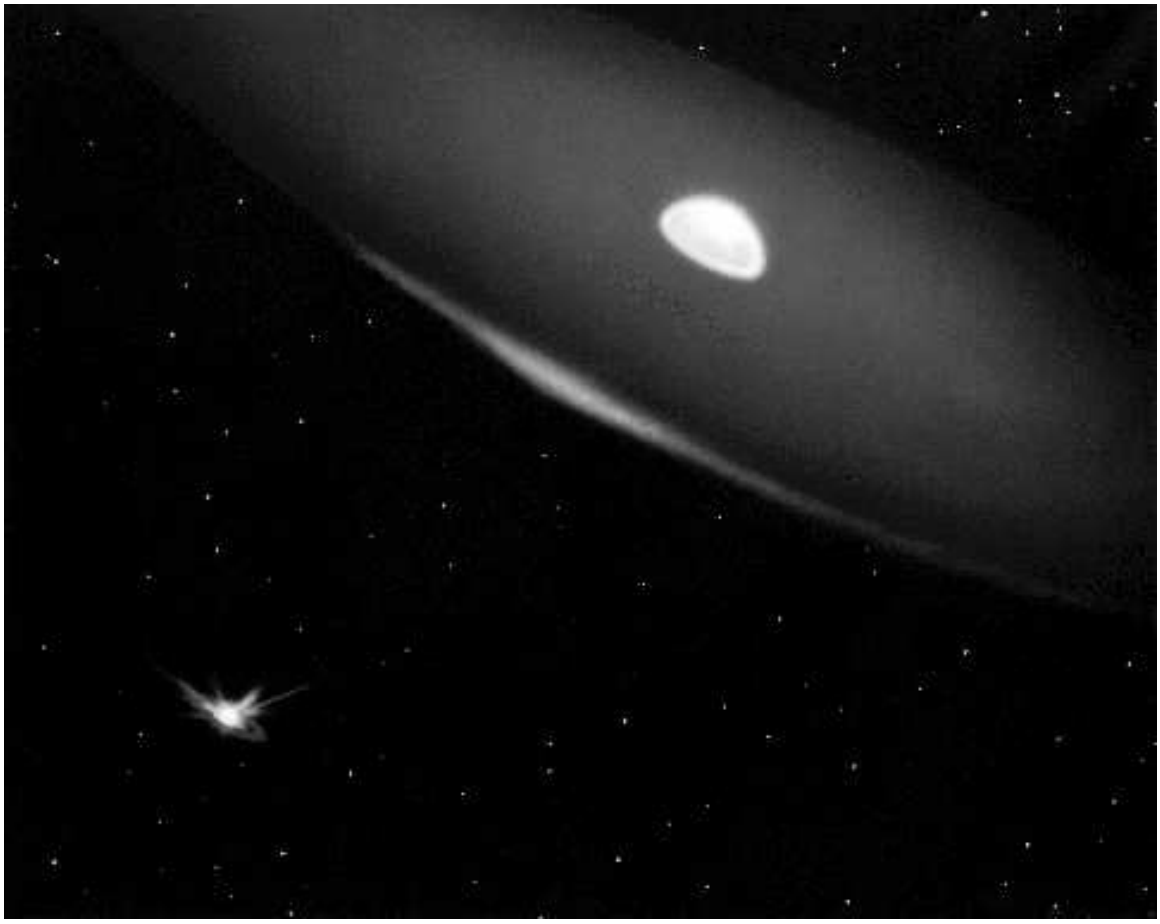
ISSN 0296-3140



Be STAR NEWSLETTER

NUMBER 33 - June 1998

Editor-in-Chief:
Geraldine J. Peters
e-mail: gjpeters@mucen.usc.edu
Space Sciences Center
University of Southern California
University Park
Los Angeles, CA 90089-1341
Tel: (213) 740-6336
FAX: (213) 740-6342

Technical Editor:
Douglas R. Gies
e-mail: gies@chara.gsu.edu
Center for High Angular Resolution Astronomy
Department of Physics and Astronomy
Georgia State University
Atlanta, Georgia, 30303-3083
Tel: (404) 651-1366
FAX: (404) 651-1389

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://www.chara.gsu.edu/BeNews/intro.html`) *or by anonymous ftp* (`ftp chara.gsu.edu, cd BeNews`).

1. EDITORIAL

An appropriate theme for this Issue No. 33 of the *Be Star Newsletter* might be "New Faces for Old Friends". Consider, for example, μ Cen, discovered to have Balmer emission almost 110 years ago by W. P. Fleming. For the past two decades it has been trying to reestablish its former prominent circumstellar (CS) envelope, apparently through a series of quasi-periodic mini-outbursts. Now researchers show that these outbursts apparently coincide with the maxima from the constructive interference of at least four of six coherent NRP periods in the star. NRP and the mini-outbursts that are slowly producing another prominent CS envelope appear to be linked.

Another familiar face is that of γ Cas, or do we know this star? It was the first Be star to be discovered, more than 130 years ago by A. Secchi, but has not endured as a prototype for a classical Be star, especially in view of its unusually strong X-ray emission. In this issue new data from the *IUE* spacecraft are presented that lend further support to a prior conclusion that the star has a magnetosphere that may produce it's X-ray emission. Contributions on both γ Cas & μ Cen follow earlier reports in the last issue of the *Newsletter*.

In WHAT'S HAPPENING we include a report on the new model for the interacting binary Be star ϕ Per that emerged from recent *HST* observations. What a change from the model some of us advocated at the Cape Cod meeting in 1975! But the consensus is still that mass transfer spun up the Be star. But the new revelation is that the secondary is indeed a hot O-type subdwarf (suggested earlier by several researchers) that is the remnant of a more massive star that transferred its material to the Be star. Indeed, a newly-confirmed face for this Be star. Also in this issue of the *Newsletter* are contributions on the variable mass infall in FY CMa and the energy budget in Be stars, a report from the new Chair of the Working Group on Active B Stars, minutes from the WG meeting held at the IAU GA in Kyoto, a prospectus for the proposed meeting on the Be phenomenon in Alicante, Spain in 1999, abstracts of new papers, the newly expanded bibliography, and information on forthcoming meetings of interest to the active star community.

Beginning with items received for the next issue of the *Newsletter*, we plan to adopt a new publication procedure in order to communicate with the community in a more timely fashion. Contributions, including abstracts & meeting announcements will be posted on our web site shortly after they are received and undergone review by the editors. In fact we have already been doing this on an experimental basis (have you noticed?). So please make a bookmark in your web browser and check our web edition often! At irregular intervals, usually twice per year, we will collect all material received since the last issue, produce a bibliography, and publish a paper copy. We will still offer a postscript file of the entire issue. This procedure will allow us to alleviate a perennial problem that items received just after an issue comes out are old news by the time the next issue is published! Please let us know if you approve of the new approach.

We urge those who are receiving the paper edition of the *Newsletter* to inform us of address changes as soon as possible. With each mailing we have a significant number of returns that increase our cost of distributing the paper copies.

Contributions/abstracts for Issue 34 should be received by:

November 30, 1998.

Send contributions by Electronic Mail to

gjpeters@mucen.usc.edu and **gies@chara.gsu.edu**

either as LaTex or postscript files. We are now **requiring** that abstracts be submitted as LaTex files using the template provided in this issue (it can also be downloaded from our web site). Illustrations should be sent by E-mail as postscript files. If it is not possible to transmit your contribution electronically, please send or fax (213-740-6342) a dark camera-ready copy.

We would like to thank those who contributed to this issue. It is *your* input that keeps the *Newsletter* both interesting and useful to the active B star community, and we look forward to receiving your contributions for Issue No. 34.

We appreciate the continuing support from the Department of Physics & Astronomy at Georgia State University for the production of the paper edition of the *Newsletter*.

Gerrie Peters, Editor-in-Chief

2. WORKING GROUP MATTERS

2.1. Working Group News

Some months ago, the Working Group on Active B Stars completed another three-year IAU activity cycle. This also implied changes in the composition of committees. In the case of our Working Group, Petr Harmanec, Myron Smith, and Rens Waters reached the end of their respective second term and therefore left the Organizing Committee (OC). Katy Garmany served as a member of the OC on behalf of our sponsoring Commission 45 (Stellar Classification). We thank all four of them for the work they have done for the Working Group.

In his last e-mail as the Chairman of the Working Group Myron Smith has already informed all members about the new composition of the OC. But for good order's sake let me repeat it here: D. Baade (chair), J. Bjorkman, J. Cassinelli D. Gies, H. Henrichs, M. Marlborough, V. Niemela, A. Okazaki, G. Peters (NL editor, nonvoting), M. Smith (outgoing chair, nonvoting), and S. Štefl. As the new chairman, I cordially welcome the new members Jon Bjorkman, Virpi Niemela (on behalf of Commission 45), Atsuo Okazaki, and Stanislav Štefl and congratulate them on their election.

Myron Smith deserves our special thanks as an unusually active chairman of the Active B-Star Working Group. As is being reported elsewhere in this issue of the Newsletter, his efforts will come into full fruition with the Alicante meeting in 1999. Several OC members also serve on the Scientific Organizing Committee (SOC), which has furthermore kindly granted the chairman of the OC active observer status. Therefore, the meeting should serve the interests of the Working Group members and their research actively and well. It will undoubtedly guide and inspire our work into the next century.

Unfortunately, only few members of the Working Group could attend the IAU General Assembly in Kyoto and, if so, in many cases only partly. Therefore, only a very limited meeting could take place in Kyoto. It was very kindly organized and chaired by John Percy. A summary by Petr Harmanec is included in this issue of the Newsletter. I thank both of them for their support.

I wish to extend the Working Group's gratitude also to Gerrie Peters and Doug Gies for their constant successful efforts to edit, produce and distribute this Newsletter. It is an important vehicle for the exchange of information within the Working Group and thereby provides the essential glue for the cohesion of the Working Group. Not only have Gerrie and Doug provided this community service already for many years but they have also kindly agreed to continue with it – thank you!

In this period of rapidly changing communication tools and information carriers, our Working Group, too, has to monitor these developments and check the needs for adaptation. One obvious idea that has been floating around for quite some time now is to supplement the printed copies by electronic means, especially the Worldwide Web. Such a solution would save cost and make news accessible more quickly. For instance, all contributions could within days after receipt by the editor be posted on the Web, perhaps also using an e-mail notification system for subscribers. A printed version would, then, only be issued at irregular intervals and when there is sufficient

material. I invite the Working Group members to communicate their views on this matter to me. In particular, we would need one or more volunteers who would be willing to maintain the necessary home page!

Dietrich Baade
(dbaade@eso.org)

2.2. WG Meeting at the IAU

Minutes of the meeting of the Working Group on Active B Stars held on August 27, 1997 during the 23rd General Assembly of the IAU

The 23rd General Assembly in Kyoto was attended by more than 2000 registered participants and it was necessary to schedule many parallel sessions. Very unfortunately, this also led to only a limited attendance of the Working Group meeting. There was a similar problem with many of the other business sessions, and this was called to the attention of the IAU Executive Committee. Yet, people like Dr. M. Jerzykiewicz, the newly elected president of Division V were present.

The meeting was chaired by Dr. John R. Percy who first announced the newly elected members of the organizing committee of the WG Drs. J. Bjorkman, V. Niemela, A. Okazaki and S. Štefl and reported that Drs. K. Garmany, P. Harmanec, M. Smith and R. Waters are leaving the committee after serving for two consecutive periods. They were thanked for their service to the WG. Dr. Dietrich Baade has been elected as the new chairman to replace Dr. M.A. Smith.

Then, the plans to have another large international conference devoted to active B stars were discussed at some length. Since Hungarian colleagues plan to organize a meeting on stellar pulsations in Budapest between August 9 and 13, 1999 (to celebrate the one-hundredth year anniversary of the Konkoly Observatory and to allow witnessing a total solar eclipse during the meeting), there was a proposal to have the B star meeting (to be held in Alicante, Spain) in a week before or after the Budapest meeting. However, it was stressed that the Budapest meeting will mainly be focused on (late-type) Cepheids and RR Lyr stars. Moreover, Dr. Fabregat, the chairman of the provisional Local Organizing Committee of the planned Alicante meeting, announced that the Congress hall will only be available in June and July but not in August. Furthermore, the weather is hot, and the city is crowded in August. The majority opinion then was to hold the meeting in June as originally recommended by the Spanish hosts.

Some discussion took place on the three tentative titles of the meeting suggested by the Scientific Organizing Committee. The title "OB Stars and the Be phenomenon" was considered to be the most appropriate one by most of the participants. It was also recommended that the SOC should try to contact the colleagues who regularly organize meetings on mass loss from luminous stars and coordinate the program of the meeting with their plans.

The next topic was the Be Newsletter. Dr. P. Harmanec reminded that the suggestion of the organizing committee of the WG which met in Juan les Pins in 1993 was to replace the printed Newsletter by an electronic board with an automatic circulation of

the news, calls for observations etc. He expressed the opinion that the Be Newsletter is sometimes being misused for cheap unrefereed publishing. His opinion was partly opposed by Dr. J. Percy who agreed with the idea of an electronic board but expressed his belief that the printed Newsletter is still very helpful to colleagues who do not have an easy access to Internet. No further discussion followed and no recommendation was accepted on this matter, though there was sympathy for keeping the paper edition. The meeting then discussed the idea of having an electronic "bulletin board" for time-dependent information, such as unusual behaviour of stars, and observing campaigns. Dr. Conny Aerts agreed to conduct this bulletin board, as long as it did not develop into a discussion or "chat" group.

Several brief scientific presentations followed. Dr. P. Harmanec reported about the systematic UBV monitoring of bright Be stars at Hvar. A summary report on these 1972-1990 observations will soon appear in press (Pavlovski, Harmanec, Božić et al. 1997 A& AS, 125, 75). This paper also contains references to all earlier studies based on Hvar photometry. In two other papers (Harmanec, Pavlovski, Božić et al. 1997 Journal of Astronomical Data; Harmanec and Horn 1997, Journal of Astronomical Data), the original observations, complete data archives and software for the data reduction and retrieval will be published.

Then, Dr. J. Percy reported on his program of UBV monitoring of Be stars which includes Toronto observations, observations secured with the Phoenix-10 Automatic Photoelectric Telescope and observations obtained by the AAVSO photoelectric photometry program. The results are in press (Percy et al., PASP). The data are to be deposited in the IAU Archives of unpublished observations. As a rule, the same comparison and check stars as those recommended for the international campaign and used at Hvar were usually adopted.

These two large data sets, in combination with the long-term monitoring program organized by C. Sterken at ESO, represent a substantial increase of our knowledge about the light and colour behaviour of bright Be stars on various time scales.

In a comment to this, Dr. M. Jerzykiewicz offered his unpublished UBV observations of ES Vul.

Finally, Dr. N.G. Bochkarev reported on ocassional optical flares of V1357 Cyg, the optical counterpart of the well-known X-ray source Cyg X-1. Some doubts were raised on the reality of this phenomena but Dr. P. Harmanec reported that the Hvar data also show similar brightenings for some "more normal" Be binaries (without a known X-ray secondary in the system).

P. Harmanec, Secretary (Internet: hec@sunstel.asu.cas.cz)
Astronomical Institute, Academy of Sciences of the Czech Republic, 251 65 Ondřejov, Czech Republic

2.3. Proposed Alicante Conference

TITLE: **The Be Phenomenon in Early-Type Stars**

DATE: 28 June–2 July, 1999

VENUE: Conference Hall of the Caja de Ahorros del Mediterraneo, Alicante, Spain

SPONSORING INSTITUTIONS: University of Valencia, University of Alicante, Caja de Ahorros del Mediterraneo ("CAM")

PROPOSING IAU COMMISSIONS: (requested)

27 (Variable Stars)
25 (Stellar Photometry & Polarimetry)
29 (Stellar Spectra)
42 (Close Binaries)
44 (Space & High Energy Astrophysics)

THE SCIENTIFIC ORGANIZING COMMITTEE (SOC):

Balona, L. (South Africa)
Bjorkman, J. (United States)
Fabregat, J. (Spain)
Fullerton, A. (Canada)
Hummel, W. (Germany)
Kambe, E. (Japan)
Marlborough, M. (Canada)
Mennickent, R. (Chile)
Roche, P. (United Kingdom)
Smith, M. (United States, Chair)
Stefl, S. (Czech Republic)

Six of these members were initially proposed by the IAU Working Group on Active B Stars (Chair: D. Baade); the remainder were elected by the initially selected SOC. Criteria used in this election included recent refereed publications in the field of Be stars and geographical distribution. We note that the majority of the SOC are young astronomers, with half of them having been in graduate school a decade ago.

The title for the conference was the result from many discussions within the Working Group (WG) on Active B Stars, the WG's OC, and the SOC.

LOCAL ORGANIZING COMMITTEE:

J. Fabregat (Chair), J. Berna, G. Bernabeu, E. Enjuto, J. Perez-Ortiz

The LOC members are members of the two sponsoring universities.

DETAILS OF THE PROPOSED CONFERENCE

1. The Venue

In 1997 the Universities of Alicante and Valencia extended an invitation to the Organizing Committee of the Working Group on Active B Stars to hold a conference in Valencia, Spain. It is easy to understand why the proposed venue was readily accepted by the Organizing Committee. Alicante is an affordable site for Asian and North American as well as European participants. It is both a tourist and university city which offers a variety of natural and cultural attractions for visitors. Moreover, it is appropriate to salute the longstanding observational work on Be stars by astronomers at two sponsoring institutions, and thirdly to acknowledge the expanding role of Spain in providing modern astronomical observing sites in Europe which are well equipped for studies of variable stars and galaxies.

