# NEWSLETTER OF CHEMICALLY PECULIAR RED GIANT STARS

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Edited by
Sandra B. Yorka
Denison University

## I. MESSAGE FROM THE WORKING GROUP CHAIRMAN

The specific site for IAU Symposium 177 on The Carbon Star Phenomenon has at last been settled. Our activities will be based at the Talya Hotel in Antalya, Turkey. This hotel has a splendid location on a promontory overlooking the Mediterranean Sea, and it is also well within the city limits, close to the Old Harbor and numerous restaurants, shops, and places of interest. The dates given previously -- May 27-31, 1996 -- have been confirmed with the hotel, and we have negotiated a favorable group rate for rooms.

In the last issue of this Newsletter I reported the disturbing news that we had been informed that construction of the Talya's new conference facility, which we had been expecting to use, had been delayed indefinitely. Although we were offered the use of the Hotel's existing meeting room, I was concerned that it did not seem up to the standards of an IAU symposium, being flat and somewhat small and geometrically awkward. We have now found a solution to this problem (see below), but not before spending several months searching for alternative sites with better conference facilities.

Zeki Aslan, our LOC Chair, spent much of the winter visiting hotels in the Antalya region and talking to their managers. During much of this time he was out of contact with me because of computer networking problems, which involved not only Turkey's slow and painful changeover from Bitnet to the Internet but also the physical move of Akdeniz University's computer center to a new building. In April, Zeki convened a meeting of a subcom-mittee of the LOC, including astronomers from Antalya, Ismir, and Istanbul, to visit several hotels and make a recommendation. In addition to hotels in Antalya and Kemer that I had seen last summer, they considered two new resort hotels well to the east of Antalya. These latter hotels do have excellent facilities and are completely self-contained, offering "everything for every need". Undoubtedly it would be possible to hold a successful meeting at such a place. Zeki and I eventually decided, however, that their remote locations, quite far from Antalya or any major city, was an important disadvantage. Although the purpose of the Symposium is to discuss the problems of red giant stars, most people who travel long distances to attend it will also be interested in seeing Turkey (‘experiencing’ might be a better word), and we felt that many participants would be disappointed to find themselves sequestered at an isolated resort where nothing is more than five years old.

The breakthrough came when I happened to talk to Bruce McHenry, husband of Harvard astronomer Martha Hazen, at the Spring Meeting of the AAVSO. Bruce is a former employee of the U.S. National Park Service, and his interests include not only parks and wildlife but also museums and the preservation of historic sites. As luck would have it, he had been to Antalya and was familiar with the Antalya Museum which, in addition to its fine archeological collection, has an excellent auditorium. Following up on Bruce’s suggestion, Zeki visited the Museum and was warmly received. They offered us not only the use of the auditorium but also their beautiful gardens for a reception! In addition, they will be happy to supply Symposium participants with passes to all the museums and sites operated by the Department of Cultural Affairs in and around Antalya.

With this encouragement from the Museum, we decided to keep the Symposium within the city of Antalya and to use the Talya Hotel as our headquarters. The Hotel and Museum are some distance apart (about 2 km), but a shuttle link between the two can be arranged. We have not yet determined which sessions of the Symposium will be held at the Museum and which at the Hotel; that decision can be made after we have a better idea of the expected attendance.

Because of the delay in establishing the meeting site, other aspects of the symposium organization have not progressed as far as I had hoped. I am now in the process of communicating again with Invited Speakers to confirm their participation, so that the SOC can proceed with development of the detailed scientific program. The official First Announcement has been drafted and will soon be distributed to a long list of individuals and institutions; it will include general information about the Symposium and a response form for those who wish further information. The Second Announcement, to be distributed during the autumn, will include a more detailed program, information on hotel and registration fees, travel tips, instructions for the preparation of abstracts, and so on.

Some readers may be wondering about the availability of financial support for participants. We expect to be able to help in three ways:

1) The funds to be made available by the IAU are intended to help pay the travel expenses of Invited Speakers. These individuals will be informed how to apply for travel support; in the meantime they are encouraged to investigate other sources of support so that the limited IAU funds can be stretched as far as possible.

