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In Memorial

In Memorial of Professor Victor Ambartsumian[1]

Eminent Armenian scientist, astronomer Professor Victor Ambartsumian, Honorary President of the Armenian National Academy of Science, died on the 12^{th} of August, 1996. He was an honorary, or foreign, member of the academies of sciences of more than 25 countries and a Doctor of many well-known Universities. The scientific community of the world recognized his activites by electing him president of the IAU (1961-1964) and president of the International Council of Scientific Unions (1970-1974). His book *Theoretical Astrophysics* (1958, Pergamon Press) became a bible for a generation of astronomers.

V. Ambartsumian was born in 1908. He wrote his first papers on "The New Sixteen-Year Period for Sunspots", "Description of Nebulae in Connection with the Hypothesis on the Origin of the Universe" when he was only an 11–year–old schoolboy. His talent was recognised very soon and his father sent him to Leningrad where he obtained his higher education. V. Ambartsumian's first collaborators and friends then were A. Kozyrev, D. Ivanenko and M. Bronstein. During the short period 1928-1930 (he was still a student) Ambartsumian published 22 papers in Astron. Nachrichten, Z.f.Phys, MNRAS and other journals. He had broad research interests. His work "The Quantization of Space" was reported at the International Conference in Odessa where Sommerfeld, Pauli, Jordan, Dirac and many others were present. After the meeting Pauli told Ambartsumian,"Colleague Ambartsumyan, at the moment

[1] Also known as Ambartsumyan or Ambarzumyan

the position of quantum electrodynamics appears hopeless. However, in a conversation with Mr Tamm I said that just a few ideas are needed like those of the English mathematician Ursell and yours to make the study of quantum mechanics possible again.“ In another paper published in 1930 (when neutrons had not yet been discovered) V. Ambartsumian and D. Ivanenko argued against the presence of electrons in the atomic nuclei. Soon Ambartsumian became a lecturer at Leningrad State University and when after 1934, he was made a professor at 26 years old!, he organised and headed the Chair of Astrophysics at the Leningrad State University. His first PhD student was V.V. Sobolev (known from the Sobolev Approximation). It is commonly accepted that V. Ambartsumian is a father of the Soviet school of Theoretical Astrophysics. The most important steps in his scientific career can be given as:

1. Early papers published in the 30s and devoted to radiative transfer and stellar dynamics. After many years Edward Arthur Milne would write in *Observatory* that he had never imagined that the theory of radiation transfer, on which he, too, had been working, could have attained the level of development and beauty which it had achieved in the hands of Ambartsumyan.

2. First numerical inversion of the Radon transform (MNRAS, 96, 172, 1935, the paper presented to MNRAS by Arthur Eddington), involved the 3D velocity distribution of stars in the Galaxy. After many years A. Cormack (Dept.of Physics, Tufts University, USA) would write in this connection: *...even in 1936 computed tomography might have been able to make significant contributions to, say, the diagnosis of tumors in the head....it seems to me quite possible that Ambartsumian's numerical methods might have made significant contributions to that part of medicine had they been applied in 1936* (Computed Tomography, some history and recent developments, Proc. of Symposia in Applied Mathematics, Vol.29, p 35, 1985).

3. First idea about the patchy structure of the interstellar absorption: 1938. S. Chandrasekhar wrote in this connection,... *Ambartsumian's marvelously elegant formulation of the fluctuations in brightness in the Milky Way* “in the limit of infinite optical depth, the probability distribution of the fluctuations in the brightness of the Milky Way is invariant with respect to the location of the observer.“ *... Ambartsumian introduced for the first time the now commonly accepted notion that interstellar matter occurs in the form of clouds.*

4. The Principal of Invariance: 1943. The power of this method introduced in a theory of radiation transfer has been applied in other sciences (optics, mathematical physics, etc.) allowing people to handle easily very complex mathematical problems. The method was succesfuly developed later by S. Chandrasekhar in his monograph *Radiation Transfer*.