2. Accommodation and other costs

The LOC is currently in the process of searching for funding to defray the expenses of some conference participants, particularly those astronomers who are young, must travel far, or come from developing countries. The registration fee is expected to be about $150. This price includes the cost of publishing the proceedings.

Accommodations include dormitory housing ($12/night; approx), with shared baths, and hotels. The following are estimates of hotel room rates in Alicante available to the participants:

Single Room: $25–75 Double Room: $35–100

The hotel rooms are equipped with bathrooms and TV. The CAM conference hall itself is in the center of Alicante and has a large auditorium which is equipped with audiovisual facilities.

3. The Date and Duration of the meeting

The choice of late June was dictated by the availability of the conference center, the University of Alicante's academic schedule, and the local tourist season. Late June is a time when the spring academic semester is nearing completion and university dormitories are still open for rental of available and economical rooms. During this time the average temperature is still rising, so the tourist influx (with attendant higher hotel costs) will have not yet started. This time also assures that the home obligations of most conference participants who have university jobs will be ended. The conference is planned for 4-1/2 days.

4. Structure of the Meeting

The structure of the meeting will be in a conventional dual format of oral talks and poster presentations which will run eight hours (including coffee breaks) per day. The oral presentations will be a series of review summaries and invited talks (dominated by the work of one or two groups) of a series of subfields pertaining to the main subject of the Be phenomenon. An attempt will be made in the oral talks to weave findings from relevant poster papers into the presentation. In addition, there are many arguments circulating within the Be scientific community, so adequate time will be set aside for discussion following major talks. Time will be provided for personal reconnaissance

of the posters every day, and two sessions of summaries of poster papers, which will be followed by short group discussion. The conference will be ended with a short summary by the Chair and by a discussion of future research directions needed for the field.

5. Dedication

The meeting will be dedicated to the works of **Dr. Arne Slettebak** and **Mercedes Jaschek**.

Dr. Slettebak is currently semi-retired. For more than three decades he led a research group devoted to the observations of Be stars and to the role rotation and other possible physical process which might be responsible for the appearance of Balmer line emission in early-type stellar spectra. Dr. Slettebak and collaborators initially carried out his studies from ground- based data and later extended them into the ultraviolet. He has taught all of us the importance of setting high standards in data description and measurements and caution in interpretation. Many of his publications have remained benchmarks over the years for describing spectral signatures of the Be phenomenon.

Dr. Mercedes Jaschek was also well known for her spectroscopic observations of Be stars. She began these in Argentina and continued them when she and her husband Carlos moved to Strasbourg. One of her major contributions was the construction of the Catalog of Stellar Groups, which listed all types of stars with peculiarities, including an extensive listing of Be stars. She chaired IAU Symposium No. 98 on Be stars and also started the *Be Star Newsletter*. The conference will be opened by a public lecture on stars in Spanish to the local lay public. We plan to ask Dr. Carlos Jaschek to give this talk as an added memorial to his wife's contributions. Dr. Jaschek has retired in Spain and frequently conducts informal seminars with the public on outreach themes.

6. The Proceedings

Written versions of the talks and posters will be published within a few months of the conference. As much space as possible will be given for poster papers (but no limit to posters per participant), but the number of pages could be limited by coverage of discussions following major talks. The proposed editors of the proceedings are M. A. Smith (talks) and H. F. Henrichs (posters).

PRELIMINARY AGENDA

The Be Phenomenon in Early Type Stars

Session 1: Overview of the Be Phenomenon

- Definition of the Classical Be Phenomenon
- Physical Parameters and Evolutionary Status of Be Stars
- Connection with Other Emission-Line Stars

Session 2: New Missions and Technologies

- Positions of B/Be Stars on the HRD from HIPPARCOS
- Direct Optical Imaging of Be Disks
- An Infrared View of Be Star Disks
- A View of Isolated Be Stars at High Energies
- Recent Attempts to Detect Zeeman Signal in Be Stars

Session 3: Time Variability – The Role of Stellar & Atmospheric Processes in Isolated Be Stars

Subsession 1: The Nature of Periodic Variations

- Observed Periodic Phenomena
- Multimode Detections from Surveys
- Competitive Models for Periodic Variations

Subsession 2: Reports on campaigns

- MUSICOS
- Heros
- Asian Participation
- IUE

Subsession 3: Aperiodic Variations

- Photospheric Activity
- Physical Requirements for Magnetic Flaring in an Early-Type Stars

---

Session 4: The Circumstellar Environment of Be Stars
Subsession 1: Observational Diagnostics

- Polarization Studies
- Line Profile Modeling
- Review of Disk Variability (V/R, Photometric Monitoring, Polarimetric Monitoring, etc.)

Subsession 2: Theoretical Models

- Theory of Global Disk Oscillations (1-Armed Density Wave model)
- Review of Theoretical Models of Disk Formation (Wind Compressed, Mass-Transfer Accretion Disks, etc.)

Session 5: The Be Phenomenon and binary systems

- Roche-lobe mass transfer systems
- Wind Accretors - Be/X-Ray Binaries
- Glimpses of Binary Evolution (ϕ Per, etc.)

Session 6: Future Directions

- What Have We Concluded? (Synthesis of Current Understanding)
- Where Do We Go from Here? (Key Questions/Problems)

Detailed Motivation

After much electronic-chat among the full SOC, the enclosed preliminary program has been constructed. The motivation for the meeting themes is as follows:

1. Overview

The most important focus of the conference is to place the classical Be stars within a larger context of early-type stars with emission lines. The conference will begin with an overview of the phenomenology of "classical" Be stars and recent progress in understanding them as a class.

Next, we will contrast the classical Be stars with overviews of the B[e] and related stars, which are thought to lose or gain mass by some combination of radiation pressure, nonradial pulsations, magnetic fields and mass accretion processes. The relative importance of these and doubtless other mechanisms probably differs among these classes and in suitable parameter spaces. This will be the first time in which participants of the classical Be, massive variable supergiant, and X-ray Be stars, and flare-physics communities have been assembled in order to explore the commonality of these subclasses and to pool knowledge obtained among them.

2. Results from New Missions and Technologies

Results from the HIPPARCOS mission have led to a number of important advances in the study of Be stars, including the first reliable distances and luminosities in Be stars and the first meaningful period-luminosity diagram for pulsating B stars. These studies will lead to an improved understanding of what role evolution may play in development of the Be phenomenon.

HIPPARCOS has also been used as a monitor of nonradial pulsations in Be stars. Its observations have been made of a variety of objects at essentially random times, which will be more effective in the detection of multiple mode than most previous ground-based efforts. One long-term study, which should be completed by the time of this conference, will have searched for the existence of many low-amplitude pulsation modes in several Be stars from a sample which is selection-free as possible. This research promises to supply an answer to a new degree of confidence as to whether rare constructive superpositions of these modes can produce atmospheric shocks over short durations and eject matter from the star.

Interferometric measurements have been made already of a number of disks around Be stars in Hα, and in some cases in wavelengths of an optical He I line and nearby continuum. By comparing these with kinematic studies of the line profiles, this work has revealed for the first time the size and geometry of their circumstellar disks. Moreover, their apparent obliquity provides a reliable estimate of the aspect ratio of the disk (and rotation) axes. Currently, two research groups are continuing these studies, with a third to come on line by the time of the conference, and will study the internal velocities and degrees of inhomogeneities in disks. These are critical parameters for testing theories of disk formation. We expect that these results could be announced in this conference. It is anticipated that these results may be compared directly with new optical and UV spectropolarimetry of the same Be-disk systems.

Results from several new X-ray satellites (RXTE, BeppoSax, ASCA, AXAF) will be

available at the time of the conference and will further illuminate the possible role of high-energy phenomena in classical Be stars as well as the connection between X-ray and optical variability in X-ray Be binary systems. This conference will also be the first opportunity to present and discuss with the hot-star community results from ISO which bear on the question of Be disk formation and maintenance. Finally, it is anticipated that a new generation of zeeman observations will be made of photospheric lines in several Be stars by groups from Europe and Canada.

3. Temporal Phenomena in Isolated Classical Be Stars

Some periodic process (either nonradial pulsations or magnetic signals carried by rotational modulation) is generally thought to be the trigger of atmospheric instabilities which result in spasmodic mass ejections. This conference will be the first occasion in which monitoring of stars by HIPPARCOS over 3.5 years without seasonal gaps will be reported. A comprehensive report on multiple periods in Be stars, the first of its kind and scope, can discuss the differences in mode structure and amplitude (if any) between stars which have undergone recent Be episodes and those which have not.

Some of the periods discovered in these long-term campaigns may be due to rotational passages of surface structures, particularly if examination of archival reprocessed IUE data should show variations in chemical abundances of He or Si. Moreover at this writing, some of the first reports are being published of co-rotating magnetospheric lobes over the surfaces of Be stars. The study of these periods will provide evidence for the existence of quasi- stable magnetic structures on these stars. These studies will address past hints of a connection between the Be and Bp (peculiar abundance) phenomena.

A variety of studies over optical, UV, and X-ray energies have recently shown that rapid high-energy transients occur often on selected Be stars. These events are evidenced as variations of UV continuum flux, ephemeral features in profiles of optical He I and H lines, and X-ray flares and "shots". Detailed studies of the processes causing these signatures, and of their cascades to lower wavelengths, are currently underway and will provide exciting discussion topics for an audience composed both of X-ray and optical/UV astronomers. A reanalysis of reprocessed IUE data can exploit the key He II 1640 Åline as link between the high-energy transients and warm-star thermal background. Anticipating that at least some of these signatures could be caused by the dissipation of magnetic energy, the conference will include a talk on the conditions needed in plasma above a hot star for flares to erupt by a prominent expert from the cool star community.

4. Circumstellar Wind and Disk Environment

In the early 1990's the "Wind-Compressed Disk" model was formulated and first advanced to the Be star community at the Juan les Pins symposium. This picture was attractive because it predicted the formation of disks in the outflows from single stars with moderately high rotation rates. However, recent HD simulations have shown that additional effects can prevent the formation of the disk, depending on the details of the wind driving mechanism. In the meantime, the one-armed density wave model has been proposed to explain the cyclical variations of the "V/R" emission-component of Balmer lines of several Be stars. A key difference between

these pictures is whether the disks are Keplerian or angular momentum-conserving - a testable prediction. This conference will present both pictures, suggest possible observational tests, investigate hybrid models combining attributes of both, and discuss the physical forces responsible for their characteristics. An important contribution to the conference will be a summary of the results of IR observations (ISO, SIRTF) of Be disks.

5. Interacting Be Binary Stars

Be interacting binary systems generally are members of two groups, Algol- related and Be X-Ray Binaries (XRBeBs). Each of these represents a different evolutionary stage of the mass-exchange/loss process in these systems. Somewhere between these stages a Type II supernova can be produced. Several high energy studies have shown that high temperature accretion regions occur as the result of mass flow between these stars. Similar types of structures have been searched for in BeXRB systems with interestingly different results. This meeting will be the first to examine the results of searches since the last few episodes of the IUE mission, when many such searches were carried out. The conference SOC will ask that typical parameter spaces of the mass- transfer, energy-release processes be compared for these two types of binary systems. The conference participants will be invited to suggest observations with new X-ray satellites with enhanced spectral capability, broad energy range and large effective aperture (ASCA, RXTE, BeppoSax, AXAF) to search for the elusive (but supposedly frequent) Be-white dwarf systems.

Conclusions

Be stars as a group, and even individually, display a large variety of physical processes and therefore require a complex array of observational approaches to understand them. Within about two years we can hope for a "considered" assessment of what has been learned from UV (IUE) data. The Be community will be intensively engaged in research in the X-ray and IR regimes. The UV data have so far led to a picture of sudden violent mass ejections from the Be star's surface. A new generation of X-ray and IR missions is now poised to provide us with new insights into the physics of Be star disks. The Alicante conference stands at a historical crossroads of these space-borne missions, the consolidation of results by one, and a guide for future work by the other. The Spanish venue of this conference is appropriate as this country has undertaken to fully exploit its Canary island observing sites and to expand its already substantial contributions in variable star astronomy.

Myron Smith (SOC Chair)
msmith@nebula.gsfc.nasa.gov

3. CONTRIBUTIONS

3.1. Mu Cen: the ticking and ringing of a star

Th. Rivinius[1], D. Baade[2], S. Štefl[3], O. Stahl[1], B. Wolf[1], and A. Kaufer[1]
[1] Landessternwarte Heidelberg, Königstuhl, D-69117 Heidelberg, Germany, e-mail: T.Rivinius@lsw.uni-heidelberg.de
[2] European Southern Observatory, Karl-Schwarzschild-Str. 2, D-85748 Garching b. München, Germany, e-mail: dbaade@eso.org
[3] Astronomical Institute, Academy of Sciences, CZ-251 65 Ondřejov, Czech Republic, e-mail: sstefl@sunstel.asu.cas.cz
Received: 1997 November 28

Introduction

In the most recent issue of the Be Star Newsletter, we published a prediction of the circumstellar activity of the Be star μ Cen (Rivinius et al. 1997), which in this regard is one of the most prolific stars of its kind. It not only exhibits low- and high-order line profile variability (Baade, 1984) as most other Be stars, but also *apparently* random and frequent line-emission outbursts (e.g. Baade et al. 1988, Hanuschik et al. 1993, Peters 1995). A link between both phenomena could not so far be established. But it now seems as if at least in μ Cen part of this secret could be lifted.

Photospheric lpv

Our time series analysis, based on the overall radial velocities of mostly emission-free lines, revealed six coherent periods (Rivinius et al. 1998a, Rivinius et al. 1998b [Paper I], Rivinius et al. 1998c [Paper II]). These periods are sorted in two closely spaced groups at 0.28 and 0.5 days, respectively (Table 1). The trustworthiness of this analysis is intensively discussed in Paper II. A 2-dimensional time series analysis was performed on more than 20 spectral lines not only to confirm the multiperiodicity but to derive the properties of either variability. In each group, the periods are associated with identical surface variability patterns, whereas these patterns differ between the groups.

	Period $\mathcal{P}$ [days]	Phase ϕ at MJD 50 000	Amplitude A [km s^{-1}]
$\mathcal{P}_1$	0.502925 ± 0.000006	0.897 ± 0.010	14.3 ± 1.0
$\mathcal{P}_2$	0.507519 ± 0.000009	0.150 ± 0.016	8.4 ± 0.9
$\mathcal{P}_3$	0.494523 ± 0.000011	0.646 ± 0.019	5.8 ± 0.7
$\mathcal{P}_4$	0.516358 ± 0.000015	0.922 ± 0.022	4.8 ± 0.7
$\mathcal{P}_5$	0.281405 ± 0.000005	0.850 ± 0.017	7.6 ± 0.7
$\mathcal{P}_6$	0.279137 ± 0.000008	0.425 ± 0.032	3.3 ± 0.7

TABLE 1. Parameters for the sine fits of the radial velocity variation in the line cores of He I $\lambda\lambda$4121,4168,4438, i.e., the amplitudes given are *not* the physical pulsation amplitudes.

