to share, please contact us *as soon as possible*. Please send photometry to Dr. John Percy, Department of Astronomy, University of Toronto, Toronto, ON M5S 1A1, Canada (Bitnet: PERCY@UTORPHYS), and spectroscopic results to me (address on front cover, SPAN: CYGNUS::PETERS,5546::GPETERS). Thank you very much.

Gerrie Peters

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PREPRINTS RECEIVED

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Flares in the X-Ray Source EXO 2030+375
APPARAO K.M.V.; Department of Astronomy, Pennsylvania State University, 525 Davey Laboratory, University Park, PA 16802, USA.
To be Published in: *Astrophysical Journal (July 10, 1991 issue)*
Preprints: K. Apparao at above address.

Abstract: Six x-ray flares were observed in the source EXO 2030+375 with an average time interval of about 4 hrs. between the flares. It is shown here that the flares can be due to Rayleigh-Taylor instabilities near the magnetospheric boundary of the neutron star when it reaches the equilibrium period.

Optical Emission Enhancements in Be Stars
APPARAO K.M.V.; Department of Astronomy, Pennsylvania State University, 525 Davey Laboratory, University Park, PA 16802, USA.
To be Published in: *Astrophysical Journal (July 20, 1991 issue)*
Preprints: K. Apparao at above address.

Abstract: Be stars show enhancement of optical emission up to a few magnitudes. Optical continuum enhancements due to (*i*) conversion of Lyman continuum photons of the Be star to visual photons in the envelope of the Be star, (*ii*) emission from the H II region formed by x-ray and EUV emission from a compact object in binary motion around the Be star, and (*iii*) emission from an accretion disk around the compact object are considered. These considerations indicate that large increases of optical emission ($\geq$0.5 mag) would need an ionizing source other than the Be star, like for example an accreting compact object emitting radiation. Specific examples of large increases of optical emission as in the sources γ Cas and 4U0115+63 are discussed.

White Dwarfs in Be Star Binary Systems
APPARAO K.M.V.; Department of Astronomy, Pennsylvania State University, 525 Davey Laboratory, University Park, PA 16802, USA.
Submitted to: *Astronomy and Astrophysics*
Preprints: K. Apparao at above address.

Abstract: Possible reasons for the non-detection of white dwarf stars in Be star binary systems is discussed. Signatures of such white dwarfs are also discussed.

The Light Curves of Periodic Be Stars in NGC 3766
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Submitted to: *Monthly Notices of the Royal Astronomical Society*
Preprints: L. Balona at the first address.

Abstract: In this paper we present results of an intensive photometric campaign on four periodic Be stars (λ Eri variables) in the southern open cluster NGC 3766. Light curves covering the years 1985-1990 are presented. We find that in spite of dramatic changes in the shapes and amplitudes of the light curves, phase locking is maintained and the period is unchanged over the five-year interval.

This represents the largest amount of data for any λ Eri star and we are able to state conclusively that within the observational limits there is no evidence at all for coherent multiperiodicity in any of the four stars. Incoherent variability (flickering) is often present. We find no obvious correlation between the amplitudes or shapes of the light curves and the Hα profiles. We discuss these findings in the light of the nonradial pulsation and starspot hypotheses and show that they are observationally indistinguishable. Both are incapable of accounting for the observed radial velocity variations. We discuss a model in which matter is trapped in a magnetic field and forced into co-rotation with the star. This model explains the observed periods, the double-wave nature of most λ Eri stars, the phase locking, and probably the line profile variations as well.

Light Variations of B Stars
CUYPERS J.; Koninklijke Sterrenwacht van Belgie, Ringlaan 3 - B-1180 Brussels, Belgium.
To be Published in: Proceedings of the ESO Workshop on *Rapid Variability of OB-Stars: Nature and Diagnostic Value*
Preprints: J. Cuypers at the above address.

Abstract: Different types of variable B-type stars are opposed by means of the characteristics of the observed photometric light variations. Chemically peculiar (CP) stars of type B, mid-B or 53 Per variables and Be stars are discussed in detail. With one period and its first harmonic the light variations of CP stars are well described and this supports the generally accepted oblique rotator model. The mid-B stars are identified with the 53 Per line profile variables and multiperiodicity is now well established for a few cases. A long time base and a very stable photometric system are necessary to disentangle the complex frequency structure. Strong indications for nonradial pulsations are present. Be stars exhibit light variability on all time scales. A short period in the range 0.4 to 3 days seems ubiquitous, but irregular scatter on a slightly shorter time scale is also present together with intermediate- and long-time scale variations. The search for multiperiodicity is seriously hampered by this complex variability pattern, but not one convincing case with coherent multiple short periods has been presented yet. Therefore photometry has not refuted rotational modulation theories for Be stars. The confirmed biperiodicity with a short and a longer period (8.9 days) in the Be star HD 137518 and the apparently mutual exclusion of the β Cephei and the Be phenomenon in open clusters of the same age are examples of the large number of unsolved problems on light variability of Be stars.