2) A separate fund has been established to help with other (non-travel) expenses of participants. These funds will be used primarily to

pay the registration fees -- and in some cases the hotel bills -- of astronomers most in need of such assistance. Preference will be given to young and/or unemployed astronomers, and to colleagues from economically-depressed countries, who would not otherwise be able to attend. Information on how to apply for this support will be distributed with the Second Announcement.

3) We hope to raise money from Turkish sources to help with the expenses of Turkish students attending the Symposium. In this way we hope to encourage the next generation of Turkish astronomers to participate fully in the Symposium and to mingle with the international participants by staying at the hotel, instead of sleeping on the beach.

Finally, a word about the Turkish National Observatory. You may recall that one reason for considering Antalya as the location for the meeting was its proximity to Balirlitepe, the site selected for the National Observatory. Development of the site has been slowed by a moritorium on government spending; however, some progress has been made. Negotiations have been completed to erect a 1.5-m Russian telescope; Zeki Aslan is just back from Moscow and reports that the telescope is now being packed for shipment to Turkey. There are also plans for a 1-m photometric telescope. We expect that Symposium 177 participants will have an opportunity to visit the site.

--- Robert F. Wing
Chair, WG on Peculiar Red Giants

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NEWSLETTER ON THE WORLD WIDE WEB

A homepage has been established for this Newsletter on the World Wide Web (WWW). The Uniform Resource Locator (URL) is:

http://www-astronomy.mps.ohio-state.edu/~wing/prgnews.html

The homepage gives a list of the files currently available for display on your monitor or for downloading to your computer. Just ‘click’ on the items you want! The files include both text files (i.e. continuous texts) and post-script files (which include page breaks and pagination) of the current issue and several recent back issues. The post-script files for the covers may be added later.

If you have access to the Web, please try this out and send me a message (to wing@payne.mps.ohio-state.edu) to tell me what success you had. This use of WWW for Newsletter distribution is experimental -- we only started thinking about it a few days ago -- so don’t expect anything fancy. If you have difficulties, please report them to me, as well as your ideas for improvements.

We expect that the announcements and forms relating to Symposium 177 will also be retrievable via the Web as soon as they are ready. I am grateful to Rick Pogge of the OSU Astronomy Department for setting up our home page. ---RFW

## II. SPECIAL REPORT

# ASYMMETRIES IN THE ENVIRONMENTS OF LUMINOUS RED VARIABLES

Antonio Mario Magalhaes(1) and Ken H. Nordsieck(2)

(1) Instituto Astronomico e Geofisico, Universidade de Sao Paulo
(2) Department of Astronomy, University of Wisconsin-Madison

## I. INTRODUCTION

Mass loss plays a central role in the late stages of stellar evolution. In addition, mass loss from Asymptotic Giant Branch (AGB) stars, such as Mira variables, and from red supergiants may be responsible for up to 60%, relative to all stars, of the interstellar dust input into the interstellar medium (Gehrz 1989). Mass loss for low- and intermediate-mass stars occurs at rates of up to 10(-4) solar masses/yr in the AGB stage (see, e.g., Chapman 1994 for a review). It has been proposed (e.g. Bedijn 1988; Bowen and Willson 1991) that the mass loss rate actually increases with time so that a star loses a good share of its mass near the end of the AGB evolution, its envelope being finally stripped away.

Despite the success of this general picture, details of the physical processes occurring during mass loss are still not well understood. Models for pulsating red giant stars have been able to incorporate a great deal of physics in describing the atmospheric structure and stellar winds from Luminous Red Variables, or LRVs (Willson and Bowen 1988; Bowen and Willson 1991). In particular, these impressive models assume spherical symmetry. Nevertheless, departures from spherical symmetry are known to exist around LRVs. One piece of evidence for this is that light from these objects typically shows some degree of linear polarization.

Intrinsic optical polarization in red long-period variables was discovered in the early sixties (see Magalhaes 1988 for a review) and indicated that non-spherically-symmetric structures do exist in the extended atmospheres of LRVs (see II below). Further evidence of asphericity in LRV envelopes comes from details of OH maser emission profiles from Miras and OH/IR stars (Collison and Fix 1992), rings of SiO maser emission around some stars (Diamond et al. 1994; Greenhill et al. 1995) and OH radio images (Chapman et al. 1994). Aspherical symmetries such as found by Trammell, Dinerstein and Goodrich (1994) for post-AGB stars from spectropolarimetry may then be naturally understood, as they are already present in earlier stages. The observed, more obvious non-spherical symmetries in Protoplanetary and Planetary Nebulae (PPN) studied in the optical and IR (Kwok 1993) and also seen in optical polarimetry of evolved objects (Johnson and Jones 1991; Trammell, Dinerstein and Goodrich 1994) are also consistent with the origin of the asymmetries being early in the AGB phase.