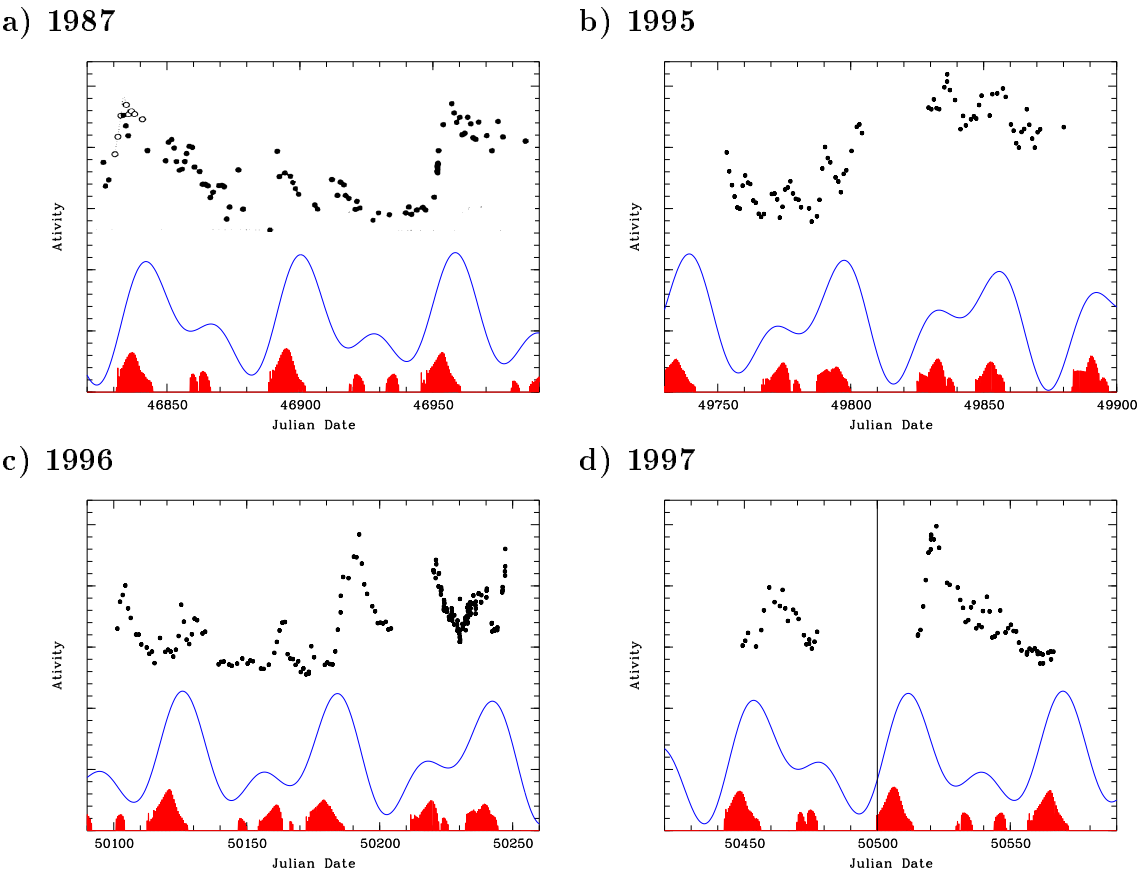


FIGURE 1. The measured strength of the broad wings of the Hδ line (dots), the co-added amplitudes of the 0.5-day group of periods (line) and the calculated mass ejection (filled areas). The 1995, 1996 and 1997 data are the strengths of the broad emission wings measured in Hδ. For 1987 the Hα equivalent width measured by Hanuschik et al. (1993) is shown. Line emission outbursts start when the co-added radial velocity amplitude is maximal. Note that the uncertainity of the periods can cause shifts of up to ten days for the 1987 calculation. However the temporal pattern of the outburst sequence is much more stable against errors of the periods. The vertical line in panel d marks the submission date of the prediction of the 1997 activity (Rivinius et al. 1997)

Constructing the ephemeris

Working on the datasets available in 1996 November, we noticed that the typical recurrence times of outbursts is on the same order of magnitude as the beat period of the two strongest variations of the 0.5-day group. A first check using only these two periods showed some, albeit weak, coincidence between outbursts and constructive interference of the two sinewaves by which we have approximated the measured radial velicoity variations. By taking into account all periods of the 0.5-day group (Table 1) and developing an appropriate criterion for the determination of the beginning of an outburst in a way that is independent of the strength of the persistent disk emission, we could improve the correlation quite considerably (Fig. 1, panels b and c). As far as we can see, the 0.28-day group of periods does not significantly contribute to the

outbursts. This indicates on the one hand that interference of variabilities with different surface patterns is much less effective. On the other hand, interferences within the 0.28-day group probably do not reach the amplitude threshold which apparently needs to be exceeded for an outburst.

In a sense, we have been extraordinarily lucky that only few combinations of variabilities are strong enough to trigger outbursts, namely $\mathcal{P}_1 + \mathcal{P}_2$, $\mathcal{P}_1 + \mathcal{P}_3$ and $\mathcal{P}_2 + \mathcal{P}_3$, the latter beeing already so weak that it induces only minor activity. With a lower threshold, we might have lost the possibility to recognize individual events. Furthermore, the initially very weak emission from the disk has also helped a lot.

In an experimental model, we calculated the amount of ejected mass by

1. allowing the amplitudes of all individual modes to grow
2. defining an outburst threshold for the vectorial amplitude sum
3. damping the amplitudes and ejecting mass so long as the threshold was exceeded.

The accuracy of the periods derived allowed us to perform an independent check to be performed with the data obtained by Hanuschik et al. (1993) back in 1987, using the same parameters as derived from the 1995 and 1996 data. The quite successful match between observations and model is shown in Panel a of Fig. 1. Also the outburst event reported by Peters (1995) between April 1 and 5, 1994 coincides with a positive amplitude interference.

After reduction of our 1997 January data, the model turned out to still work well (Fig. 1, left half of panel d). But the ESO 50-cm telescope, with which our observations were mainly taken, was already earmarked for mothballing after 1997, March. Accordingly, further verification of the model from own observations would have become difficult. For this reason, and encouraged by the positive experience with the 1987 and 1997 datasets, we decided to submit our prediction of the activity and a request for help with the confirmation of the prediction already in February 1997, although the analysis of the data was still in an intermediate working stage. We are grateful to Michelle Thaller, Conny Aerts, and Martin Kürster for having provided us with some additional spectra. The results, also of our own observations in March (and 11 further nights with the ESO 1.5-m telescope in April) are shown on the right hand side of Panel d in Fig. 1. *The coincidence of combined radial velocity amplitude maxima and outbursts was proven for each of the predicted events on MJD 50 515 and MJD 50 540.* Even the double structure of the latter event predicted by the preliminary model with sub-peaks on MJD 50 435 and MJD 50 447 was detected. Unfortunately our campaign ended just before an expected second major event.

In spite of the success of predicting the times of increases of the line emission from the beating of the radial velocity curves, we will nevertheless have to revise our preliminary (and as of yet completely unphysical) model of mass ejection. Although the structure of the bursting pattern is now reproduced in quite some detail, the calculated times of the onset of the mass ejection are for larger outburts systematically

too early (compared to the times when the line emission actually rises). Because the O-C values do not increase with time, this only shows that without a physical model the outburst mechanism cannot be properly understood.

We wish to thank again Michelle Thaller, Conny Aerts and Martin Kürster and all HEROS observers for their observational efforts to check our prediction.

We will keep the readers of the Newsletter informed by submitting the abstracts of newly finished papers, starting with the abstract of Paper I in this issue. Our publications are also available on the web at URL
`http://www.lsw.uni-heidelberg.de/~triviniu/Bestars.html`
as soon as they have been accepted (refereed journal articles) or submitted (proceeding and newsletter contributions).

References

Baade D. 1984, A&A, 135, 101
Baade D., Dachs J., van de Weygaert R., Steeman F. 1988, A&A, 198, 211
Hanuschik R.W., Dachs J., Baudzus M., Thimm G. 1993, A&A, 274, 356
Peters G.J. 1995, In: Strassmeier, K.G. (ed.), Stellar surface structure, IAU Symp 176, poster proceedings, Vienna, p. 212
Rivinius Th., Štefl S., Baade D., Stahl O., Wolf B., Kaufer A., 1997, Be Star Newsletter 32, 14
Rivinius Th., Baade D., Štefl S., Stahl O., Wolf B., Kaufer A. 1998a, In: Bradley P.A. and Guzik J.A. (eds.), A Half Century of Stellar Pulsation Interpretations, ASP Conf. Ser., in press
Rivinius Th., Baade D., Štefl S., Stahl O., Wolf B., Kaufer A. 1998b, A&A, 333, 125, Paper I
Rivinius Th., Baade D., Štefl S., Stahl O., Wolf B., Kaufer A. 1998c, to be submitted to A&A, Paper II

3.2. A Multi-Wavelength Campaign on Gamma Cas. II. Circumstellar Structures Inferred from Ultraviolet Continuum and Si IV Line Variations

Myron A. Smith
CSC/STScI
3700 San Martin Drive
Baltimore, MD 21218
msmith@nebula.gsfc.nasa.gov
Received: 1998 March 1

This is the third report appearing in these newsletters of a optical/UV/X-ray campaign carried out on the prototypical B0.5e star γ Cas about two years ago. The thrust of the first part of our work was to show that the X-rays from this source can be easiest understood as originating from near the surface of the Be star itself, with no hypothetical companion needed (Paper I). Below we argue that magnetospheric lobes exist over the star. The work described in the former and current report have been submitted to the ApJ for publication and is currently in the refereeing process. The authors of this Paper II are Smith, R. Robinson, and A. Hatzes. If further

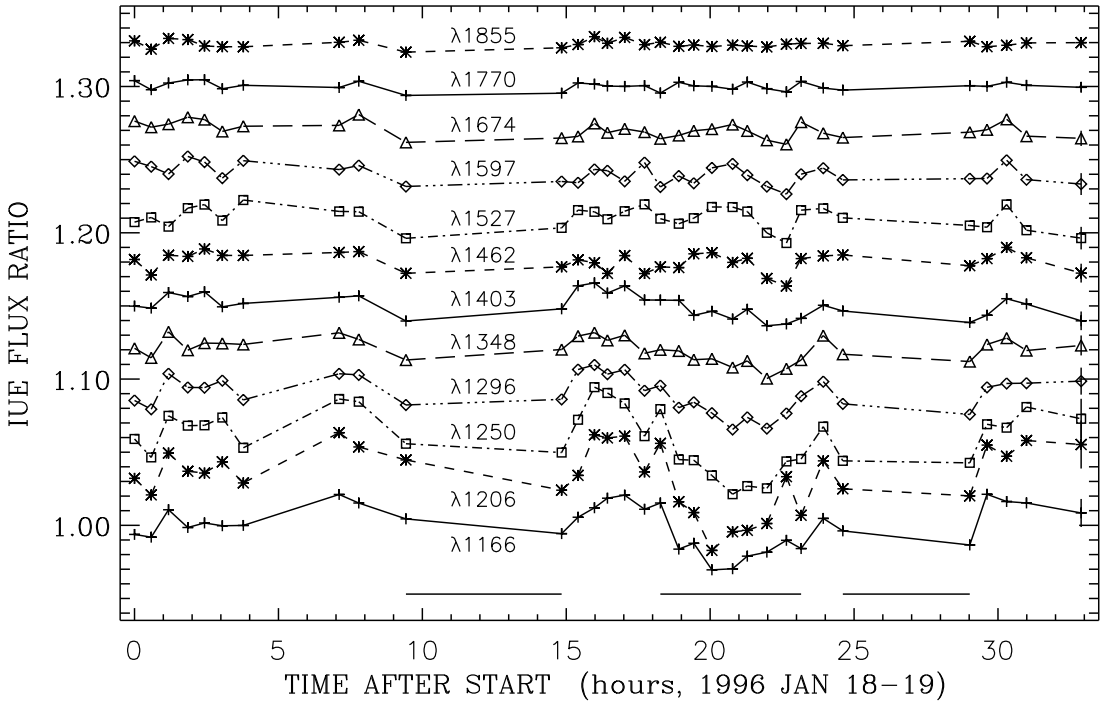


FIGURE 1. Flux ratio curves as a function of wavelength for γ Cas, taken during 1996 Jan. 18-19 (zero pts. arbitrary).

interested, you may also consult a Web site of a press release on this subject at: http://oposite.stsci.edu/pubinfo/pr/1998/07/pr.html. An article for *Mercury* magazine is further planned for later this year.

Simultaneous X-ray and UV observations over a full day on 14–15 March 1996 have been made of γ Cas using the *RXTE* satellite and the *Goddard High Resolution Spectrograph (GHRS)* on board the *Hubble Space Telescope*. The *GHRS* spectra, taken in the region of the Si IV $\lambda\lambda$1394–1403 doublet, also permitted the construction of a light curve from a nearby "pseudo-continuum" region. The continuum UV and X-ray light curves from this effort reveal a pair of X-ray maxima $\sim$10 hours apart which coincide in time with UV continuum flux "dips" of 1%. In Paper I of this series we attributed the UV dip features to magnetic activity sites on the star's surface which undergo rotational modulation (RM) on a $\sim$1.125 day period. In the current study we find that flux and color curves generated from a 33-hour sequence of *IUE* echellograms obtained in January 1996 display dip features similar to those in the *GHRS* data. Comparing the timings of the continuum flux dips and the Si IV line strength variations in both the *GHRS* and *IUE* datasets gives a slightly revised period of 1.123 days for both the UV and X-ray activities. This strengthens the argument that high-energy activity on γ Cas over is modulated by rotation of long-lived structures close to its surface.

Analysis of pseudo-continuum high-quality, monochromatic light curve constructed from the *GHRS* spectra and lower quality color curves constructed from the *IUE*

echellograms over a broad range of wavelengths shows at least two surprising characteristics for the flux dips: (1) the dips last only ∼0.3 cycles. This duration is too brief for rotational modulation of surface features, and (2) their amplitudes increase from long to short wavelengths, attaining a maximum near λ1206. The *IUE* color curves are shown as Figure 1.

The character of the variations of the photospheric Si IV line profiles is also unexpected in that the profile fluctuations do not correlate with the slow undulations of the continuum flux. Moreover, the profile variations do not show an expected blue-to-red migration of microfeatures. Except for an interval when they showed a pair of general weakenings and strengthenings, the photospheric Si IV line profiles do not show clear patterns. During this same interval these variations showed a correlated time-lag as one samples fluxes redward across the line profile. We suggest that these amorphous variations are not caused on the surface but rather by wind inhomogeneities from active regions on the star impacting at the inner edge of the star's circumstellar disk.

We have modeled the attenuation of flux with wavelength due to an occulting "cloud" which transits γ Cas with Hubeny's suite of "CIRCUS/SYNSPEC" model atmosphere program. The result of these simulations is shown in Figure 2. The solid lines in this figure depict the flux attenuations caused by three models a cloud having a temperature of 9000K, 7000K, or 5000K. The uncertainties in the observed amplitudes at various wavelengths (triangles) decrease from about the size of the symbol at short wavelengths to about half the size at long wavelengths.

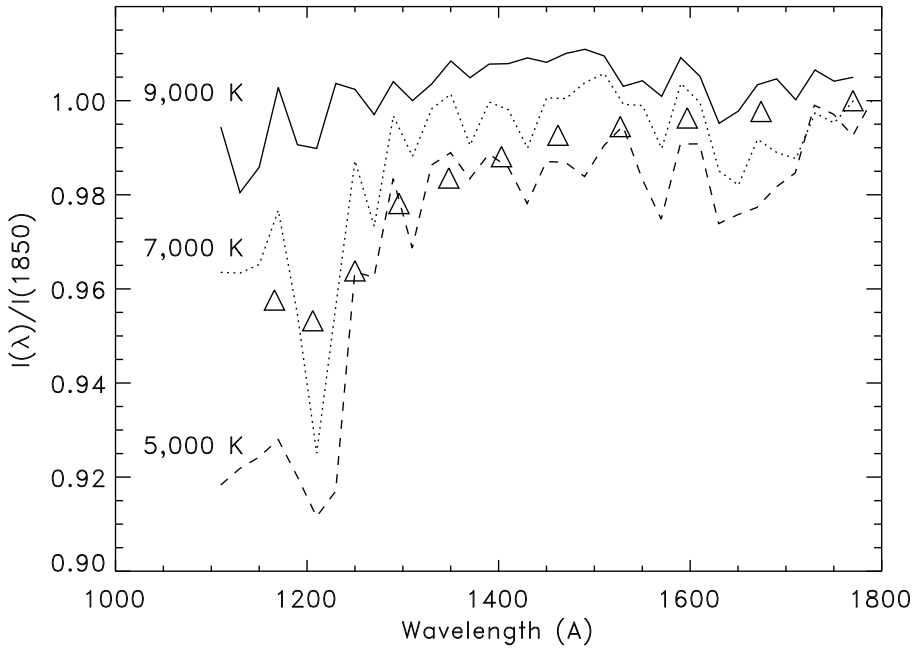


FIGURE 2. Comparison of observed vs. theoretical line-blanketed color variations for a cool occulting cloud.

We interpret the monotonically increasing absorption toward short wavelengths, as being due to the strength of a strong Lyman α line which can occur only in a cool,

essentially recombined, gas. Such cool gas might co-exist near a hot source like a B0.5 star in the presence of thermal instabilities, similar to those occurring in active coronal canopies of cool stars; these are fed from the surface by a nonthermal energy sources.

Finally, assuming a tilt of the rotational axis of 45^o to the observer's line of sight from optical interferometry, our model simulations of the two major dips in the UV light curves (see our last report) indicate that the clouds have radii of a few tenths of a stellar radius and are attached to points on the surface at low- to mid-latitudes on the near hemisphere. In all, these results support Paper I's conclusion that γ Cas is a member of a small group of OB stars which have magnetospheres associated with X-ray activity.

3.3. Stellar wind variability of the Be star FY CMa

Huilai Cao[1,2] and Joachim Dachs[2]
Beijing Astronomical Observatory, Beijing, China[1]
Astronomisches Institut der Ruhr–Universtät, D–44780, Bochum, Germany[2]
Received: 1998 January 29

ABSTRACT: Unusual activity connected with infalling mass motions was recorded for the B0.5 IVe star FY CMa in February 1987 both from archival IUE spectrograms of circumstellar N V resonance lines and from optical spectra of Hα emission and He I λ5876Å lines showing inverse P Cygni–type profiles. We estimate the mass loss rate, $\dot{M}$ to be about 4.1 $\times$ 10^{-9}M$_\odot$ yr^{-1} for a spherically symmetric wind. If we assume instead conical shape for the wind, for a cone half angle of $\sim 30°$, $\dot{M} \approx 3.4 \times 10^{-10}M_\odot$ yr^{-1}, or $\dot{M} \approx 2.2 \times 10^{15}$ gm s^{-1}. We attempt to give a qualitatively explanation of activity observed for FY CMa in term of circumstellar matter raining down to the star.