5. Discovery of Stellar Associations: 1947. V. Ambartsumian originally introduced the term *Stellar Association* dividing them into two groups: OB and T associations. He showed that Stellar Associations are star forming regions.

6. It was in the early 50s when Prof. Victor Ambartsumian first raised the issue of the Activity of Nuclei of Galaxies (AGN). In his famous report at the Solvay Conference on Physics (Brussels, 1958) Ambartsumian said that enormous explosions take place in galactic nuclei and as a result a huge amount of mass is expelled. In addition if this is so, these galactic nuclei must contain bodies of a huge mass and unknown nature. During a break in the session Walter Baade went up to Ambartsumian and said,*Professor Ambartsumian, you have come from the Soviet Union, and I from America. Logically speaking, you should be a materialist, and I an idealist. But what you have just said is nothing other than a pure idealism! It's fantastic! You speak about some kind of “non-stellar“ objects which no one has seen. So it must be something inexplicable, mysterious.* The concept of AGN was widely accepted a few years later. One of the students of

V. Ambartsumian, B. Markarian (known from Markarian galaxies) completed a famous survey of galaxies with a UV excess using the 1 m–Shmidt type telescope of the Byurakan Observatory. IAU Symposia No. 29 and 121 were hosted by the Byurakan Astrophysical Observatory in 1966 and 1986, 10 and 30 years after Ambartsumian's pioneering ideas about AGN phenomenon.

V. Ambartsumian returned to Armenia from Leningrad and in 1946 founded the Byurakan Astrophysical Observatory on the slopes of Mt. Aragats (4090 m) rising from the valley of Mt. Ararat. Soon he became a President of the Armenian Academy of Science. About 20,000 scientists, most of them in the system of the Academy of Sceince, were working in 1985 in a small republic with less than a 3.5 million population. V. Ambartsumian was the founder of the journal Astrofizica (Astrophysics). He remained as an Editor in Chief of the journal and a Director of the Byurakan Astrophysical Observatory until the mid 80's.

It is commonly recognised that V. Ambartsumian's papers were very *original* and *revolutionary*, striking in their mathematical beauty and accuracy. Congratulating Ambartsumian on his 80^{th} birthday Chandrasekhar wrote, ... *The only other astronomer of this century who compares with Academician Ambartsumian in his constancy and devotion to astronomy is Professor Jan Oort; but they would appear to be dissimilar in every other way. It will be a worthy theme for a historian of science of the twenty-first century to compare and contrast these two great men of science. He is an astronomer par excellence. There can be no more than two or three astronomers in this century who can look back on a life so worthily devoted to the progress of astronomy.* (Astrophysics, Vol 29, No.1, p 408, 1989).

All material was collected from different articles and books.

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Accepted Papers

HD 9974: A case for a Wolf–Rayet star associated with an unusual interstellar bubble?

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The neutral matter distribution from the interstellar medium local to the galactic Wolf–Rayet (WR) star HD 9974 has been analyzed by means of interferometric HI 21–cm line observations. The interesting finding is an ovoidal HI minimum spanning the velocity range -43.40 km s^{-1} to -53.30 km s^{-1}, created, very likely, by the joint action of the progenitor of HD 9974 and the WR itself. Inside this area of low HI emissivity, two well defined minima are easily noticed. As seems to be the rule, the WR star is offset with respect to the geometrical centre of the main depression and the centroid of the

inner minima. Based on the systemic radial velocity of the HI void, a kinematical distance of $\sim$4.3$\pm$0.9 kpc is derived. The dual HI–minimum geometry, a feature also observed in the interstellar bubbles likely to be associated with other galactic WR stars, appears to be a consequence of the interaction process itself. The ovoidal shape of the main HI cavity cannot be explained within the framework of the standard interstellar bubble theory, unless the assumption of the isotropy of the stellar wind is dropped. A simple *geometrical* model for the spatial distribution of the HI is elaborated. This model can explain some of the new features (e.g. the dual–lobe appearance) observed in a few of the interstellar bubbles related to WR stars observed with high angular resolution.