II. MECHANISMS THAT PRODUCE POLARIZATION IN LRVs

Polarization observations yield otherwise unobtainable diagnostics related to the geometrical structure of unresolvable objects as well as the nature of the scattering physics. The basic information available for analysis is the degree of polarization and its wavelength and time dependence. The degree of polarization depends on the nature and optical depth of the scatterers and on their geometrical distribution. The polarimetric wavelength dependence arises from the wavelength dependence of single-scattering polarization, of the scattering cross-section, of any competing opacity, and of any unpolarized, diluting stellar light. Time dependence arises when the asymmetry or the optical depth of the scatterers varies with time, as in a pulsating star or variable stellar wind.

Linear polarization parameters, i.e. the degree of polarization P, in percentage, and the position angle theta, are usually transformed for analysis into two of the Stokes parameters, Q = P.I.cos(2.theta) and U = P.I.sin(2.theta), where I, the first Stokes parameter, is the beam intensity (the fourth Stokes parameter is V, which describes circular polarization). The Q-U plane, where the polarization is represented by a point with polar coordinates {[Q^2 + U^2]^1/2, 2(theta)}, lends itself well to polarization diagnostics. In this plane, if the observed polarization results from multiple components, the Q,U components of each polarization add like a vector for each band. A classical case occurs when the observed polarization in the several wavelength bands is the combination of an intrinsic component plus an interstellar component. If the intrinsic polarization has a wavelength-independent position angle, an appropriate correction for the interstellar polarization will result in points along a straight line in the Q-U plane. Another situation occurs when a restricted wavelength interval is being studed, such as across a spectral feature. The vector difference line-continuum will not be affected by the interstellar polarization. Since the polarization is usually small, these considerations will also be true for the more often used normalized Stokes parameters, q = Q/I and u = U/I, and the analysis can be carried out in the q-u plane.

As mentioned above, polarimetry, and in particular spectropolarimetry, may be a helpful probe in studying the environs of evolved cool stars (Magalhaes 1988). In general, the optical linear polarization of LRVs is moderately large (a few to several percent); the polarization position angle and wavelength dependence typically vary with time, and the polarization typically increases with decreasing wavelength, which is taken as indicative of Rayleigh or Mie scattering.

Two basic models have been invoked to explain the observations. One of them involves scattering in a non-spherically-symmetric dust cloud (Kruszewski, Gehrels and Serkowski 1968; Shawl 1975). In this case, stellar light gets polarized by being scattered off dust grains. A non-spherically-symmetric dust distribution, such as that if a disk, would then produce a net observable polarization. Shawl (1975) has considered optically thin models whereas the Monte Carlo method can be used for arbitrary optical depths (Lefevre and Daniel 1988).

In contrast to this model, photospheric scattering, coupled to some asymmetry over the stellar disk, could cause the observed polarization (Harrington 1969). The reasoning is that the strong gradient of the photospheric source function with optical depth at the shorter wavelengths will cause radiation at these wavelengths to come predominantly from deeper layers. This could cause strong limb polarization, with position angle usually tangent to the limb, as a consequence of molecular Rayleigh scattering, the phase function of which has maximum polarization at a 90 degree scattering angle.

The needed asymmetries over the disk could arise from non-radial pulsations, stellar spots, or other, more systematic variations in the temperature across the stellar surface. It has been suggested, in a different context, that temperature differences could indeed arise from the formation of giant convective cells (Schwarzschild 1975). Other possible origins for asymmetries in models for the atmospheric structure of LRVs are discussed by Willson and Bowen (1988). The wavelength dependence of the polarization produced by an asymmetric photosphere can be quite complex, as it will depend on details such as how the ratio of absorption to scattering varies with optical depth and wavelength and the temperature gradient (Magalhaes, Coyne and Benedetti 1986). Of course, a combination of stellar surface asymmetries with scattering by a dust shell could also give rise to a net polarization. Changes in the polarization across molecular bands, such as TiO bands, may also result from dust scattering alone, as the size of the source as seen by the dust shell will vary with wavelength across the feature. A large stellar spot, with a different overall temperature than the remainder of the stellar disk, may provide the asymmetry and cause changes in the polarization across spectral features.