Introduction

Since 1949, the spectrum of the Be star FY CMa (HR 2855, HD 58978, MWC 179, B0.5 IVe, $v \sin i \sim 280$ km s^{-1}) has changed quite often. Merrill & Burwell (1949) noted that the hydrogen emission lines in the photographic region had disappeared. Burbidge & Burbidge (1954) reported that this object showed double emission lines at Hβ and Hγ with $R/V > 1$, the Balmer lines from H9 onward appeared as absorption only. Occasional optical studies of Balmer emission lines profiles obtained for this star at moderate resolution (1–2Å at Hα) between 1981–1983 showed FY CMa to be in a rather stable state of optical emission–lines formation in its circumstellar disk (Dachs et al. 1986), while a number of high–resolution IUE spectrograms obtained for the star since 1981 demonstrated strong variations of fine structure of C IV, Si IV and N V resonance absorption doublets, indicating variable mass loss (Grady et al. 1987).

In the present work we once more want to draw attention to the fact that FY CMa was observed in a state of unusually high activity of mass–loss variations during early–1987, as already noted by Peters (1988) and by Grady et al. (1988), and that these mass–loss variation were accompanied by strong infalling motions of circumstellar

matter in front of the star, simultaneously visible in ultraviolet N V resonance absorption line profiles and in an optical He I λ5876Å inverse P Cygni–type line profile obtained by Dachs et al. (1992).

Data Obtained and Reduction

Six high resolution ($\lambda/\delta\lambda \sim 10^4$) ultraviolet spectra obtained between 1981 and 1987 by the International Ultraviolet Explorer (IUE) spacecraft were provided by the archives of the ESA Vilspa Data Center at the ESA Satellite Tracking Station at Villafrance del Castillo, Spain.

Two high quality optical spectra of Hα and He I λ5876Å were measured with the ESO Coudé Echelle Spectrometer fed by the 1.4 m Coudé Auxiliary Telescope at La Silla, Chile. The instrumentation full width at half maximum (FWHM) measured in the thorium lamp comparison spectrum corresponds to a spectral resolution of 76 mÅ at either wavelength. These high–resolution optical spectrograms were supplemented by a total of 11 medium–resolution Hαemission line–profiles obtained for the star between 1981 and 1987 by various observers of the University of Bochum at the 61–cm telescope at ESO La Silla, using the University of Bochum scanner spectrometer at 1 to 2 Å resolution, as described by Dachs et al.(1986). Both for IUE spectrograms and for optical spectrograms obtained at ESO, reductions were performed bymeans of IHAP and MIDAS image processing software systems provided by ESO. Radial velocities were first calculated in the heliocentric system, and then further corrected by subtracting the radial velocity of the star listed in the Bright Star Catalogue, $V_{\rm rad} = +25$ km s^{-1}, in order to obtain velocities in the stellar reference frame. Typical mass–loss rates implied for FY CMa by the Si IV profiles were determined by employing the method used by Snow (1981). For the ion number density fraction in the wind, N(Si IV)/N(H) = 3.5 $\times$ 10^{-5} was adopted.

Morphology of Stellar Wind Variations

Asymmetric ultraviolet resonance doublet line profiles showing stellar wind absorption were inspected on six selected IUE spectrograms obtained in 1981 (SWP 15053, 15478), 1982 (SWP 15933, 15979) and 1987 (SWP 30183, 30392). Wavelength regions corresponding to N V (λ1235–47 Å) and to C IV absorption (λ1539–58 Å) are plotted in Fig. 1, while Si IV doublet regions (λ1384–1412 Å) are drawn in Fig. 2. As judged from equivalent widths and asymmetries of C IV, N V and Si IV absorption profiles, stellar wind in FY CMa is very strong, by comparison to other Be stars of similar spectral types, as noted by Grady et al. (1987). While no large variations are seen in the Si IV profiles recorded between 1981 and 1987 (Fig. 2), dramatic variations occurred in the C IV and in particular, in the N V profiles (Fig. 1). Especially N V profiles are characterized by broad flat bottom absorption troughs in 1981 September and November, while multiple discrete absorption components located at about –30 and –450 km s^{-1}, dominate N V profiles recorded both in 1982 January and in 1987 January (day 28). By contrast, one month after the 1987 January spectrum had been taken, in 1987 February 26 (day 57), N V and also C IV absorption profiles are distinctly different, showing evidence for simultaneous presence of outflowing and inflowing motions, most probably occurring in adjacent regions of the visible circumstellar hemisphere in front of FY CMa. While outflow is observed at N V extending from about –250 to at least –540 km s^{-1}and at C IV from about –175

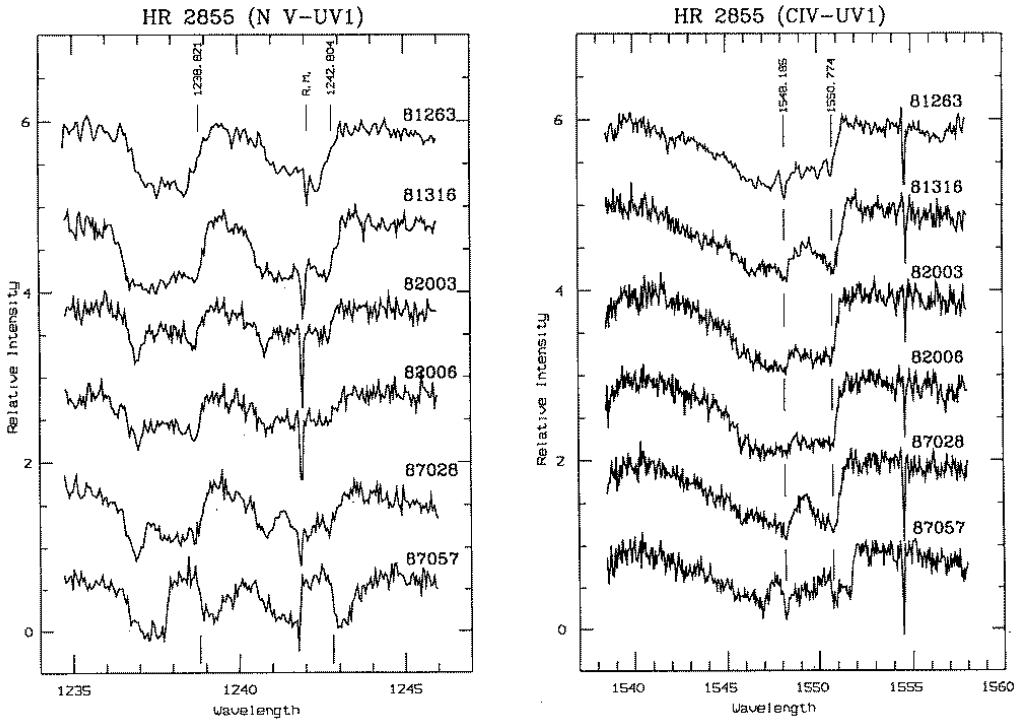


FIGURE 1. The spectral variations of FY CMa in resonance doublet lines N V and C IV of the high resolution IUE spectra.

km s^{-1}to around –1500 km s^{-1}, inflow is visible both in C IV and N V at velocities extending from about 0 to +200 km s^{-1}.

It is interesting to note that infalling motion in about the same velocity range was also clearly visible in an optical He I λ5876Å profile of the star showing inverse P Cygni–type structure (Fig. 3), as obtained already on 1987 February 12 (day 43) and described earlier by Dachs et al. (1992). The sequence of the optical He I λ5876Å profile taken 1987–43 and the ultraviolet N V λ1239Å profile measured 1987–57 point to an extended phase of infalling motions of highly excited plasma (at electron temperature T $\geq 10^5$ K) from the circumstellar envelope of the Be star raining down to the stellar surface and lasting at least 14 days (Grady et al. 1988). In many other IUE spectrograms of this star, absorption by infalling matter can be detected at similar velocities ranging between +30 and +100 km s^{-1}from transitions of ions in lower–ionization states, e.g. from Si III–UV1 λ1892.0Å, Si III–UV4 $\lambda\lambda$1299.0, 1303.3Å or Fe III–UV34 in λ1895.5Å, pointing to infall of relatively cool plasma. This can be seen, e.g. 1982 January or, as noted by Grady et al. (1988), in 1987 May. Terminal velocities of the expanding wind flows read from the profiles average around –950 km s^{-1}for the Si IV ion and approximate –1450 km s^{-1}for C IV. Available medium–resolution Hαemission–line profiles collected between 1981 and 1987 usually indicate double–peak structure of the emission, with violet–to–red peak intensity ratios varying between $V/R \approx 1.02$ and 1.14. Equivalent widths of Hαline emission recorded range between $W_e = -7.3$ Å measured on 1985 April 07 (R. Hanuschik, unpublished) and –14.5 Å found in 1981 November–December (Dachs et al. 1986).

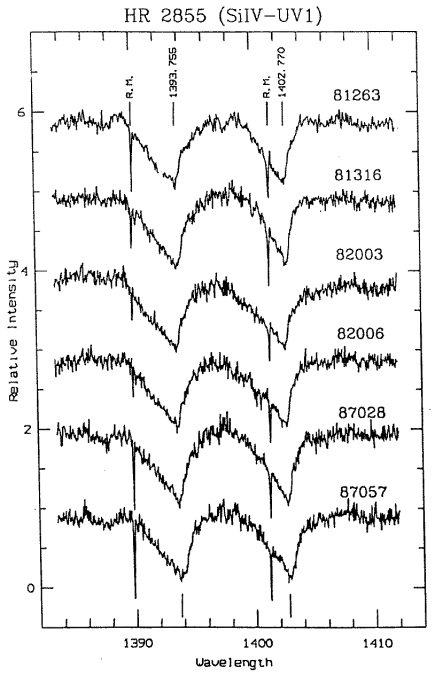


FIGURE 2. Circumstellar doublet lines Si IV $\lambda\lambda$ 1393.755,1402.770Å had no obvious variation during Jan.28–Feb.26, 1987.

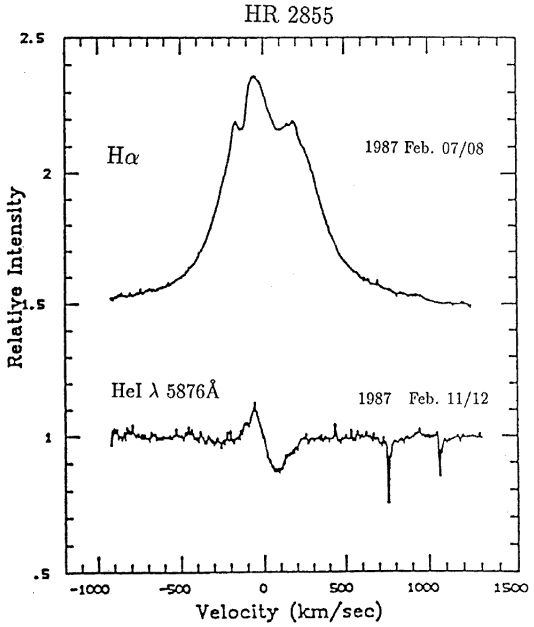


FIGURE 3. Infalling motion in the circumstellar gas surrounding FY CMa is indicated by the inverse P Cygni profile shown by the He I λ5876Å line measured 1987 Feb. 11/12.

Discussion

The ultraviolet and optical observations clearly show that an abrupt change observed in the circumstellar region around FY CMa involved the simultaneous presence of both infall and outflow of material (Peters 1988). The data which we collected showed that this activity sustained at least 30 days. Combining our observation with Peters data it can be estimated that this activity persisted more than 3 months. Similar sudden spectral variations have been seen in pre–main sequence objects in which accretion of matter is occurring, but such bursts of activity have rarely been observed in classical Be stars.

A more plausible explanation of the abrupt activity is probably a sudden accretion event in the circumstellar envelope, as evidence for infall of matter is clearly seen in several species of moderate ionization. Such spectral change could be due to magnetic activity, i.e. magnetic flares or loops. FY CMa perhaps has large magnetic loops or jets with a flow of material that originates near one of the poles and falling down upon the star in the line of sight. In this case the line profile presents strong blue shift with inverse P Cygni–type feature.

References

Baade, D., Dachs, J., Weygaert, R. van de, & Steemann, F. 1989, A&A, 198, 211
Burbidge E. M., & Burbidge G. R. 1954, ApJ, 119, 496
Dachs, J., Hanuschik, R., Kaiser, D., et al. 1986 A&AS, 63, 87
Dachs, J., Hummel, W., & Hanuschik, R. 1992, A&AS, 95, 437
Grady, C. A., Bjorkman, K. S., & Snow, T. P. 1987, ApJ, 320, 376
Grady, C. A., Bjorkman, K. S., Peters, G. J., & Henrichs, H. F. 1988, in A Decade of UV Astronomy with IUE, ESA–SP 281, Vol. 1, 257
Merrill, P. W., & Burwell, C. G. 1949, Ap. J. 110, 387
Peters, G. J. 1988, ApJ, 331, L33
Snow, T. P. 1981, Ap. J. 251, 139

3.4. Energy Crisis in Be star Radiation Emission?

Krishna M. V. Apparao
Department of Physics, University of Bombay
Santa Cruz East, Mumbai 400098, India

Received: 1998 May 12

This note is an attempt to draw the attention of the Be star community to the problem of energetically accounting for the Hα and infrared radiation from Be stars.

It is generally agreed that the emission lines observed from Be stars arise from the gas envelope around it. It is presumed that the ionization of the envelope is by the Lyman continuum from the Be stars. The ionized gas in the envelope is also considered responsible for the infrared excess observed. Some attempts have been made to quantitatively account for the Hα and infrared radiations from the disk (Hoflich 1988; Waters, Cote, and Lamers 1987; Kastner and Mazzali 1989; Kerkwijk, Waters and Marlborough 1994). Hoflich considered a model in which the gas envelope is an extension of the atmosphere of the Be star and spherical symmetry is assumed. He was able to reproduce the Hα equivalent widths by considering Balmer continuum

absorption in addition to the Lyman continuum absorption. However, the spherical symmetry assumed is clearly not tenable in view of several observations. Waters, Cote, and Lamers (1987), Kastner and Mazzali (1989), and Kerkwijk, Waters, and Marlborough (1995) on the other hand assume a temperature throughout the envelope considered, in order to account for the Hα and infrared radiation. It needs to be shown that the assumed temperature can occur throughout the envelope due to the absorption of radiation from the Be star, before the results can be accepted.

We have been examining the energetics of Hα and infrared radiation from Be stars by considering the absorption of all the ionizing radiation from the Be star; this should give the maximum possible ionization by the radiation (Apparao and Tarafdar 1987; 1997a; 1997b). We have assumed the Lyman and Balmer continua given by atmospheric calculations of Kurucz (1979) for various spectral types of Be stars and considered their absorption for ionizing the Be star envelope. In the first publication we have calculated the energy in the Hα emission due to the absorption of Lyman and Balmer continua from the Be stars, and compared the results with observations. We found that the observations can be accounted for Be star spectral types up to B5 (see Table 1); the emission from later spectral types cannot be accounted for by the above process. We had suggested the need for additional ionizing photons.

TABLE 1 – Hα Emission (HII Region formed by Be and He stars)

Spectral Type	Temperature (K)	Lyman (erg s^{-1})	Balmer (erg s^{-1})	Observed * (erg s^{-1})
B1.....	25000	8.2E+32	2.7E+34	2.5E+34
B3.....	20000	2.4E+32	5.8E+32	4.0E+33
B5.....	16000	3.6E+30	8.3E+30	8.0E+32
B8.....	13000	7.0E+28	1.7E+29	5.0E+32
He.....	50000	9.9E+32	2.5E+33	...
He.....	70000	3.7E+34	8.0E+34	...

* The values given are the maximum observed values.

In Apparao and Tarafdar (1997a) we suggested that in the case of late type Be stars, a He star binary companion to the Be star can supply the necessary ionizing photons (see Table 1). We had shown that the He star will not visible in the glare of the Be star optical emission. This will imply that all the late type Be stars which are observed to emit Hα emission have a He star binary companion, and for those without a He star companion, though having a gas envelope, Hα emission will not be detected. Some of the other consequences of our suggestion are given in the paper.

We have examined whether the observed infrared excess for Be stars (these considerations do not pertain to B[e] stars, where the infrared emission is believed to occur from heated dust) can be accounted for by free-free emission by the gas envelope ionized by the Lyman continuum of the Be star (Apparao and Tarafdar 1997b). The calculated values and the observed values are given in Table 2.

TABLE 2 – Infrared Emission (HII Region around Be Stars)

Spectral Type	IR from Calculation (ergs s^{-1})	IR from Observation [a] (ergs s^{-1})
09.5 ...	7.2E+36	1.0E+36 [b]
B1.....	8.4E+34	2.4E+36
B3.....	2.5E+33	1.9E+35
B5.....	3.9E+32	1.0E+35
B8.....	8.7E+30	1.9E+34

[a] Highest values observed for the spectral type (Ashok et al. 1984).
[b] Observed value for X Per, when not peak emission (Roche et al. 1993).

It is seen from Table 2 that the infrared emission calculated from the absorption of the Lyman continuum is inadequate to account for the observed infrared emission from Be stars of spectral types of B1 and later. In the case of spectral types greater than B4, the energy in the Lyman continuum itself is smaller than that in the observed infrared radiation.

How then the infrared emission is energized? We had considered two possibilities: 1) Be stars emit a Lyman continuum more copiously than given by the atmospheric calculations of Kurucz (1979), or 2) additional ionizing photons are supplied by a companion star to the Be star (He star, white dwarf, or neutron star).