Properties and Nature of Be Stars. 15. Light Variations of LQ And and Its Check Stars Revisited
HARMANEC P.[1,2] - MATTHEWS J.M.[2] - BOŽIC H.[3] - PAVLOVSKI K.[3] - HUANG L.[4] - GUO Z.-H.[4] - PERCY J.R.[5] - PLUME R.[5] - RUŽIČ Ž.[3] - WEHLAU W.H.[6] - BOHLENDER D.A.[6] - HORN J.[1] - KOUBSKÝ P.[1] - WALKER G.A.H.[2] - YANG S.[2]; 1. Astronomical Institute Czechoslovak Academy of Sciences, 251 65 Ondřejov, Czechoslovakia; 2. Department of Geophysics and Astronomy, University of British Colombia, Vancouver, B.C., V6T 1W5 Canada; 3. Hvar Astrophysical Observatory, Faculty of Geodesy, Zagreb University, 41000 Zagreb, Yugoslavia; 4. Beijing Astronomical Observatory, Academia Sinica, 100080 Beijing, China; 5. Department of Astronomy, University of Toronto, Toronto, Ontario, M5S 1A1 Canada; 6. Department of Astronomy, University of Western Ontario, London, Ontario, N6A 3K7 Canada.
To be Published in: *Bulletin of the Astronomical Institutes of Czechoslovakia*
Preprints: P. Harmanec at first address.

Abstract: From an analysis of 624 UBV observations of LQ And made at six observatories between 1980 and 1988 we find a period of 0.30952 or 0.61904 days with a full amplitude of ~ $0^{m}.025$. There are weak indications of small irregular changes of amplitude and/or shape of the light curve, but no evidence of multiperiodicity. LQ And is thus a Be star with one of the most stable periodic light curves known. Although we are still unable to identity the true physical cause of the periodic light variations observed (pulsation, rotation or duplicity), we argue that the true rotational period of the star is in all probability close to the 0.619-day period. Additionally, we present some evidence of a

gradual secular decrease in the brightness of LQ And between 1951 and 1988, possibly connected with weakening of the Balmer emission observed over a similar interval of time. A comprehensive analysis of the six comparison and check stars that have been used for LQ And confirms earlier reports that HD 224166 is variable. We derive a new period of 3.5112 days for its light and color variations, and suggest that this hot CP star is probably an oblique rotator. We also suspect κ And of microvariability at the $0^{m}.01$ level and advise caution when using this star as a photometric standard.

Closer to a Solution of the Puzzle of 5 κ Dra?

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To be Published in: *Bulletin of the Astronomical Institutes of Czechoslovakia*
Preprints: P. Harmanec at first address.

Abstract: Analysis of the radial velocities from 158 new photographic, Reticon and CCD spectrograms as well as from 266 older velocities found in the astronomical literature indicate that 5 Dra is the primary component of a binary system in a circular orbit when $P_{orb} = 61.55$ days and $K = 6 - 7$ km s^{-1}. The basic physical properties of this system show clear similarities to other known Be binaries (a low-mass secondary, phase-locked V/R variations and a period in the range between about 10 and 500 days). The controversial short period of 0.890384 days - reported by early observers but later questioned - is reconfirmed here in order data, but does not appear clearly in more recent observations. Several periods between about 0.3 and 1.1 days are detected by us in velocity, line-widths and line-asymmetry measurements at different epochs. We show that these periods and other short periods reported in the literature (based on polarimetry and observations of travelling subfeatures in the line profiles) are all aliases and/or harmonics of the 0.890-day period. Therefore, we argue that a single physical periodicity (perhaps corresponding to the star's rotation) may be responsible for the rapid variations seen in 5 Dra.

Spectroscopic Variations of the Be Star LQ And: Binarity and Rotation

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Submitted to: *Monthly Notices of the Royal Astronomical Society*
Preprints: J. Matthews at first address.