Finally, even though this discussion includes linear polarization only, circular polarization may also appear in envelopes of LRVs. Circular polarization can arise from multiple Mie scattering in an asymmetric dust envelope. This is because, besides different cross sections for scattering in perpendicular polarization planes, even spherical dust grains will usually have different cross sections for a phase change after scattering. The first (say) scattering linearly polarizes the light; the next scattering will convert the incoming linear polarization into elliptically polarized scattered light, similarly to a waveplate retarder. Multiple scattering by molecules will cause no circular polarization, as the elementary Rayleigh scattering process per se does not introduce any phase shift on the incoming polarization. Light leaving the photosphere linearly polarized will similarly be circularly polarized when scattered off a dust envelope. Magneto-emission from stellar spots will also be circularly polarized (Holenstein 1991).

## III. SPECTROPOLARIMETRIC MONITORING OF LRVs

Changes in the polarization across photospheric features and with time should in principle provide a wealth of information concerning the processes occurring in these environments and should help distinguish among the different models (Magalhaes 1988). A detailed analysis of asymmetries around LRVs requires high-accuracy spectropolarimetry. Until the late 80's however, the spectropolarimetric database of LRVs was very meager. This was due basically to the long integration times necessary to achieve the needed accuracy, and to the difficult task of obtaining adequate phase coverage of these long-period variables.

Since 1989, a dedicated spectropolarimeter, HPOL, has been operating on every clear night at the University of Wisconsin's 90-cm telescope at Pine Bluff Observatory (PBO). The main features of the equipment are high polarimetric stability (0.002% in broad band work), high precision due to the large dynamic range of the CCD, and wide wavelength coverage (presently 3200 - 10500 A, with 8 A resolution). We have been monitoring a few specific red variables which earlier data have shown to be of particular interest. A survey of several red variables is also being conducted. Below we discuss some of the data we have been acquiring for three red variables, namely Alpha Ori, o Cet (Mira) and V CVn, which are among the ones with better phase coverage. These objects give some clues as to the processes involved in causing the polarization and the diverse phenomena that take place in the complex circumstellar environments of LRVs.

## III(a). Alpha Ori

Alpha Ori is a red supergiant of type M2 Iab, with probably around 10 solar masses, 1350 solar radii and 3500 K effective temperature. It is a semiregular variable of type SRc. After about one year of B-filter polarimetry, Hayes (1984) found that Alpha Ori showed variations with ~1% amplitude that seemed to be slow and orderly. Clarke and Schwarz (1984) found TiO spectral features in plots of both degree of polarization and position angle as a function of wavelength. A pulsation period of about one year was found both in the UV continuum and in radial velocity measurements (Dupree et al. 1987; Smith, Patten and Goldberg 1989). Alpha Ori has a dust shell with an inner radius of about 45 stellar radii (Danchi et al. 1994).

Alpha Ori has been monitored spectropolarimetrically at PBO since 1990. In addition, in December 1990 and February 1995 it was observed from 1500 to 3000 A by the Wisconsin Ultraviolet Photo Polarimeter Experiment, WUPPE, on board the Space Shuttle Astro-1 and Astro-2 observatories. In the PBO data, the different TiO band systems (gamma, gamma' and alpha) show distinct behavior in percent polarization and position angle. Further, "B filter" data obtained from the spectral data and the TiO gamma-system track each other in the Stokes Q-U plane, while the TiO alpha-system behaves as a separate, unmodulated component. The "B filter" measurements actually describe a seasonal loop in the Q-U plane, with an amplitude of about 0.8% and a random position angle from year to year.

The WUPPE Astro-1 UV data show a dramatic rise in polarization to about 2% at 3000 A, followed by a steep drop below 2900 A (Nordsieck et al. 1994). The Mg II emission line at 2800 A is unpolarized. The UV upturn has the same position angle as the alpha system in the optical region. The interpretation of these rather complex sets of data is that there are two geometrically separate components. One component is responsible for the visible blue continuum and TiO gamma-system polarization and is modulated by an yearly cycle, albeit with a random position angle. The TiO alpha system and UV upturn component seem to vary smoothly on a longer timescale.