Observations of the star Epsilon CMa (Cassinelli et al. 1995) by the EUVE Satellite has shown that the EUV flux is about thirty times the flux given by atmospheric calculations. Modifications of the atmospheric calculations could not explain the observations so far and the origin of this flux remains obscure. However, the possibility exists that B and Be stars emit EUV flux more copiously than given by the atmospheric calculations. If this is true, then the observed infrared and Hα fluxes for Be stars (at least for the early spectral types) can be accounted for energetically. However, the problem still remains for the late spectral types.

The required ionizing photons to account for the infrared and Hα fluxes from Be stars can easily be supplied by the presence of a compact object (He star, white dwarf, or neutron star) in binary motion around the Be star. The formation of such binaries was discussed by Pols et al. (1991). The surface temperature of the He star is high enough to supply the requisite photons (Apparao and Tarafdar 1997a). If the compact object is a white dwarf or neutron star, matter accretion is needed to give out ionizing photons. The presence of a neutron star is indicated by an X-ray flux, but the presence of a white dwarf star is difficult to detect due to absorption of the radiation by the Be star envelope itself (Apparao 1991). The detection of white dwarf and He stars in the far and extreme UV is discussed in Apparao and Tarafdar (1997a; 1997b). As mentioned earlier, the presence of a He star will be difficult to detect in the visible region due to the brightness of the Be star.

There is enough energy in the Balmer continuum of Be stars to account for the observed infrared and Hα emissions. However, a process by which the energy can be utilized to provide the necessary ionization has not been found yet.

The suggestion that the ionizing photons to account for the infrared and Hα emissions come from a compact object implies that all the Be stars, at least the later spectral

types, are binaries. Even though this is a possibility considered earlier by other authors (e.g. Harmanec 1982), there is no evidence to support this contention.

We suggest that at present the accounting for the energy needed for infrared and Hα emissions of Be stars is not done adequately. Further observations and theoretical work are needed to give an answer.

Acknowledgments: I thank the Indian National Science Academy for a Senior Scientist Fellowship. I thank the Director of Tata Institute of Fundamental Research for use of the library and other facilities. I thank Prof. S. B. Patel and other colleagues at the Bombay University.

References

Apparao, K.M.V., and Tarafdar, S.P., 1987, ApJ, 322, 976
Apparao, K.M.V., and Tarafdar, S.P., 1997a, Bull.Astr.Soc.Ind., 25, 345
Apparao, K.M.V., and Tarafdar, S.P., 1997b, J. Astrophys.Astr., 18, 145
Ashok, N.M. et al., 1984 MNRAS, 211, 471
Cassinelli, J.P., et al., 1995, ApJ, 438, 932
Harmanec, P., 1987, IAU Colloquium no. 92, 339
Hoflich, P., 1988, A&A, 176, 93
Kastner, J.H., and Mazzali, P.A., 1989, A&A, 210, 295
Kurucz, R.L., 1979, ApJS. 40, 1
Pols, O.R., Cote, J., Waters, L.B.F.M., and Heise, J., 1991, A&A, 241, 419.
van Kerkwijk, M.H., Waters, L.B.F.M., and Marlborough, J.M., 1994. A&A, 300, 259
Waters, L.B.F.M., Cote, J., and Lamers, H.G.J.L.M., 1987, A&A,185, 206

4. WHAT'S HAPPENING?

4.1. Discovery of periodic brightenings in the B variable HD 6226

Petr Harmanec
Astronomical Institute, Academy of Sciences of the Czech Republic
251 65 Ondřejov, Czech Republic. e-mail: hec@sunstel.asu.cas.cz
Received: 1997 July 21

Hrvoje Bozic and I have published in A&A (1998, A&A, 330, 222) a short paper in which we report our discovery of a little studied B variable HD 6226 for which we found occasional, and possibly regular brightenings for about 0.2 mag. in V. We suspect that the brightenings could re-appear with a period of 481 d, and I decided to alert readers after I realized that if we are right, the next brightening should occur literary these days, centred on 1997 August 2. You can get a postscript copy of our paper from anonymous ftp to sunstel.asu.cas.cz (147.231.104.100) directory pub/hd6226.

4.2. A Painting of the Be + sdO Binary Phi Persei

Douglas R. Gies
Center for High Angular Resolution Astronomy and Department of Physics and Astronomy
Georgia State University, Atlanta, GA 30303, e-mail: gies@chara.gsu.edu
Received: 1998 February 2

A recent issue of ApJ (Gies et al. 1998, ApJ, 493, 440) contains our report on new UV spectroscopy made with the *Hubble Space Telescope* and Goddard High Resolution Spectrograph of the unusual binary system, Phi Persei. This system contains a rapidly rotating Be star orbiting a hitherto unseen companion in a 127 day orbit. The new HST/GHRS spectra show for the first time clear evidence of the companion's spectrum: it is a hot (53000 K), small star (1 $M_\odot$) which is presumably the stripped-down remains of a much more massive star which lost both mass and angular momentum to the companion (which is spinning at close to the critical break-up speed). The new results are important for several reasons:

- This is the first time we have actually observed this stage in massive star binary evolution.
- The observations demonstrate that rapidly spinning Be stars can be formed through binary processes.
- The companion (a hot subdwarf) represents the brightest such object in the sky (but hitherto lost in the glare of the Be star).

The Outreach Office of the Space Telescope Science Institute was interested in making a WWW News Release about this work, but we needed some kind of image to accompany the text. I contacted Bill Pounds, an astronomical artist living here in the Atlanta, and with the help of Jon Bjorkman (University of Toledo) and others, Bill produced a beautiful and, hopefully, accurate rendering of what Phi Persei might look like close up. The painting and press release are available on the WWW at URL `http://oposite.stsci.edu/pubinfo/pr/97/39.html`, and the painting graces the cover of this issue of the *Be Star Newsletter*.

The painting depicts the binary system for an assumed inclination of 80° and an orbital phase just prior to primary superior conjunction. The Be primary (*upper right*) appears oblate and gravity darkened because of its extremely fast rotation ($V \sin i$ = 450 km s^{-1}). The surrounding circumstellar disk was made assuming a Gaussian intensity distribution based on interferometric measurements Quirrenbach et al. 1997, ApJ, 479, 477) and the *Hipparcos* distance estimate (220 pc), and the red colour reflects the dominance of the Hα flux. The inner edge of the disk facing the companion has a brighter appearance because we believe it is heated there by the secondary (observed in the appearance of Fe IV shell lines in the *HST* spectra at this orbital phase). The hot subdwarf secondary appears in the foreground (*lower left*) with radial features suggesting its strong stellar wind (see Thaller et al. 1995, ApJ, 448, 878). The secondary also has a circumstellar disk (seen in the He II λ4686 line) which we imagine results from infall from the Be star's disk.

Hopefully future interferometric observations will show how closely this painting matches the real situation.

4.3. Interferometric Results Highlighted on WWW Site

Philippe Stee
Observatoire de la Cote d'Azur, Departement Fresnel - UMR 6528, Equipe GI2T, 2130, route de l'Observatoire, Caussols, 06460 St Vallier de Thiey - France, e-mail: stee@obs-nice.fr
Received: 1998 January 21

I have assembled on my World Wide Web site a number of papers and results related to high resolution studies of hot stars. Interested readers can find the page at http://www.obs-nice.fr/stee/bienvenue.html.

4.4. Atlas of Spectropolarimetric Observations of Be Stars

Karen Bjorkman
Ritter Observatory, Department of Physics and Astronomy, University of Toledo, Toledo, OH 43606, e-mail: karen@astro.utoledo.edu
Received: 1998 January 21

We are in the process of putting together an atlas of spectropolarimetric observations of Be stars using data taken at the University of Wisconsin's Pine Bluff Observatory from 1989-94 (a second installment later will include data from 1995 onward). Part of this publication will include a web-based atlas, to allow easy access to the data by the astronomical community. Sample pages from the atlas were presented at the January, 1998, AAS meeting in Washington DC.

In order to make this atlas as useful as possible, we are soliciting feedback from potential users about the tentative layout of the web pages. If you would be interested in having a look at our sample pages, please point your Web browser to the following URL: http://www.sal.wisc.edu/HPOL/atlases/bes

Any feedback or suggestions you would care to offer would be greatly appreciated. You can send your comments via e-mail to either me (karen@astro.utoledo.edu) or to Marilyn Meade (meade@sal.wisc.edu).

Thanks for your assistance!

5. ABSTRACTS

Photometric Monitoring of Bright Be Stars. III. 1988-89 and 1992-95

John R. Percy, Jason Harlow, Katharine A.S. Hayhoe, Inese I. Ivans, Matthew Lister, Rene Plume, Tara Rosebery, Sarah Thompson, and David Yeung

Erindale College and Department of Astronomy, University of Toronto, Mississauga, Ontario, Canada L5L 1C6

We report long-term photometric (BV) observations of 23 bright, active Be stars made in 1988 and 1989 and 1992 to 1995 with the 0.4m telescope at the University of Toronto. Cumulative light curves, including observations made earlier at the University of Toronto, and with the Automatic Photometric Telescope Service in Arizona, are presented for several of the stars. Many of the stars show cyclic variations of up to 0.2 in V and B on time scales of a few years, as well as variations on time scales of about a day.

1997, PASP, 109, 1215

On the spectacular variations of γ Cas: Evidence for a temporarily tilted circumstellar disk

W. Hummel

Universitätssternwarte München, Scheinerstr. 1, D-81679 München, Germany

A new explanation for the spectacular emission line variations occuring in the Be stars γ Cas and 59 Cyg is presented. We propose a circumstellar Keplerian disk, tilted with respect to the equatorial plane. The precessing nodal and apsidal line causes a variation in the emission line widths and profile shapes. In particular the sequence of alternating shell-phases and narrow single-peak phases is proposed to be due to an apparent variation in the disk inclination.

1998, A&A, 330, 243

Long-term visual spectrophotometric behaviour of Be stars

A. Moujtahid,[1], J. Zorec[2], A.M. Hubert[1], A. Garcia[2] and D.G. Burki[3]

[1] Observatoire de Paris-Meudon, DASGAL, F-92195 Meudon Principal Cedex, France
[2] Institut d'Astrophysique de Paris, C.N.R.S. - 98^{bis}, bd. Arago, F-75014 Paris, France
[3] Observatoire de Genève, CH-1290 Sauverny, Switzerland

The long-term spectrophotometric variations of 49 Be stars are studied using the U and V magnitudes of the UBV system, the total Balmer discontinuity D and the

visible gradient $\Phi_{\rm rb}$. BCD spectrophotometric and photometric data in five different photometric systems, obtained in most cases since 1950 and reduced to the BCD system, were used. The (U, D), (V, D), $(\Phi_{\rm rb}, D)$ and $(\Phi_{\rm rb}, V)$ correlations obtained differ from star to star and they can be single or double-valued. They differ clearly for Be phases or Be-shell phases. Be stars with small $V \sin i$ showing the "spectrophotometric shell behaviour": $D > D_*$, were found. This finding implies either that strongly flattened models of circumstellar envelopes are in doubt for these stars, or that not all Be stars are rapid rotators. Comparison of observed variations with those predicted for model Be stars with spherical circumstellar envelopes of variable densities and dimensions implies that spectrophotometric patterns of Be phases are due to circumstellar envelopes in low opacity regimes, while those of spectrophotometric shell phases are due to circumstellar envelopes in high opacity regimes. In a given star, the envelope regions responsible for the observed variations of D and $\Phi_{\rm rb}$ in spectrophotometric shell phases seem to be smaller and denser than those producing the observed variations of these parameters in spectrophotometric Be phases. The high positive RV found in strong shell phases might favor the formation of compact circumstellar layers near the star.

1998, A&AS, 129, 289

The optical counterparts to Be/X-ray binaries in the Magellanic Clouds

J.B.Stevens[1], M.J.Coe[1] and D.A.H.Buckley[2]

[1] Dept. of Physics and Astronomy, University of Southampton, Highfield,
[2] South African Astronomical Observatory, P.O. Box 9, Observatory, 7935, South Africa

The fields of 8 X-ray sources in the Magellanic Clouds believed to be Be/X-ray binaries have been searched for possible Be star counterparts. BVR and Hα CCD imaging was employed to identify early type emission stars through colour indices and Hα fluxes. Follow up Hα spectroscopy of 5 sources confirms the presence of Hα emission in each case. Based on the positional coincidence of emission line objects with the X-ray sources, we identify Be star counterparts to the ROSAT sources RX J0032.9-7348, RX J0049.1-7250, RX J0054.9-7226 and RX J0101.0-7206, and to the recently discovered ASCA source AX J0051-722. We confirm the Be star nature of the counterparts to the EXOSAT source EXO0531.1-6609, and the HEAO1 source H0544-665. In the field of the ROSAT source RX J0051.8-7231 we find three possible counterparts, each showing evidence for Hα emission.

Submitted to MNRAS
Preprints from jbs@astro.soton.ac.uk

HIGH STATE OF Hα EMISSION ACTIVITY OF THE HERBIG Be STAR HD 200775

Anatoly S. Miroshnichenko[1], Christopher L. Mulliss[1], Karen S. Bjorkman[1],

Nancy D. Morrison[1], Yuri V. Glagolevskij[2], Georgij A. Chountonov[2]

[1] Ritter Observatory, Dept. of Physics & Astronomy, The University of Toledo, Toledo, OH 43606-3390, USA

[2] Special Astrophysical Observatory of the Russian Academy of Sciences, Karachai-Cherkess Republic, Nizhnyi Arkhyz, 357147, Russia

We present the results of high-resolution spectroscopic observations of the pre-main-sequence Herbig Be star HD 200775 obtained between September 1994 and February 1998. Strong variations of the Hα line associated with an extended period of strong emission during summer and fall 1997 have been observed. The line equivalent width took on the highest value reported in the last 20 years. Evidence of a strong stellar wind followed by enhanced accretion of circumstellar matter onto the star, as suggested previously by Beskrovnaya et al. (1994, A&A, 287, 564), is confirmed. A review of the observational literature dating back to 1977 indicates periodic behavior of the Hα equivalent width with a period of 3.68 years. The next high emission state is predicted to occur in the first half of 2001. We emphasize the importance of coordinated photometric and high–resolution spectroscopic observations for further understanding of the star's behavior.

Submitted to PASP *For preprints, contact* anatoly@physics.utoledo.edu
or by anonymous ftp to `ftp.physics.utoledo.edu /users/anatoly/hd200775`

Evidence for one-armed oscillations in the equatorial disk of ζ Tau from GI2T spectrally resolved interferometry

F. Vakili[1], D. Mourard[1], Ph. Stee[1], D. Bonneau[1], P. Berio[1], O. Chesneau[1], N. Thureau[1], F. Morand[1], A. Labeyrie[2], and I. Tallon-Bosc[3]

[1] GI2T, Fresnel, Observatoire de la Côte d'Azur, F-06740 Caussols, France

[2] Observatoire de Haute Provence, 04870 Saint Michel l'Observatoire, France

[3] Centre de Recherche Astronomique de Lyon, UMR CNRS 5574, 9 avenue Charles André, 69561 St Genis Laval Cedex, France

We report sub-mas observations of the Be Shell star ζ Tau with the Grand Interféromètre à 2 Télescopes (GI2T) on November '93 and October '94. In '93, the Hα line presented a V/R ratio of 0.57 with a central absorption shell component. On October '94 the Hα line presented a reversed V/R ratio of 1.26 with a shallower absorption component. For both epochs we analysed the amplitude and phase of the fringe signal relative to the local continuum as a function of Doppler-shift across Hα. We clearly resolve the Hα emitting envelope on October '93. We find that the bulge of the emission which occurs around RV=+130 km.s^{-1} has a N-S projected position of 0.7 mas to the South of the continuum source. This value corresponds to a linear separation of 3.6 photospheric radii. For October 94, the same analysis shows that the projected position of this bulge, occuring around RV=-70 km.s^{-1} has moved to 0.5 mas, i.e. 2.6 photospheric radii, North of the continuum source. On account of the opposite V/R values between 93 and 94 and the long term Hα cyclic variability of ζ Tau this apparent motion corresponds to the first interferometric detection of an

axi-asymmetric envelope around a Be star that we interpret as direct evidence for a prograde one-armed oscillation of its equatorial disk.

Accepted by Astronomy & Astrophysics, Main Journal, March 1998
Preprints from vakili@obs-azur.fr

Stellar and circumstellar activity of the Be star μCen I. Line emission outbursts

Th. Rivinius[1], D. Baade[2], S. Štefl[3], O. Stahl[3], B. Wolf[3], and A. Kaufer[3]

[1] Landessternwarte Königstuhl, Heidelberg, Germany
[2] European Southern Observatory, Garching bei München, Germany
[3] Astronomical Institute, Academy of Sciences, Ondřejov, Czech Republic

With a total of 408 echelle spectra obtained with HEROS (Heidelberg Extended Range Optical Spectrograph) during 6 observing runs covering 355 nights in 4 years and the spectral range from 3450 to 8620 Å at a resolving power of 20 000, this study is based on one of the most extensive homogeneous observational records of the short-, medium-, and long-term variability of any Be star. One week worth of low-resolution spectra with very high temporal sampling was additionally obtained. Three dense series of very high-resolution low-noise profiles of He Iλ6678 observed in 1985-1987 (309 spectra) and one of Si IIIλ4553 obtained in 1995 (27 spectra) simultaneously to the low-resolution data could also be relied upon for verification purposes.