Abstract: Based on radial velocity and line intensity variations seen in 62 CFHT and DAO Reticon spectra of LQ And (HR 9070) obtained in 1988, and using earlier published data, we argue that this Be star belongs to a spectroscopic binary with a period of 7.413 day. The RV curves of the Hγ shell core and He I λ4387, along with the lack of observable eclipses in photometry, are used to constrain the orbital elements and properties of the secondary. When the 7.413-day variations are removed from the data, the residuals show a periodicity of 0.619 day (with single- and double-wave curves in various line parameters). This corresponds to the longer of two possible photometric periods already identified in LQ And (for which the star has a double-wave light curve) and resolves a long-standing ambiguity about the true period. We attribute the 0.619-day period to the star's rotation, which is consistent with the value of $v \sin i \simeq 280$ km s^{-1} determined from our spectra. There are also variations in the velocity of Mg II λ4481 with a period near 0.12 day which may be due to pulsation,

but we find no travelling bumps in the line profiles - above 0.3% of the continuum level - which might result from high-degree nonradial modes. There remain several problems with our scenario for LQ And which must be addressed: (i) The equivalent width of He I λ4387 and the velocity of He I λ4471 vary in ways not easily reconciled with the 7.413-day period. (ii) The velocities of those two lines appear to vary roughly in antiphase at the 0.619-day period. (iii) The γ-velocities of He I λ4471 and Mg II λ4481 differ from those of the Hγ shell core and He I λ4387 by about -30 km s^{-1}. In an Appendix, we describe a new method we have used to measure the velocities of the spectral lines, adapted from the Kwee - van Woerden technique for determining times of minima int he light curves of eclipsing binaries.

Rapid Photospheric Variability and Circumstellar Activity in Be Stars
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To be Published in: Proceedings of the ESO Workshop on *Rapid Variability of OB-Stars: Nature and Diagnostic Value*
Preprints: G. Peters at above address.

Abstract: The phenomenon of short-term variability in Be stars has been investigated through four multiwavelength campaigns and two collaborative projects. The focal points of the study were an attempt to find the cause for the optical light variability and whether it is linked to the mass loss mechanism. Some initial results including the variation in the light curve with wavelength and the phase-dependent behavior of the wind are presented here. *IUE* and ground-based photometry confirm that it is a modulation in the star's photospheric temperature that causes the light variations as the amplitude of the light curve increases with decreasing wavelength. Phase-dependent variations are observed in the equivalent width and profile of the C IV wind line. Wind mass loss tends to be enhanced when the star is brightest, and in a Be-shell star (ε Cap) the absolute intensity of the C IV emission component appears to be anticorrelated with the absorption strength and FUV flux level. The observations support the suggestion that nonradial pulsations are responsible for the photometric variability and the generic model of a star pulsating in an $\ell = 2$ sectorial mode appears plausible.

Consequences of the Star-Stream Interaction in Algol
RICHARDS M.T.; Department of Astronomy, University of Virginia, P.O. Box 3818, University Station, Charlottesville, VA, USA.
To be Published in: *Astrophysical Journal (June 20, 1991 issue)*
Preprints: M. Richards at above address.

Abstract: We have studied the Hα profile of Algol to determine the nature of the interaction between the gas stream and the primary, and have found evidence of an asymmetric transient accretion disk with an average radius of $(1.8\pm0.2)R_A$, and electron density $N_e \sim 10^{10} cm^{-3}$, and mass $\sim 10^{-12} M_\odot$. The trailing side of the disk is wider and denser than the leading side. Algol is the first partially-eclipsing short-period Algol-type system in which a transient disk has been found. The emission produced by the disk is weak relative to the continuum of the triple system, so the disk emission was enhanced by subtracting the composite theoretical photospheric absorption line profile of the three stars from the observed line profile. Our theoretical calculations of the depth of the shock region produced when the gas stream strikes the primary indicate that the shock occurs above the photosphere of the star. This result is based on the best estimates of the rate of mass loss from the secondary which range from 10^{-11} to 10^{-10} $M_\odot$ yr^{-1} for Algol. The predicted location of the shock is in agreement with the results of a previous paper in which a localized region was found just above the photosphere of the primary. The analyses of Hα and ultraviolet resonance lines have shown that the circumstellar material in Algol consists of four components in addition to the gas stream. There is a localized high density Hα region, a high-temperature region, and a high-rotational-velocity region, which are all part of a low density transient H II accretion disk. We feel that these transient phenomena are all consequences of the impact of the gas stream on the primary star, known as the star-stream interaction.