Other correlations confirm that the first, "B filter" component is indeed modulated by a radial pulsation. Radial velocity data (Smith 1994), spectral types from PBO TiO equivalent widths, and "B" polarization amplitudes all correlate rather well. In addition, the blue component polarization extrema occur at the maximum and minimum extensions of the photosphere. There is a puzzle, however: the largest TiO equivalent widths (i.e. the latest types) seem to happen at minimum photospheric radius.

Such analyses of the spectropolarimetric data of Alpha Ori, still in progress, with their changes across molecular features and wavelength dependence, indicate that the polarization is caused by photospheric Rayleigh scattering with a time-varying obscuration or photospheric spot (Nordsieck et al. 1994). The asymmetry could also arise from non-radial pulsations (Holenstein 1991), which could cause a hot region over the stellar disk.

## III(b). V CVn

The remarkable semiregular variable V CVn (M4-6 IIIe, P = 192 days) was one of the first objects noted to show large intrinsic polarization in broad-band data (Serkowski 1966). Most of the time V CVn shows a rather well behaved light curve and could be considered a small-amplitude Mira. A small, apparently constant polarization in the near IR would seem to come from dust scattering in an asymmetric shell (Shawl 1975). Shawl noted that his single-scattering grain models were not adequate to explain the observed polarization, particularly the large increase in polarization to the blue that is often observed. Coyne and Magalhaes (1977) conducted broad- and narrow-band measurements and suggested that resonant or fluorescent scattering in lines such as H-beta could be operative. Such a mechanism, capable of producing polarized light, would compete with the unpolarized recombination radiation as a shock front moved through the photosphere. Further spectropolarimetric data with a scanning instrument (Coyne and Magalhaes 1979) showed that the polarization changed through the TiO 4955 A band, giving evidence for a photospheric origin for the polarization in V CVn.

Additional support for a photospheric mechanism for the optical polarization comes from the data of Holenstein (1991), who noted that his circular polarization measurements were not consistent with the idea that the time variations in the linear polarization were due to variations in grain formation and density. Circular polarization would be quite sensitive to such variations and it would vary much more than is observed; more likely, it could come from spots on the stellar surface.

The PBO data for V CVn from 1990 through the present have several features. As in earlier data (Serkowski 1966; Coyne and Magalhaes 1977, 1979) but now with much more resolution, the polarization generally increases towards the violet, reaching at times up to 10% (!) in that spectral region. The average polarization level is tightly related to the light curve, and actually mirrors it, in the sense that the polarization is small when V CVn is bright and vice-versa. Another interesting feature is that PBO data, as well as the earlier data and in contrast to Alpha Ori, show that the position angle is always observed to be within rather limited bounds, +/-15 degrees or so, over the years. Finally, the polarization generally decreases across TiO bands, sometimes with modest position angle changes. The behavior of the TiO alpha and gamma bands actually resembles that of Alpha Ori discussed above.

If the optical polarization in V CVn were produced by scattering in an asymmetrical dust shell, one would expect the observed polarization to decrease as the star pulsates and becomes more extended, due to the larger range of scattering angles involved, contrary to what is observed. In contrast, a more extended, non-spherically-symmetric atmosphere leads to a higher polarization (Peraiah 1976) if the polarization is produced by Rayleigh scattering in the photosphere. The close correlation of polarization and phase is also more naturally explained.

The V CVn data are then consistent with most of the optical polarization being produced in its photosphere. Some asymmetry exists already at the photospheric level, even though the nature of the asymmetry is not completely clear. The stability of the position angle, always within rather strict bounds, as observed for decades now, raises the possibility that the asymmetry could be related to the rotation of the star. A modest rotation could, for instance, cause a noticeable pole-to-equator temperature variation over the stellar surface.

III(c). o Ceti

The prototype of the Mira variable class is also known to be intrinsically polarized, though most of the data in the literature are broad-band observations. Filter measurements of Shawl (1975) showed that the polarization of Mira in the blue increased sharply around phase 0.8 in the light curve, when the hydrogen lines from the periodic shock front first appear in the spectra. The data were interpreted to indicate that grains form in the circumstellar envelope around that phase. Spectropolarimetric data of McLean and Coyne (1978), obtained around maximum light, indicated a sharp increase in the linear polarization across the hydrogen Balmer emission lines.