The star was found to be in the process of continued gradual recovery of the Hα emitting disk which had been lost from 1977-1989. During the monitoring period numerous line emission outbursts were observed. A detailed generalized pattern of an outburst cycle is derived from observations of different circumstellar lines at times of various levels of emission from the disk. Relative quiescence, precursor, outburst, and subsequent relaxation can be distinguished as the main constituing phases, even though there are distinct differences between different groups of spectral lines.

Outbursts are preceded by a significant decline in the peak height of all circumstellar emission lines, which only lasts a few days. The outbursts proper are characterized by the occurrence within 1-3 days of (i) broad emission wings, (ii) rapid cyclic variability of the violet-to-red (V/R) emission peak ratio, (iii) temporary high velocity absorptions, (iv) transient sharp absorption spikes at the edges of photospheric lines, (v) an increase in the separation of emission peaks, and (vi) an increase of emission strength as the burst goes on. Particularly the V/R activity may be accompanied by relatively short-lived narrow, blueshifted high-velocity absorption components. The relaxation phase following the outburst exhibits a slow but steady decline from these sudden enhancements and ultimately returns to the pre-outburst state of relative quiescence. Outbursts can differ in amplitude and duration by a factor of a few, and the larger an outburst is, the more time it takes relative quiescence to be reached. At times the frequency of outbursts is so high, or the amplitude of an outburst is so large, that the next outburst takes place before the previous pre-outburst state has been re-established.

Based on this empirical phenomenology, a schematic picture of the associated ejection of matter into a near-stellar orbit is sketched.

1998, A&A, 333, 125

Stellar and circumstellar activity of the Be star μ Cen II. Multiperiodic low-order line-profile variability

Th. Rivinius[1], D. Baade[2], S. Štefl[3], O. Stahl[1], B. Wolf[1], and A. Kaufer[1]

[1] Landessternwarte Heidelberg, Königstuhl, D-69117 Heidelberg, Germany,
email: T.Rivinius@lsw.uni-heidelberg.de

[2] European Southern Observatory, Karl-Schwarzschild-Str. 2, D-85748 Garching b. München, Germany, e-mail: dbaade@eso.org

[3] Astronomical Institute, Academy of Sciences, CZ-251 65 Ondřejov, Czech Republic,
e-mail: sstefl@sunstel.asu.cas.cz

After the study in Paper I of the morphology of the line emission outbursts of this bright Be star, the same database is analyzed for the temporal characteristics of the photospheric variability.

In the 1992-1997 spectra, separate time series analyses were performed for the mean radial velocities of two groups of lines, He I and Si III, which were selected for their being the least contaminated by emission components. A period search with iterative pre-whitening revealed six periods which maintained phase coherence over the entire time interval covered. Four of them are close to the previously reported 0.505-day period (and, in fact, constitute it). Their relative frequency spacings are about 1.8%, 0.9%, and again 1.8% and cannot be resolved in single-season data strings. The other two periods, which were not found in the SiIII lines, are near 0.28 day. Additionally, the radial velocity variations of the single line He I λ6678 were studied. This data set extends from 1985 to 1997 thereby permitting a refinement of the periods found in the other lines.

Similar time series analyses of the flux contained in $5\,\mathrm{km\,s^{-1}}$ wide line-profile bins of the 1995-1997 spectra found periods that are identical to those of the radial velocities to within 4 decimal places. However, not all periods are detected in all 21 lines studied.

Within either group of periods, the line-profile variability patterns are indistinguishable from one another whereas the difference between the two groups is highly significant. This implies that there are also two different stellar surface patterns associated with the two groups. Their analysis is deferred to the third paper in this series.

Numerous different tests were performed to check the genuineness of the multiperiodicity. None of them could disprove the reality of any of the periods which seems to be well founded on many observational facts.

At times of enhanced V/R variability, an additional line-profile modulation with period $\sim 0.505\,\mathrm{day}$ may develop. It consists of narrow absorption spikes at $\pm\sim$

$0.7v \sin i$ and, in the respective opposite wing, a very extended ramp-like ascent of the profile to the adjacent continuum.

Finally, a series of 348 low-resolution spectra obtained during 8 nights, which coincided with a line-emission outburst, indicates cyclic variations of the radial velocity of Balmer and He I lines with a time scale of 0.58 day. The same time scale was also present in the V/R ratio of the two emission peaks in Hβ.

Submitted to Astronomy & Astrophysics
Preprints will be available from the first author after the paper has been accepted for publication.

Multiperiodic line-profile variability and a tentative ephemeris for line-emission outbursts of the Be star μ Cen

Th. Rivinius[1], D. Baade[2], S. Štefl[3], O. Stahl[3], B. Wolf[3], and A. Kaufer[3]

[1] Landessternwarte Königstuhl, Heidelberg, Germany
[2] European Southern Observatory, Garching bei München, Germany
[3] Astronomical Institute, Academy of Sciences, Ondřejov, Czech Republic

Between 1992 and 1997 the bright Be star μ Cen was monitored spectroscopically with a high-resolution echelle spectrograph. A thorough period analysis of the stellar radial velocity could resolve the previously suspected 0.505-day period into 3 distinct, closely spaced periods. The line-profile variations associated with all three periods are about the same and can be best described as a roughly sinusoidal low-order modulation of the line profiles. A fourth mode with higher frequency in both the spatial and temporal domain was also detected. Qualitatively, low-order NRP g-modes of (different) high radial degree can readily serve as a possible interpretation. This might open meaningful asteroseismological opportunities.

From the phases and mean amplitudes of the three 0.5-day periods the times of maximal amplitude superposition were re-constructed which correlate well with the times of the observed increases of the emission line strength. This may lead to a revival of the notion of pulsationally driven outbursts of Be stars.

To appear in: "A Half Century of Stellar Pulsation Interpretations: A Tribute to Arthur N. Cox" held in Los Alamos in June 1997, eds. P.A. Bradley and J.A. Guzik.
Preprints from `T.Rivinius@lsw.uni-heidelberg.de`
or on the web at `http://www.lsw.uni-heidelberg.de/~triviniu/Bestars.html`

Circumstellar quasi-periods accompanying stellar periods of Be stars

S. Štefl[1], D. Baade[2], Th. Rivinius[3], O. Stahl[3], B. Wolf[3], and A. Kaufer[3]

[1] Astronomical Institute, Academy of Sciences, Ondřejov, Czech Republic
[2] European Southern Observatory, Garching bei München, Germany

[3] Landessternwarte Königstuhl, Heidelberg, Germany

Several hundred high spectral and temporal resolution spectra (345-862 nm) of three southern Be stars obtained in three seasons were used for time series analyses of line profiles. The periodicity pattern differs significantly: (I) across a given line-profile, (II) between different spectral lines, and (III) between different phases of an emission outburst cycle. In some seasons, newly discovered transient periods co-exist with the main stellar periods which maintain long-term stability and phase coherence. They differ typically by $\sim 10\%$ from the main periods, less from transient periods at other epochs, and are not present in purely photospheric lines, but can be dominant in the lines formed in the upper parts of the extended atmosphere. The nature of the phenomenon and concerns about implications for studies of rapid variability are discussed.

To appear in: "A Half Century of Stellar Pulsation Interpretations: A Tribute to Arthur N. Cox" held in Los Alamos in June 1997, eds. P.A. Bradley and J.A. Guzik.
Preprints from `sstefl@sunstel.asu.cas.cz`
or on the web at `http://www.lsw.uni-heidelberg.de/~triviniu/Bestars.html`

Weak and Post T Tauri Stars around B-type members of the Sco-Cen OB association

E.L. Martín[1,2]

[1] Astronomy Department, University of California, Berkeley, CA 94720
[2] Instituto de Astrofísica de Canarias, 38200 La Laguna, Tenerife, Spain

I report medium-resolution (FWHM=1.9 Å) spectroscopic observations of six H_α emission stars proposed by Meyer et al. (1993) to be T Tauri stars formed in the vicinity of the B1 giant σSco, a bright member of the Sco-Cen OB association. Using spectroscopic criteria (spectral types, H_α and LiI equivalent widths), which are distance-independent, I classify these stars in different PMS classes. Taking data from the literature, a number of stars detected by X-ray observations around other B-type members of Sco-Cen are also classified. The current census of "bona-fide" low-mass PMS stars identified in about 9 deg.^{2} in Sco-Cen is 2 CTTS, 18 WTTS and 10 PTTS. The presence of a mixture of T Tauri and post T Tauri stars implies that previous results based on isochrone fitting that indicated an extremely young age ($\sim$1 Myr) for the Sco-Cen PMS low-mass population are incorrect. A distance of about 125 pc for Sco-Cen, instead of the 160 pc used in previous works, is consistent with the Hipparcos parallaxes for many of the B-type stars and would lead to older H-R diagram ages. Taking into account that PTTS are generally fainter and harder to identify than WTTS, I argue that the WTTS/PTTS ratio in Sco-Cen may be of order of unity. This result suggests that the low-mass stars of the OB association span an age range similar to the B-type members (5–15 Myrs), i.e. the low and high-mass star populations are essentially coeval. Sco-Cen appears to be indeed a promising place to find many PTTSs in future surveys.

Coupled long-term photometric and V/R variations in Be stars: evidence for prograde global one-armed disk oscillations

R.E. Mennickent [1], C. Sterken[2] and N. Vogt[3]

[1] Dpto. de Física, Facultad de Ciencias Físicas y Matemáticas, Universidad de Concepción, Casilla 4009, Concepción, Chile.

[2] University of Brussels (VUB), Pleinlaan 2, 1050 Brussels, Belgium.

[3] Departamento de Astronomía y Astrofísica, Pontificia Universidad Católica de Chile, Casilla 104, Santiago 22, Chile and Sternwarte Sonneberg, Sternwartenstr. 32, D-96515 Sonneberg, Germany.

We review theoretical work on global oscillations of Be star disks and summarize possible observational tests. In addition, we analyze existing records on photometric data and V/R ratio for a sample of 6 V/R variable Be stars. Five stars showed coupled long-term photometric-V/R variations. In all cases the photometric extrema coincided with times of $V = R$ transits, the fainter state being followed by a $V < R$ phase. V 1294 Aql, 48 Lib and MX Pup showed anticorrelated c_1 and $b{-}y$ colors during light cycles, the stars being redder in $b - y$ when brightest. 48 Lib shows a complex color behaviour, exhibiting two minima during a V/R cycle and a pronounced $b - y$ drop just at maximum light. In addition, this star shows enigmatic, non-periodic, eclipse-like features in its light curve. In general, the V/R-photometric observations can be grouped in three main groups, depending on the degree of correlation exhibited by the V/R ratio and the photometric fluxes and the rate of change of the u flux. These groups are compatible with *prograde* global disk oscillations observed under different system inclinations.

1997, A&A, 326, 1167

Long-Term Photometry of Be stars III: Evidence for periodic outbursts of λ Eri and photometric activity in HR 2142.

R.E. Mennickent[1], C. Sterken[2], N. Vogt[3,4]

[1] Dpto. de Física, Facultad de Ciencias Físicas y Matemáticas, Universidad de Concepción, Casilla 4009, Concepción, Chile.

[2] University of Brussels (VUB), Pleinlaan 2, 1050 Brussels, Belgium.

[3] Grupo de Astrofísica, Universidad Católica de Chile, Casilla 314, Santiago, Chi le.

[4] Sternwarte Sonneberg, Sternwartenstr. 32, D-96515 Sonneberg, Germany.

Strömgren differential *uvby* photometry of λ Eri and HR 2142 is analyzed. The data were taken during the time interval 1983–1994 in the framework of the Long-Term Photometry of Variables project at La Silla. λ Eri exhibited four photometric events (probably associated with line emission episodes) that last several months and which were characterized by a common pattern of change in all passbands ($\sim \pm 10^{-3}$

mag/day) along with an apparent decrease of the amplitude of the short-term variability and an increase of the stellar temperature. A search for periodicities reveals that these events fit a 486 d recurrence time. On the other hand, HR 2142 showed a relatively "quiet" long-term photometric behaviour, the orbital period being detected only marginally in the photometric data set. In contrast, a 344 d period optimally fits the data. We discuss the possibility of an internal "clock" regulating the outburst activity of λ Eri and show that the photometric variability of HR 2142 can hardly be explained by its interacting binary nature. We also discuss an empirical relationship found between $\frac{\partial c_1}{\partial u}$ and $v\ sini$ in a sample of 11 Be stars.

1998, A&A, 330, 631

On the inner envelope of the Be star Gamma Cas

Ph. Stee, F. Vakili, D. Bonneau and D. Mourard

GI2T, Fresnel, Observatoire de la Côte d'Azur, F-06740 Caussols, France

We report the first spectrally-resolved observations of the Be star γ Cas in the He I λ6678 and Hβ emission lines using the Grand Interféromètre à 2 Télescopes in the southern France. Milliarcsecond angular resolution measurements were carried in both lines and their neighbouring continuum during October and November 1993. The He I λ6678 and Hβ maximum emissions correspond respectively to 1.05 and 1.5 of the local continuum level. The interferometric baselines ranged from 15 m to 51 m on the sky which correspond to angular resolutions of 9 to 3 mas at HeI λ6678 and 6.5 to 2 mas at Hβ wavelengths. We compare these values to predicted extents of Hβ and He I λ6678 components of the circumstellar gas from models of radiative transfer in these lines. We conclude that the emitting region must be smaller than 8.5 stellar radius in Hβ and close to 2.3 stellar radius in He I λ6678 which is, for He I λ6678, smaller than the nearby continuum extent. These results confirm γ Cas basic parameters for this star obtained by Stee et al. in 1993 from their model constrained by GI2T observations in the Hα line.

1998, A&A, 332, 268

The Equatorial Disc of the Be Star X Persei

J.H. Telting[1,2], L.B.F.M. Waters[1], P. Roche[3], A.C.A. Boogert[4], J.S. Clark[5], D. de Martino[6,7], and P. Persi[8]

[1] Astronomical Institute Anton Pannekoek, University of Amsterdam, and Center for High Energy Astrophysics, Kruislaan 403, 1098 SJ Amsterdam, Netherlands

[2] Isaac Newton Group of Telescopes, ASTRON/NFRA, Apartado 321, 38780 Santa Cruz de La Palma, Spain

[3] Astronomy Centre, CPES, University of Sussex, Falmer, Brighton, BN1 9QH, UK

[4] Kapteyn Institute, p.o. box 800, NL-9700 AV Groningen, Netherlands

[5] Physics Department, University of Southampton, Southampton, SO17 1BJ, UK

[6] ESA IUE Observatory, VILSPA, Villafranca, Apartado 50727,

28080 Madrid, Spain
[7] Osservatorio Astronomico di Capodimonte, via Moiariello 16,
I-80131 Napoli, Italy
[8] Instituto di Astrofisica Spaziale CNR, C.P. 67, I-00044 Frascati, Italy

We have studied the long-term behaviour of the equatorial disc of the Be/X-ray binary X Persei, combining new low-resolution IUE spectra and IR photometry with UV, optical and IR observations collected from the literature.

We find that the near-UV continuum level of X Per varies along with the optical brightness. From the UV observations we find that during optical high states the flux excess due to the intrinsic stellar variability and/or electron scattering in the disc is at most 15-20% of the photospheric flux.

¿From the data taken in discless and near-discless states (optical low states) we derive that the stellar photosphere can be modelled with T_{eff}=31,000K and log(g)=4. With this model we derive E(B-V)=0.39 and estimate the distance to X Per as 950(200) parsec (assuming $R_* = 9R_\odot$).

We fit the (quasi-)simultaneous optical and IR photometry with a simple disc model including free-bound and free-free radiation. We find that the density of the disc at the photosphere of the star varies along with the brightness of X Per, and that in optical high states the disc in X Per is among the densest of all Be stars: $\rho_0 = 1.5(0.3) \times 10^{-10}$gcm^3. The disc density at the photosphere varies by a factor of at least 20 from optical high to low states.

During disc build-up and break-down phases, and also in phases when the disc is relatively stable, we find a very steep radial density gradient of the disc of X Per. This may reflect the limitations of some of the assumptions in our model.

We find that in a disc-loss event the disc loses mass at a rate of about $5\times10^{-9}M_\odot$/year. For a disc build-up phase we find a disc-mass growth rate of about $4\times10^{-9}M_\odot$/year. This growth rate is consistent with a model that feeds the disc from the "ordinary" mass loss of the star, but we cannot exclude that other phenomena contribute to the disc growth as well.

1998, MNRAS, 296, 785

The Development and Behavior of an Active Region On/Near the Photosphere of the B2e Star μ Centauri

Geraldine J. Peters

Space Sciences Center, University of Southern California, University Park, Los Anglees, CA 90089-1341, USA

An unusual mass loss event observed in the B2e star μ Cen during the course of 5 days in 1994 April is described and discussed within the framework of contemporary

ideas on the Be phenomenon. The onset of the activity occurred in less than 1^d and was characterized by variable emission in He I λ6678 that displayed a distinctive character. Unlike the transient microemission in He I that frequently occurs in μ Cen and other Be stars, the emission line variations seen in this event took place more slowly in *three discrete velocity intervals*. On two occasions, violet (v) and red (r)-shifted emission components declined on a time scale of < 2 hr, while the emission at/near the line center *increased*. The short time scale and observed velocity behavior suggest the site of the activity was near the photosphere. The possible importance of nonradial pulsations and magnetic fields in precipitating the event is discussed. A scenario is suggested to explain the observations in which material originating from an active site on the photosphere is injected into a slab. Layers in the active region become visible in He I λ6678 as the prevailing density builds to values favorable for the production of this emission line. It is estimated that the slab covered $\sim$30% of the star. A 22% increase in the Hα emission strength by the final day of the observations indicates that the activity did indeed add material to the circumstellar disk.