Spectral Line Transients in λ Eri and Related Be Stars
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To be Published in: Proceedings of the ESO Workshop on *Rapid Variability of OB-Stars: Nature and Diagnostic Value*
Preprints: M. Smith at above address.

Abstract: In this paper we report that certain types of spectral transients in the He I λ6678 line of λ Eri result from the brief appearance of low-velocity emission features from regions just above the photosphere of the star. A comparison of the strengths of the λ6678 and λ4922 (next series member) between this star and non-emission B-stars suggests that these events may well arise from local perturbations of a bonafide chromosphere in this and perhaps other Be stars. Rapid changes in even 200^s are used via Alfvén speed arguments to estimate a characteristic field strength of putative disrupted magnetic structures that could be responsible for these events: ~3 kG. It is also argued that other spectral transients in λ6678 occur from localized failed ejections which, after an explosive release, rise to a maximum height and then return to the star ballistically. During some Hα-active phases, there are indications that ejecta return from the regions of a detached circumstellar ring.

Absolute Magnitudes of B Emission Line Stars - Correlation Between the Luminosity Excess and the Effective Temperature
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To be Published in: *Astronomy and Astrophysics*
Preprints: J. Zorec at first address.

Abstract: A new determination of visual absolute magnitude of Be stars, which is a very important parameter for the knowledge of these stars, was carried out. For this, a new calibration of visual absolute magnitudes of B stars of luminosity classes V, IV and III is first obtained from a sample of 215 stars. The absolute luminosity excess in the visual is determined for a sample of 49 Be stars. We find that this excess is correlated with the effective temperature of the underlying stars. We find also a well defined correlation between this excess and the emission in the first two Balmer lines. From these results using a simple model of circumstellar envelope, we infer that the zones of the circumstellar envelope contributing to the emission in the continuum and in the lines have to be rather small. We also deduce that the emission measure ($\int N_e N_i dr$) of the envelope is correlated with the temperature of the central star and that the irregular photometric variations of Be stars are an envelope-opacity phenomenon.

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ERRATUM: In Issue N° 22 (p. 28) the authors for the paper *Be-Herbig Star HD 200775 and Related Compact Region of Star Formation (RSF) 1 Cep* should read:
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Abbreviations used for the Publications

AA	Astronomy and Astrophysics
AASS	Astronomy and Astrophysics Supplement Series
AJ	Astronomical Journal
APJ	Astrophysical Journal
APJS	Astrophysical Journal Supplement
ASS	Astrophysics and Space Science
AZ	Astronomicheskii Zhurnal
BAAS	Bulletin of the American Astronomical Society
BAC	Bulletin of the Astronomical Institutes of Czechoslovakia
IAUC	IAU Circular
IBVS	Information Bulletin on Variable Stars
IUEEA	"Evolution in Astrophysics: *IUE* Astronomy in the Era of New Space Missions", Proceedings of an International Conference held in Toulouse, France from 29 May - 1 June 1990.
MNRAS	Monthly Notices of the Royal Astronomical Society
MSAI	Memorie della Societa Astronomica Italiana
PASJ	Publications of the Astronomical Society of Japan
PASP	Publications of the Astronomical Society of the Pacific
RMAA	Revista Mexicana de Astronomia y Astrofisica

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SPECIAL MEETING ON Be STARS

Luis Balona
South African Astronomical Observatory
Cape, South Africa

The Working Group on Be stars will hold its business/scientific meeting during the IAU General Assembly in 1991 July in Buenos Aires. The proposed scientific program is "Current Observational and Theoretical Problems in Be Star Research". The aim of the meeting is to define as clearly as possible the observational and theoretical problems that need to be solved. There will be no presentation of results, but short summaries of our present knowledge and unresolved questions will be presented by an observer and a theoretician. Discussion will centre around practical ways of addressing these problems. As far as possible, the questions to be resolved should be formulated in such a way that the answer is either "Yes" or "No". One of the principal aims of the meeting is to attract astronomers from outside the field of Be star research. It would be particularly appropriate if specialists in stellar pulsation, stellar magnetism and stellar winds could be persuaded to turn their talents towards solving some of these problems. Observers with specialized equipment such as polarimeters and magnetometers are urgently required. Readers are requested to bring this meeting to the attention of these people. Another important aim of the meeting is encourage collaboration among observers. There will be no formal discussion of observing campaigns, but it is hoped that the desired clarification of issues will stimulate participants into joining a coordinated effort to answer these questions.