PBO data for Mira show for the first time that the overall polarization around maximum light (phases 0.9 through 0.3) is strongly related to the shock wave that progresses outward in each cycle. Also, the degree of polarization increases sharply through the Balmer emission lines, as they appear and then fade, with little or no position angle rotation through the lines. H-gamma and H-delta reach their peak intensity earlier than H-beta, as the latter is within a TiO band. The overall degree of polarization also rises and falls through the cycle, being steeper into the blue when the polarization is higher, around phase 0.0. Changes in the polarization percentage and position angle across TiO bands are also seen.

These data for Mira suggest a non-spherically-symmetric shock front, whose light is scattered further above, in the molecular atmosphere or dust envelope. The polarization then reflects the shock energy distribution, modified by the wavelength-dependent scattering and absorption opacities. Non-LTE effects, i.e. scattering in the lines as discussed above for V CVn, may be present. The fact that line radiation may have such an additional component besides thermal recombination radiation indicates that polarization through the Balmer emission lines can be useful as a probe through the atmosphere.

## VI. FINAL REMARKS

Spectropolarimetric monitoring of red giants and supergiants is continuing at PBO and data for almost 40 LRVs now show that the lack of spherically-symmetric LRVs is indeed ubiquitous. This finding corroborates the idea that the phenomenon observed at later stages of stellar evolution (OH/IR stars, PPN, PN, etc.) appears early in the AGB and red supergiant phases.

The data will allow models to provide further insight into the extended atmospheres and circumstellar environments of LRVs and will give feedback into already existing models. Radiative transfer of polarized radiation will be useful to fully analyze the expected limb darkening and polarization from an LRV photosphere. Such an analysis could be done using the results from model atmospheres such as those by Plez, Brett and Nordlund (1992), in combination with a polarized radiation transfer code. This would allow detailed study of the limb polarization through the main molecular features at different spectral types. Comparison of such a study with the observations should provide important feedback to the model atmospheres themselves and to details such as TiO band formation.

Monte Carlo scattering models (Lefevre and Daniel 1988; Holenstein 1991; Rodrigues and Magalhaes 1995) have become sophisticated enough that modelling of observational data is already possible when scattering in an extended atmosphere plus a combination of geometries are involved. These models are also useful for interpreting polarimetry data for PPN. Observing programs of PPN are currently under way in Wisconsin and Sao Paulo.

Finally, future coordination between polarimetric observations and other techniques, such as optical interferometry and radio imaging, for a few selected objects, may prove instrumental for gaining a complete picture of the asymmetries around LRVs and improved knowledge of the mass-loss process.

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## III. RESEARCH NEWS

L. Zacs (Riga), with V. Klochkova, V. Panchuk (Nizhny Arkhyz), and R. Spelmanis (Riga), has carried out high-resolution and high-signal-to-noise observations of the protoplanetary nebula candidate IRAS 19114+0002 using the 6-m telescope equipped with a CCD detector. Spectroscopic indicators provide the atmospheric parameters Teff = 6800 K and log g = 1.3 (cgs), which are approximately those of a normal F5 supergiant. Standard LTE analysis with model atmospheres using these parameters shows that most of the iron-peak elements are slightly metal-poor with [X] about -0.10 dex relative to the normal giant Epsilon Virginis; however, Sc and Ti are overabundant (by about 0.5 dex). The alpha-process elements have solar abundances or are slightly deficient, except Na, which is overabundant. The elements heavier than Ni are enhanced +0.7 dex, on the average, compared to the standard. The radial velocity derived from approximately 60 absorption lines is found to be 88.4 km/s. The Na D-line and H-alpha profiles show very complex structure, indicating the presence of a shell or disk near the star. The detached circumstellar shell, low iron abundance, radial velocity, and likely overabundance of s-process elements suggest that IRAS 19114+0002 is probably an evolved low-mass star in an evolutionary stage between the asymptotic giant branch and becoming a planetary nebula. However, this object differs essentially from extremely iron-deficient PPN candidates (van Winckel, Waelkens and Water 1995) which presumably represent a particular stage in binary evolution rather than being typical post-AGB stars.