Accepted by Astrophysical Journal Letters
Preprints from gjpeters@mucen.usc.edu

B[e] stars. IV. HD 45677=MWC 142

Yvette Andrillat[1], Carlos Jaschek[2], and Mercedes Jaschek[3]

[1]Laboratoire d'Astronomie (072), Université de Montpellier - URA 1280 et 1981, CNRS, Place Eugne Bataillon, F-34095 Montpellier, France

[2] Observatoire de Strasbourg - URA 1280, CNRS-11, rue de l'Université, F-67000,Strasbourg, France

[3] deceased

On the basis of spectroscopic CCD material obtained at the Haute Provence Observatory, we provide line identifications and equivalent width measurements in the wavelength regions 3750-5112 and 7065-10212 A of the spectrum of HD 45677 Over 235 features are identified and a comparison of our results with those of other authors is provided. We also discuss the variability of the lines using equivalent widths and the line spectrum. We conclude that the gaseous shell surrounding the star has a temperature of the order of 7000 K and that its distance to the star is less than ten stellar radii. We discuss the similarity of this star to other stars previously analyzed.

1997, A&AS, 124, 441

B[e] stars V. HD 50138=MWC 158

Carlos Jaschek[1], Yvette Andrillat[2]

[1]Observatoire de Strasbourg, URA 1280, CNRS-11, rue de l'Université, F-67000,Strasbourg, France

[2] Laboratoire d'Astronomie (072), Université de Montpellier - URA 1280 et 1981, CNRS, Place Eugne Bataillon, F-34095 Montpellier, France

On the basis of spectroscopic CCD material obtained at the Haute Provence Observatory, we provide line identifications and equivalent width measurements in the

wavelength region 3738 -10232 Åof the spectrum of HD 50138 Over two hundred features are identified and a comparison of our results with those of other authors is provided. We also discuss the variability of the lines using equivalent widths and descriptions of the line spectrum. We attribute as a best compromise a spectral type of B5 III. We conclude that the gaseous shell surrounding the star has a temperature of the order of 10,000 K and that its distance to the star is of the order of two stellar radii. We discuss the relation of this star to others previously analyzed and warn against hasty generalizations.

1998, A&AS, 128, 475

On the nature of the Be phenomenon 1. The case of Omega CMa

P. Harmanec

Astronomical Institute, Academy of Sciences, CZ 251 65 Ondrejov, Czech Republic
Internet: hec@sunstel.asu.cas.cz, hec@mbox.cesnet.czls

The main purpose of this paper is to demonstrate the extreme complexity of the observed variations of Be stars on the example of a well-observed bright Be star ω CMa. A detailed analysis of all published radial velocities and a representative set of photometric and spectral observations of this star led to the following firm conclusions:

- At least three and possibly four different time scales of variability of ω CMa, ranging from 1.37 d to more than 40 years, could be identified.
- The correct *mean* period of the RV and line-profile changes is 1.371906 d, not 1.3667 d as derived earlier.
- The brightness of the object and the strength of the Balmer emission vary in an apparent cycle of several thousands of days. The long-term brightness and emission-line changes can be understood as consequences of the formation and gradual dispersal of a gaseous envelope which is flattened and seen more face-on than equator-on. During each episode, the envelope grows from an optically thick pseudophotosphere to a more extended and optically thin envelope.
- Existence of much smaller episodes of light brightening which can have the same cause (though on a more limited scale) has clearly been demonstrated.
- The amplitude of the 1.37 d RV curve varies on a time scale somewhere between 10 and 300 d.

The following conclusions are less certain and represent possible alternatives to be tested by future, systematic and homogeneous observations:

- Some evidence is presented that the amplitude of the 1.372 d RV variations, local mean RV and brightness of the object, prewhitened for the long-term changes, all vary on a time scale of about 35 d, possibly with a period of 34.675 d.
- The O-C deviations of the local epochs of RV maxima from a linear ephemeris for the 1.372 d period seem to be undergoing a slow and probably cyclic variation in time, being shortest at times when the star is brightest and when a new Be envelope begins to grow. However, the same O-C deviations can also be reconciled with the 34.675 d period. Whatever the true timescale of the O-C deviations is, their behaviour can also be simulated as an interference of several

periods, the second most significant period being close to 1.35 d. Several reasons are given why the explanation in terms of one variable period appears more probable.

- With the help of both, real and artificial data it is demonstrated that the slow variation of the 1.3719 d period — if unrecognized — may be misinterpreted for a multiperiodic variation with several close periods between 1.3 d and 1.45 d. This constitutes a methodological warning for the period analyses of data on some Bn, Be and "slowly pulsating" B stars.

- The cause(s) of the variations with the 1.37 (and 1.345) period(s) and/or the 35 d cycle remain unexplained. It is obvious, however, that these three periods are not mutually independent. The 34.675 d period may be either a real physical period or a beat period between the 1.372 d and 1.345 d periods. In the former case, ω CMa could be a 34.7 d binary in an eccentric orbit and the periods twice longer than the two periods near 1.4 d would represent the sidereal and synodic rotational periods of the Be primary.

- Finally, some speculations are offered in terms of a hierarchical multiple system of three or even four stars.

Investigation of the variability of bright Be stars using Hipparcos photometry

A.M. Hubert and M. Floquet

Observatoire de Paris-Meudon, D.A.S.G.A.L., URA 335 du CNRS, F-92195 Meudon Cedex, France

The high accuracy and the homogeneity of Hipparcos data for bright stars have allowed us to quantify the degree of variability of Be stars. This degree has been found to be highly dependent on the temperature of the star. Rapid variability is the main feature of 86% of early Be and less than 20% of late Be stars taking into account the limit of detection considered. In addition to the Be stars reported in the Hipparcos catalogue (ESA 1997) as short-period variables, we have been able to enlarge the number of detections as well as to confirm periods previously determined. Be stars that show larger amplitude rapid variations are proposed as candidates for a search of multi-periodicity, i.e., as non-radial pulsators.
We have also searched for the presence of outbursts and fading events in the Hipparcos data. Outbursts have been frequently and preferentially detected in early Be stars with rather low to moderate $V \sin i$ while fading events seem to be more conspicuous in stars with higher $V \sin i$. Mid-term and long-term variations have also been investigated. Several stars have shown some evidence of quasi-periodic oscillations ranging between 10 and 200 days.
Finally information concerning long-term variations is reported. Cycles shorter than or equal to the Hipparcos mission have mainly been detected in stars earlier than B6. Long-term time scales of late Be stars are confirmed to be longer by far.

Accepted by A&A
Preprints from Anne-Marie.Hubert@obspm.fr

Luminous Magnetic Rotator Theory

J. P. Cassinelli

Department of Astronomy, UNiversity of Wisconsin, 475 N. Charter St., Madison, WI 53706, U.S.A.

This paper decsribes the development of a wind theory that combines forces associated with magnetic rotators with those operating in line driven winds. It has relevance to cyclic variability because if a rotating star has a magnetic field that changes from one longitude sector to the next, the wind speed can also change and this could lead to fast/slow wind co-rotating interaction region. This paper focuses on effects that can increase the radial velocity of a line driven wind within a sector.

To appear in ESO Workshop on 'Cyclical Variability in Stellar Winds'
Preprints from cassinelli@madraf.astro.wisc.edu

Large-scale perturbations in the circumstellar envelopes of Be/X-ray binaries

I. Negueruela[1,2], P. Reig[2], M. J. Coe[2], & J. Fabregat[3]

[1] Astrophysics Research Institute, Liverpool John Moores University, Byrom Street, Liverpool, L3 3AF, U.K.

[2] Physics and Astronomy Department, Southampton University, Southampton, SO17 1BJ, U.K.

[3] Departmento de Astronomia y Astrofisica, Universidad de Valencia, 46100, Burjassot, Valencia, Spain

We investigate the spectroscopic characteristics of the optical components of Be/X-ray binary systems, using data collected during our seven-year monitoring campaign. We find examples of major changes in the emission line profiles associated with Type II X-ray outbursts, later developing into V/R variability cycles. We show that the time-scales for V/R variability in Be/X-ray transients extend from a few weeks to years and interpret all these changes as due to the presence of global disruptions of the axisymmetric density distribution in the extended envelopes of the Be stars in these systemes. The association between X-ray outbursts and V/R variability, the occurrence of very fast changes and very short quasi-periods of variability displayed by the Be/X-ray binaries lead us to conclude that the presence of the neutron star is an important factor affecting the dynamics of disc-like envelopes. The interaction between the compact companion and the disc would explain the correlation between Hα strength and orbital period recently found. The characteristics of the V/R cycles are, however, mainly independent of the binary parameters.

A&A, in press
Preprints from ind@staru1.livjm.ac.uk

6. BIBLIOGRAPHY

(*compiled by D. R. Gies, A. M. Hubert, J. Jugaku, & G. J. Peters*)

B[e] Stars. IV. HD 45677 = MWC 142
ANDRILLAT, Y., JASCHEK, C. , & JASCHEK, M.,1997, A&AS, 124, 441

Infrared and H-alpha Emission from Be Stars
APPARAO, K.M.V., & TARAFDAR, S.P., 1997, BASI, 25, 345

X-Ray Properties of Bright OB-Type Stars Detected in the ROSAT All-Sky Survey
BERGHÖFER, T.W., SCHMITT, J.H.M.M., DANNER, R., & CASSINELLI, J.P., 1997, A&A, 322, 167

The Influence of Clumping on the Infrared and Radio Continuum of Early-Type Stars
BLOMME, R., & RUNACRES, M.C., 1997, A&A, 323, 886

H-Band Spectroscopic Classification of OB Stars
BLUM, R.D., RAMOND, T.M., CONTI, P.C., FIGER, D.F., & SELLGREN, K., 1997, AJ, 113, 1855

Forbidden Lines in Herbig Ae/Be Stars. The [OI](1F) 6300.31 Åand 6363.79 ÅLines. II. Longslit Observations of Selected Objects
BÖHM, T., & HIRTH, G.A., 1997, A&A, 324, 177

Nitrogen V in the Wind of the Pre-Main Sequence Herbig Ae Star AB Aurigae
BOURET, J.-C., CATALA, C., & SIMON, T., 1997, A&A, 328, 606

HD 6226: A New Bright B Variable with Occasional Brightenings: Is it an Unrecognized Be Star?
BOŽIĆ, H., & HARMANEC, P., 1998, A&A, 330, 222

Absolute Magnitudes of Be Stars
BRIOT, D., ROBICHON, N., & HUBERT, A.M., 1997, ESA SP-402, 319

WFPC2/PC Imagery of the Extended Circumstellar Disk of Beta Pictoris (Abstract)
BRUHWEILER, F., SMITH, B., MISKEY, C., SILVIS, J., DiSANTI, M., SCHULTZ, A., HART, H., SCHNEIDER, G., & REINHARD, K., 1997, BAAS, 29, 1285

Short-Term Variability of Photospheric Lines in the Pre-Main-Sequence Herbig Ae Star AB Aurigae
CATALA, C., BÖHM, T., DONATI, J.-F., SIMON, T., JIANG, S., & ZHAO, F., 1997, A&A 319, 176

Hipparcos Results on Massive X-Ray Binaries
CHEVALIER, C., & ILOVAISKY, S.A., 1998, A&A, 330, 201

Computing Gravity Modes for Rotating Stellar Models: A Progress Report (Abstract)
CLEMENT, M.J., 1997, BAAS, 29, 811

Forbidden Emission Lines in Herbig Ae/Be Stars
CORCORAN, M., & RAY, T.P., 1997, A&A, 321, 189

β Pictoris Revisited by Hipparcos. Star Properties
CRIFO, F., VIDAL-MADJAR, A., LALLEMENT, R., FERLET, R., & GERBALDI, M., 1997, A&A, 320, 29

Turbulence, Mass Loss and Hα Emission by Stochastic Shocks in the Hypergiant ρ Cassiopeiae
DE JAGER, C., LOBEL, A., & ISRAELIAN, G., 1997, A&A, 325, 714

MWC 297, B1.5Ve: A Zero-Age Main-Sequence Star in the Aquila Rift
DREW, J.E., BUSFIELD, G., HOARE, M.G., MURDOCH, K.A., NIXON, C.A., & OUDMAIJER, R.D., 1997, MNRAS, 286, 538

New Perspectives on AX Monocerotis
ELIAS II., N.M., WILSON, R.E., OLSON. E.C., AUFDENBERG, J.P., GUINAN, E.F., GÜDEL, M., van HAMME, W.V., & STEVENS, H.L., 1997, ApJ, 484, 394

ubvy Photometry of θ Coronae Borealis during 1994 and 1995
FABREGAT, J., & ADELMAN, S.J., 1998, A&A, 329, 579

Near-Infrared Spectra of the β Pictoris Disk (Abstract)
FAJARDO-ACOSTA, S.B., BACKMAN, D.E., & WITTEBORN, F.C., 1997, BAAS, 29, 1285

Wind Variability of Supergiants. III. Corotating Spiral Structure in the Stellar Wind of HD 64760
FULLERTON, A.W., MASSA, D.L.,PRINJA, R.K., OWOCKI, S.P., & CRANMER, S.R., 1997, A&A, 327, 699

Hubble Space Telescope Goddard High Resolution Spectrograph Observations of the Be + sdO Binary ϕ Persei
GIES, D.R., BAGNUOLO, Jr., W.G., FERRARA, E.C., KAYE, A.B., THALLER, M.I., PENNY, L.R., & PETERS, G.J., 1998, ApJ, 493, 440

The β Pictoris Phenomenon in AB Aurigae (Abstract)
GRADY, C.A., PÉREZ, M.R., BJORKMAN, K.S., & MASSA, D., 1997, BAAS, 29, 1285

The Star-Grazing Extrasolar Comets in the HD 100546 System
GRADY, C.A., SITKO, M.L., BJORKMAN, K.S., PÉREZ, M.R., LYNCH, D.K., RUSSELL, R.W., & HANNER, M.S., 1997, ApJ, 483, 449

The Abundances of the Iron Group Elements in ι Herculis (Abstract)
GRIGSBY, J.A., & PETERS, G.J., 1997, BAAS, 29, 808

E(B - V) Determinations of O and B Stars Using Artificial Neural Networks
GULATI, R.K., GUPTA, R., & SINGH, H.P., 1997, PASP, 109, 843

X-Ray Observations of the Slowest Known Be/X-Ray Pulsar RX J0146.9+6121 and X Persei
HABERL, F., ANGELINI, L., MOTCH, C., & WHITE, N.E., 1998, A&A, 330, 189

Spectroscopic Characteristics of 1H2214+589/3G71: 3G71 May Be a Herbig Ae/Be Star
HANG,H.-R., & XIA, J.-P., 1997, Acta Astr. Sinica, 38, 329

Search for Forced Oscillations in Binaries I. The Eclipsing and Spectroscopic Binary V 436 Persei ≡1 Persei
HARMANEC, P., HADRAVA, P., YANG, S.,HOLMGREN, D., NORTH, P., KOUBSKÝ, P., KUBÁT,& PORETTI, E., 1997, A&A, 319, 867

A Spectral Analysis of the Hydrogen Deficient Star HD 144941
HARRISON, P.M., & JEFFERY, C.S., 1997, A&A, 323, 177

Hubble/STIS Coronographic Imagery of β Pictoris (Abstract)
HEAP, S.R., LINDLER, D.J., & WOODGATE, B., 1997, BAAS, 29, 1285

Properties and Nature of Be Stars. 17. V360 Lac = HD 216200 is a B3e + F9IV: Binary
HILL, G., HARMANEC, P., PAVLOVSKI, K., BOŽIĆ, H., HADRAVA, P., KOUBSKÝ, P.,& ZINOVSKY, J., 1997, A&A, 324, 965

Post-Periastron ASCA Observation of the PSR B1259-63 System
HIRAYAMA, M.,NAGASE, F.,TAVANI, M.,KASPI, V.M.,KAWAI, N., & ARONS, J.,1996, PASJ, 48, 833

Search for Forced Oscillations in Binaries II. βScorpii A. New Physical Parameters and a Search for Line Profile Variability
HOLMGREN, D., HADRAVA, P., HARMANEC, P., KOUBSKÝ, & KUBÁT, J., 1997, A&A, 322, 565

The Surface Composition of β Pictoris
HOLWEGER, H., HEMPEL, M., VAN THIEL, T., & KAUFER, A., 1997, A&A, 320, 49

Photometric Variability of B and Be Stars
HUBERT, A.M., FLOQUET, M., GOMEZ, A.E., & ALETTI, V., 1997, ESA SP-402, 315

Multi-Site Continuum Spectroscopy. V. Rapid Photospheric Variability in the Be Star 48 Per from the MUSICOS 1989 Campaign
HUBERT, A.M., FLOQUET, M., HAO, J.X., CAILLET, S., CATALA, C., FOING, B.H., NEFF, J.E., HUANG, L., HUBERT, H., BARBAN, C., BAUDRAND, J., CAO, H., CHAR, S., CHATZICHRISTOU, H., CUBY, J.C., CZARNY, J., DREUX, M., FELENBOK, P., GUERIN, J, HRON, J., HUOVELIN, J., JANKOV, S., JIANG, S., LE CONTEL, J.M., MAITZEN, H.M., PETROV, P., SAVANOV, I., SHCHERBAKOV, A., SIMON, T., STEE;, P., TUOMINEN, L., & ZHAI, D., 1997, A&A, 324, 929