A. Larson and A. Irwin (Univ. Victoria) have developed an efficient method of dealing with line haze in stellar spectra. Their method uses a rapid evaluation of the accumulated line blocking to eliminate the ultra-weak lines from the line list. The resultant synthetic spectra can be calculated an order of magnitude faster without appreciably affecting the calculated line haze. Their paper has been submitted to Astron. & Ap., and the electronic version may be found using anonymous ftp to otter.phys.uvic.ca, directory pub/larson/linehaze.

T. Lloyd Evans (SAAO) reports that R Lep has been followed in the year since the Na D-lines were found to be abnormally weak at the time of the 1994 maximum. The star has been unusually faint visually for its phase and JHKL photometry showed it to be much redder than normal. Na-D returned to near normal while K I and Rb I were strongly in emission throughout the year. C2 emission, weakly seen at 5165 A in March and May 1994, weakened in July but was very strong from December 1994 to May 1995. This is rather similar to the behavior of V Hya during its deep minimum in 1992-1994. Episodic mass loss seems to be the likely explanation in each case.

The transition of a massive post-main-sequence star from red supergiant to luminous blue variable or Wolf-Rayet star is a rapid and therefore rarely observed phase of evolution. J. Kastner (MIT Center for Space Research) and D. Weintraub (Vanderbilt U.) have obtained evidence that the unusual yellow supergiants IRC+10420 and HD 179821 (= AFGL 2343) are undergoing such a transition. Polarimetric, coronagraphic near-infrared images reveal that each star is surrounded by an extended dust reflection nebula. These detections set IRC+10420 and HD 179821 apart from 89 Her, HD 161796 and several other luminosity class I stars that are thought to be descended from low- to intermediate-mass progenitors.

The nebulae surrounding IRC+10420 and HD 179821 are very similar: each appears circularly symmetric, is detected out to 9" from the central star at 1.25 microns, and is unusually red for a reflection nebulosity. The last result suggests that the dust grains in these envelopes are larger than typical grains in the dust envelopes of low- and intermediate-mass evolved stars. Under the assumption that both stars lie at their kinematic distances (about 6 kpc in each case), the images suggest that each circumstellar envelope has a dynamical lifetime of about 5000 yr, contains about 5 M(sun) of gas and dust, and was probably ejected during a prior OH/IR supergiant phase. Thus, in addition to bolstering the post-red-supergiant classifications of both stars, these imaging results appear to place strong constraints on the evolutionary and mass-loss histories of supernova progenitors.

Preprints are available via anonymous ftp from space.mit.edu (directory pub/jhk) or contact jhk@juggler.mit.edu.

H. Schwarz (ESO, Chile), H. Olofsson (Stockholm), and K. Eriksson and B. Gustafsson (Uppsala) have optically imaged the mass-loss shells around three bright carbon stars (R Scl, U Ant, and S Sct). These shells had previously been detected as small emission peaks in strong circumstellar absorption resonance lines using high-resolution spectroscopy, and they have been mapped at mm wavelengths with the Swedish ESO Submillimeter Telescope (SEST) in the CO line (see Olofsson et al. 1992 ApJ 380, 593; 1993 ApJS 87, 2670 and 3050, and refs). The authors have used optical coronographic polarimetry in the K I and Na-D resonance lines to look for the scattered starlight from these mass-loss-event shells. The 3.6-m telescope at ESO, La Silla, was used to make images of the candidate stars and a number of template stars without shells. By using narrow-band filters centered on the resonance lines, a coronograph to obscure the bright stars themselves, and polarimetry, the contrast against the sky background was increased by a factor of about 600 over direct imaging in broad-band filters. Subtraction of the normalized template star profile yields the shell image. Preliminary results indicate that the degree of polarization increases toward the outer parts of the shells, as expected from a shell in which Rayleigh-type scattering takes place, because the scattering angles approach 90 degrees at the edge. The sizes of the shells correlate with the sizes determined in CO. Only a preliminary reduction of the data has been done and a detailed report is in preparation.

N. van der Bliek, L. Nyman, and H. Schwarz (ESO, Chile), with K. Eriksson and B. Gustafsson (Uppsala), have started a program of observations using optical coronographic imaging polarimetry in narrow-band filters to search for fossil planetary nebulae around barium stars. Since Ba stars are thought to be binaries in which one component is probably a white dwarf, and the s-process element excess (but without Tc) has been caused by mass transfer from an AGB star which has now become the white dwarf, a planetary nebula may have formed in the process. Some of the material that formed the PN should still be present and might be detectable by a sensitive technique for detecting faint extended emission around bright stars. The observational method is described in the preceding paragraph. Observations of 5 stars have been made in CO with the SEST. No circumstellar material has been detected thus far, but the sample is very small and more stars must be observed before a statistically significant statement can be made about the presence or not of such fossil nebulae. Van der Bliek et al. are also engaged in a program of high-resolution spectroscopy of yellow symbiotic stars to determine whether they show overabundances of s-process elements other than Tc, which is the signature of a Ba star. If symbiotics are found to be Ba stars, then the binary hypothesis for the formation of barium stars is put on a much firmer footing. Yellow symbiotics were chosen for this study because the cooler types have too many lines and could have made their own s-process element overabundances by being on the AGB. This would make the analysis very difficult. The authors report that the observations are rather painful: they are attempting to get S/N = 100 spectra of a V = 10th magnitude (the brightest one!) reddish star, in the blue, with a 1.4-m telescope, at a resolving power of 55000!

## IV. MEETINGS

August 14-18, 1995
Photometric Systems and Standard Stars
Moletai, Lithuania
Contact: V. Straizys
straizys@itpa.elnet.lt

August 28-September 1, 1995
Hydrogen Deficient Stars
Bamberg, Germany
Contact: U. Heber
heber@sternwarte.uni-erlangen.de

October 3-6, 1995
9th Cambridge Workshop on Cool Stars, Stellar Systems and the Sun
Florence, Italy
Contact: R. Pallavicini
pallavic@arcetri.astro.it

October 9-11, 1995
Formation of the Galactic Halo: Inside and Out, Honoring the 65th Birthday of George Preston
Tucson AZ, USA
Contact: R. Zinn
zinn@astro.yale.edu

October 9-13, 1995
IAU Symposium 176, Stellar Surface Structure
Vienna, Austria
Contact: K. Strassmeier or J. Linsky
iau@astro.ast.univie.ac.at
jlinsky@jila.colorado.edu

October 26-November 1, 1995
Third Pacific Rim Conference, Recent Developments on Binary Star Research
Lopburi, Thailand
Contact: K. Leung or B. Soonthornthum
kleung@unlinfo.unl.edu
boonraks@cmu.chiangmai.ac.th

May 27-31, 1996
IAU Symposium 177, The Carbon Star Phenomenon
Antalya, Turkey
Contact: R. Wing
wing.1@osu.edu

June 23-29, 1996
Stellar Ecology, In celebration of the 65th Birthday of Icko Iben, Jr.
Elba, Italy
Contact: R. Rood
rtr@ninkasi.astro.virginia.edu

## V. THE WORKING GROUP ORGANIZING COMMITTEE

Uffe Grae Jorgensen
Niels Bohr Institute
Blegdamsvej 17
DK-2100 Copenhagen
Denmark
uffegj@nbivax.nbi.dk

John Lattanzio
Dept. of Mathematics
Monash University
Clayton, Victoria 3168
Australia
johnl@flash.maths.monash.edu.au

A. Mario Magalhaes
Instituto Astronomico e Geofisico
Universidade de Sao Paulo
Caixa Postal 9638
Sao Paulo,SP 01065-970
Brazil
magalhaes@vax.iagusp.usp.br

Monique Querci
Obs. Midi-Pyrenees
14 Avenue Edouard Belin
F-31400 Toulouse
France
querci@obs-mip.fr

Verne V. Smith
Dept. of Astronomy
University of Texas
Austin, TX 78712
USA
verne@astro.as.utexas.edu

Robert E. Stencel
Dept. of Physics & Astronomy
Univ. of Denver
Denver, CO 80208
USA
rstencel@diana.du.edu

Takashi Tsuji
Tokyo Astronomical Observatory
Mitaka
Tokyo 181
Japan
ttsuji@c1.mtk.nao.ac.jp

Robert F. Wing
(WG Chair)
Dept. of Astronomy
Ohio State Univ.
174 W. 18th Ave.
Columbus, OH 43210
USA
wing.1@osu.edu

Sandra B. Yorka
(Editor)
Dept. of Physics & Astronomy
Denison University
Granville, OH 43023
USA
yorka@cc.denison.edu