Line Formation in Be Star Envelopes. II. Disk Oscillations
HUMMEL, W., & HANUSCHIK, R.W., 1997, A&A, 320, 852

On the Spectacular Variations of Be Stars. Evidence for a Temporarily Tilted Circumstellar Disk
HUMMEL, W., 1998, A&A, 330, 243

The Inhomogeneous Circumstellar Envelope of Rigel (β Orionis A)
ISRAELIAN, G., CHENTSOV, E., & MUSAEV, F., 1997, MNRAS, 290, 521

On the Variable Spectrum of HD 45677 (FS Canis Majoris)
ISRAELIAN, G. & MUSAEV, F., 1997, A&A, 328, 339

HST-GHRS Observations of CO and CI in the β-Pictoris Circumstellar Disk
JOLLY, A., McPhate, J.B., LECAVELIER, A., LAGRANGE, A.-M., LEMAIRE, J.L., FELDMAN,P.D., VIDAL-MADJAR, A., FERLET, R., MALMASSON, F., & ROSTAS, F., 1998, A&A, 329, 1028

APT Observations of the Former Beta Cephei Star Spica (Abstract)
JORDAN, J., DUKES, R., & MILLS, L., 1997, BAAS, 29, 810

Analytical 2-D Solutions for Hydrodynamic Thermally and Radiatively Driven, Astrophysical Outflows. Applications to B Stars
KAKOURIS, A. & MOUSSAS, X., 1997, A&A, 324, 1071

Multiperiodicity of ζ Ophiuchi from Multisite Observations
KAMBE, E., HIRATA, R., ANDO, H., CUYPERS, J., KATOH, M., KENNELLY, E.J., WALKER, G.A.H., ŠTEFL, S., & TARASOV, A.E., 1997, ApJ, 481, 406

Long-Term Spectroscopic Monitoring of BA Supergiants. III. Variability of Photospheric Lines
KAUFER, A., STAHL, O., WOLF, B., FULLERTON, A.W., GAENG, T., GUMMERSBACH, C.A., JANKOVICS, I., KOVACS, J., MANDEL, H., PEITZ, J., RIVINIUS, T., & SZEIFERT, T., 1997, A&A 320, 273

On the Line Profile Variations and Nonradial Pulsation Modes of ζ Tauri
KAYE, A.B., & GIES, D.R., 1997, ApJ, 482, 1028

Ionization Structure of the Shells Surrounding Ae/Be Stars
KHOLTYGIN, A.F., IL'IN, V.B., & VOSHCHINNIKOV, N.V., 1997, A&A, 323, 189

Properties and Nature of Be Stars. XVIII. Spectral, Light and Colour Variations of 4 Herculis
KOUBSKÝ, P., HARMANEC, P., KUBÁT, J., HUBERT, A.M., BOŽIĆ, H., FLOQUET, M., HADRAVA, P., HILL, G., & PERCY, J.R., 1997, A&A, 328, 551

Determination of log g of Several Variable Herbig Ae/Be Stars
KOVALCHUK, G.U., & PUGACH, A.F., 1997, A&A, 325, 1077

B-Type Pulsators in the Open Cluster NGC 884 χ Persei
KRZESINSKI, J., & PIGULSKI, A., 1997, A&A, 325, 987

The β Pictoris Circumstellar Disk. XXIV. Clues to the Origin of the Stable Gas
LAGRANGE, A.-M., BEUST, H., MOUILLET, D., DELEUIL, M., FELDMAN, P.D., FERLET, R., HOBBS, L., LECAVELIER DES ETANGS, A., LISSAUER, J.J., McGRATH M.A., McPHATE, J.B., SPYROMILIO, J., TOBIN, W., & VIDAL-MADJAR, A., 1998, A&A, 330, 1091

β Pictoris Light Variations. II. Scattering by a Dust Cloud
LAMERS, H.J.G.L.M., LECAVELIER DES ETANGS, A., & VIDAL-MADJAR, A., 1997, A&A, 328, 321

HST-GHRS Observations of Candidate β Pictoris-like Circumstellar Gaseous Disks
LECAVELIER DES ETANGS, A., DELEUIL, M., VIDAL-MADJAR, A., LAGRANGE-HENRI, A.M., BACKMAN, D., LISSAUER, J.J., FERLET, R., BEUST, H., & MOUILLET, D., 1997, A&A, 325, 228

A Search for β Pictoris-like Ca II Circumstellar Gas around Ursa Major Stream Stars
LECAVELIER DES ETANGS A., FERLET, A., & VIDAL-MADJAR, A., 1997, A&A, 328, 602

β Pictoris Light Variations. I. The Planetary Hypothesis
LECAVELIER DES ETANGS, A., VIDAL-MADJAR, A., BURKI, A., LAMERS, H.J.G.L.M., FERLET, R., NITSCHELM C., & SEVRE, F., 1997, A&A, 328, 311

The Temperature Structure in the Gaseous Infall of Beta Pictoris (Abstract)
LYU, C.-H., & BRUHWEILER, F.C., 1997, BAAS, 29, 1285

Observational Manifestations of Early Mixing in B- and O-Type Stars
LYUBIMKOV, L.S.,1996, Ap&SS, 243, 329

Investigation of the Extreme Ultraviolet Line Emission from the Wind of ϵ CMa (B2 II) (Abstract)
MacFARLANE, J.J., COHEN, D.H., & CASSINELLI, J.P., 197, BAAS, 29, 807

Line Emission in Stellar Envelopes
MAGNAN, C., & DE LAVERNY, P., 1997, MNRAS, 286, 920

A Study of the Infrared Spectrum of ψ Persei. I. A Parameter Study of the Disc Model
MARLBOROUGH, J.M., ZIJLSTRA, J.-W., & WATERS, J.B.F.M., 1997, A&A, 321, 867

An Analysis of Emission Lines in the Spectrum of P Cygni
MARKOVA, N., & DE GROOT, M., 1997, A&A, 326, 1111

ICCD Speckle Observations of Binary Stars. XVIII. An Investigation of Be Stars
MASON, B.D., TEN BRUMMELARR, T., GIES, D.R., HARTKOPF, W.I., & THALLER, M. L., 1997, AJ, 114, 2112

HD 139614, HD 142666 and HD 144432: Evidence for Circumstellar Disks
MEEUS, G., WAELKENS, C., & MALFAIT, K., 1998, A&A, 329, 131

Coupled Long-Term Photometric and V/R Variations in Be Stars, Evidence for Prograde Global One-Armed Disk Oscillations
MENNICKENT, R.E., STERKEN, C., & VOGT, N., 1997, A&A, 326, 1167

Long-Term Photometry of Be Stars. III. Evidence for Periodic Outbursts of λ Eri and Photospheric Activity in HR 2142
MENNICKENT, R.E., STERKEN, C., & VOGT, N., 1998, A&A, 330, 631

Six Years of APT Observations of the Prototypical Star, 53 Persei (Abstract)
MILLS, L, & DUKES, R., 1997, BAAS, 29, 809

New Results of Studying Circumstellar Envelopes of Young Hot Stars with Spectropolarimetry (Abstract)
MIROSCHNICHENKO, A.S., BJORKMAN, K.S., BABLER, B.L., MEADE, M.R., & WUPPE SCIENCE TEAM, 1997, BAAS, 29, 1286

A New Peculiar Be Object MWC 657
MIROSHNICHENKO, A.S.,KURATOV, K.S.,IVEZIC, Z., & ELITZUR,M.,1997, IBVS, No. 4506

New Massive X-Ray Binary Candidates for the ROSAT Galactic Plane Survey. I. Results from a Cross-Correlation with OB Star Catalogues
MOTCH, C., HABERL, F., DENNERL, K., PAKULL, M., & JANOT-PACHECO, E., 1997, A&A, 323, 853

A Planet on an Inclined Orbit as an Explanation of the Warp in the β Pictoris Disc
MOUILLET, D., LARWOOD, J.D., PAPALOIZOU, J.C.B., & LAGRANGE, A.M., 1998, MNRAS, 292, 896

New Emission Line Stars with Infrared Excesses (Abstract)
MULLISS, C.L., MIROSHNICHENKO, A.S., BJORKMAN, K.S., & MORRISON, N.D., 1997, BAAS, 29, 1286

A Spectroscopic Investigation of P Cygni. H and He I Lines
NAJARRO, F., HILLIER, D.J., & STAHL, O., 1997, A&A, 326, 1117

UV Spectral Classification of O and B Stars in the Small Magellanic Clouds
NEUBIG, M.M.S., & BRUHWEILER, F.C., 1997, AJ, 114, 1951

Mid-Infrared Images and Models of the β Pictoris Dust Disk
PANTIN, E., LAGAGE, P.O., & ARTYMOWICZ, P., 1997, A&A, 327, 1123

UBV Photometry of Be Stars at Hvar: 1972-1990
PAVLOVSKI, K., HARMANEC, P., BOŽIĆ, H., KOUBSKÝ, P., HADRAVA, P., KŘÍŽ, S., RUŽIĆ, Ź., & ŠTEFL, S., 1997, A&AS, 125, 75

Photometric Monitoring of Bright Be Stars. III. 1988-89 and 1992-95
PERCY, J.R., HARLOW, J., HAYHOE, K.A.S., IVANS, I.I., LISTER, M., PLUME, R., ROSEBERY, T., THOMPSON, S, & YEUNG, D., 1997, PASP, 109, 1215

Orfeus-Spas II Observations of Algol-Type Interacting Binaries (Abstract)
PETERS, G.J., & POLIDAN, R.S., 1997, BAAS, 29, 835

Continuum IR Emission of Be Star Wind-Compressed Discs
PORTER, J.M., 1997, A&A, 324, 597

The Luminosity of the Hα Emission Envelopes of Variable Is(A)-Type Stars
PUGACH, A.F., & KOVALCHUK, G.U., 1997, A&A, 325, 1083

A New Correlation for Be/X-Ray Binaries: the Orbital Period-Hα Equivalent Width Diagram
REIG, P., FABREGAT, J., & COE, M.J., 1997, A&A, 322, 193

The Be/X Ray LSI +61 235/RX J0146.9+6121: Physical Parameters and V/R Variability
REIG, P., FABREGAT, F., COE, M.J., ROCHE, P., CHAKRABARTY, D., NEGUERUELA, I., & STEELE, I., 1997, A&A, 322, 183

Variations of the Stellar Wind in Early-B Hypergiants
RIVINIUS, T., STAHL, O., WOLF, B., KAUFER, A., GAENG, T., GUMMERSBACH, C.A., JANKOVICS, I., KOVACS, J., MANDEL, H., PEITZ, J., SZEIFERT, T., & LAMERS, H.J.G.L.M., 1997, A&A, 318, 819

Observations of the Recent Disc Loss in X Persei: Photometry and Polarimetry
ROCHE, P., LARIONOV, V., TARASOV, A.E., FABREGAT, J., CLARK, J.S., COE, M.J., KALV, P., LARIONOVA, L., NEGUERUELA, I., NORTON, A.J., & REIG, P., 1997, A&A, 322, 139

Brackett Emission in Herbig Ae/Be Stars (Abstract)
RODGERS, B., & WOODEN, D.H., 1997, BAAS, 29, 1286

Dust around Young Stars. Photopolarimetric Activity of the Classical Herbig Ae/Be Star RR Tauri
ROSTOPCHINA, A.N., GRININ, V.P., OKAZAKI, A., THÉ, P.S., KIKUCHI, S., SCHAKHOVSKOY, D.N., & MINIKHULOV, N. Kh., 1997, A&A, 327, 145

An Attempt to Detect Polarization Effects in the Envelope of γ Cassiopeiae with the GI2T Interferometer
ROUSSELET-PERRAUT, K., VAKILI, F., MOURARD, D., MORAND, F., BONNEAU, D., & STEE, P., 1997, A&AS, 123, 173

Spectroscopic Observations of Some Be Stars
SINGH, M., & SANWAL, B.B., 1996, BASI, 24, 691

A Compact, Variable Radio Nebula around P Cygni
SKINNER, C.J., EXTER, K.M., BARLOW, M.J., DAVIS, R.J., & BODE, M.F., 1997, MNRAS, 288, L7

Multiwavelength Observations of the Be/X-Ray Binary 4U 1145-619
STEVENS, J.B., REIG, P., COE, M.J., BUCKLEY, D.A.H., FABREGAT, J., & STEELE, I.A., 1997, MNRAS, 288, 988

Theory of High-Energy Emission from the Pulsar/Be Star System PSR 1259-63. I. Radiation Mechanisms and Interaction Geometry
TAVANI, M., & ARONS, J., 1997, ApJ, 477, 439

A Search for Clustering around Herbig Ae/Be Stars
TESTI, L., PALLA, F., PRUSTI, T., NATTA, A., & MALTAGLIATI, S., 1997, A&A, 320, 159

The Paschen Decrement as a Density Indicator in MWC 349
THUM, C., & GREVE, A., 1997, A&A, 324, 699

Be Stars in Open Clusters. II. Balmer Line Spectroscopy
TORREJON, J.M., FABREGAT, J., BERNABEU, G., & ALBA, S., 1997, A&AS, 124, 329

Detection of Circumstellar Dust Shells of Some Distant B Type Stars
TOVMASSIAN, H.M., NAVARRO, S.G., TOVMASSIAN, G.H., & CORRAL, L.J., 1997, AJ, 113, 1888

Subtle Structures in the Wind of P Cygni
VAKILI, F., MOURARD, D., BONNEAU, D., MORAND, F., & STEE, P., 1997, A&A, 323, 183

The Number of B-Type Binary Mass Gainers in General, Binary Be Stars in Particular, Predicted by Close Binary Evolution
VAN BEVER, J., & VANBEVEREN, D., 1997, A&A, 322, 116

Hipparcos Photometry of Herbig Ae/Be Stars
VAN DEN ANCKER, M.E., DE WINTER, D., & TJIN A. DJIE, H.R.E., 1998, A&A, 330, 145

Hipparcos Data on Herbig Ae/Be Stars: an Evolutionary Scenario
VAN DEN ANCKER, M.E., THÉ, P.S., TJIN A. DJIE, H.R.E., CATALA, C., DE WINTER, D., BLONDEL, P.F.C., & WATERS, L.B.F.M., 1997, A&A, 324, 33

Physical Properties of Be Stars in Open Clusters (Abstract)
VÁZQUEZ, J.M.T., 1997, PASP, 109, 1396

Study of an Unbiased Sample of B Stars Observed with Hipparcos: the Discovery of a Large Amount of New Slowly Pulsating B Stars
WAELKENS, C., AERTS, C., KESTENS, E., GRENON, M., & EYER, L., 1998, A&A, 330, 215

Circumstellar Disc Variations around β Pictoris
WELSH, B.Y., CRAIG, N., JELINSKY, S., & SASSEEN, T., 1997, A&A, 321, 888

Deriving the Geometry of Be Star Circumstellar Envelopes from Continuum Spectropolarimetry. I. The Case of ζ Tauri
WOOD, K., BJORKMAN, K.S., & BJORKMAN, J.E., 1997, ApJ, 477, 926

Emission Features in Brα and Brγ Spectra of Normal O and B Stars
ZAAL, P.A., WATERS, L.B.F.M., GEBALLE, T.R., & MARLBOROUGH, J.M., 1997, A&A, 326, 237

Properties of He-Rich Stars. 1. Their Evolutionary State and Helium Abundance
ZBORIL, M., NORTH, P., GLAGOLEVSKIJ, Y.V., & BETRIX, F., 1997, A&A, 324, 949

On the Excitation Mechanism of Pulsation for β Cephei Stars
ZHANG,Z.-Y., & XIONG, D.-R., 1996, Acta Astr. Sinica, 37, 154

7. MEETINGS

- 15 - 19 June 1998
  IAU Colloquium 169: Variable and Non-spherical Stellar Winds in Luminous Hot Stars
  Heidelberg, Germany
  http://www.lsw.uni-heidelberg.de/iaucoll/

- 31 August - 11 September 1998
  Variable Stars as Important Astrophysical Tools
  Izmir, Turkey
  http://sci.ege.edu.tr/~nato_asi/

- 3 - 7 November 1998
  IAU Symposium 193: Wolf-Rayet Phenomena in Massive Stars and Starburst Galaxies
  Puerto Vallarta, Mexico
  http://www.astro.ugto.mx/~eenens/hot/pv/

- 28 June - 2 July 1999
  The Be Phenomenon in Early-Type Stars
  Alicante, Spain
  http://www.chara.gsu.edu/BeNews/Issue_33/alicante.html

See http://cadcwww.dao.nrc.ca/meetings/meetings.html for more.

8. LATEX TEMPLATE FOR ABSTRACTS

```
\begin{center}{\Large\bf  Title
}\end{center}
\centerline{\bf           A. Author$^1$ and B. Author$^2$
}{\footnotesize   $^1$   Institute One and Address
             \\    $^2$   Institute Two and Address
}\vspace*{4mm}\\          Text of abstract


{\bf   Accepted by  /or/  Submitted to   JOURNAL } \\
{\it Preprints from} {\tt    YOUR ELECTRONIC ADDRESS   } \\
{\it or by anonymous ftp to} {\tt    ...      }    \\
{\it or on the web at} {\tt ... }
```