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New discoveries on the S Dor phenomenon based on an investigation of the photometric history of the variables AG Car, S Dor and η Car

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A century of photometric observations of AG Car and S Dor is investigated for general characteristics and possible periodicities in the occurrence of the S Dor (SD) phases, defined as episodes of a radius and an apparent brightness variation at a more or less constant luminosity. We identified two types of such phases: the "very-long-term" (VLT) and the "normal" SD phases. The latter are superimposed on the first.

The time scales for the VLT-SD phases are in the order of decades for both variables. The normal SD phases of AG Car and presumably also of S Dor obey stable periods of 371.4 $\pm$ 0.6 d and 6.8 $\pm$ 0.1 yr, respectively. We suspect that the SD-, or LBV phenomenon is provoked by two types of pulsational modes. The oscillating O-C values for both variables indicate the possible presence of beat cycles. Their time scales are of the order of years to decades.

We found, at least for the SD activity of AG Car, further support for a radius change of the star and a more or less horizontal displacement in the theoretical HR-diagram. However, S Dor has a higher luminosity in minimum than in maximum, amounting to $0\overset{\mathrm{m}}{.}5$ - 1m depending on the range in the visual magnitude (1m - $2\overset{\mathrm{m}}{.}4$).

Inconsistencies between existing temperature scales during the light variations of AG Car were noticed.

We found no cyclic pattern whatsoever in the SD phases of η Car. The time scale for such events within the last 20 yr lies between 1 and 3 yr. There is evidence that over the last 20 yrs the central LBV in the η Car system experienced a rising branch of a VLT-SD phase, which appears to furnish, according to the secular colour change, indirect support for an ongoing decrease of the circumstellar dust density.

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Spectroscopic analysis of early-type stars in young stellar groups. I. Differential analysis of the B1V stars in NGC 2244

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We explore the potential of analysing fast rotating early-type stars differentially with respect to templates derived from a slowly rotating star of the same spectral type. The analysis is successfully applied to the normal B1V stars in NGC 2244, which have projected rotational velocities ranging from 22 to 260 $\mathrm{km\,s^{-1}}$. A classical non-LTE analysis of the slow rotator #201 results in chemical abundances similar to those of early B-type stars in the field and in Orion. We argue that a differential analysis of the fast rotators relative to a broadened template derived from #201 can still reveal abundance differences of $\geq$0.2 dex, but no evidence was found for differences in metal composition at this level. A differential analysis of H and He line profiles reveals the need to further explore rotation models. Neither the classical approach to stellar rotation, nor the published models that include the influence of rotation on the star's atmosphere can bring the profiles of the slow rotator into complete agreement with those of the fast rotators. An attempt to extend the analysis to a Be star failed. The Be spectrum is described qualitatively and quantitative measurements are made for the emission in the core of the Balmer lines.

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Discovery of a bow shock around Vela X–1

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We report the discovery of a symmetric bow shock around the well-known high-mass X-ray binary (HMXB) Vela X–1. Wind bow shocks are a ubiquitous phenomenon around OB-runaway stars, but now such a structure is found around a HMXB. The presence of a bow shock indicates that the system has a high (supersonic) velocity with respect to the interstellar medium. From the symmetry of the bow shock, the direction of motion and, moreover, the origin and age of the system can be derived. Our observation supports Blaauw's scenario for the formation of an OB-runaway star by the supernova explosion of the binary companion.

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Ring Nebula and Bipolar Outflows Associated with the B1.5 Supergiant Sher #25 in NGC 3603

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We have identified a ring-shaped emission-line nebula and a possible bipolar outflow centered on the B1.5 supergiant Sher #25 in the Galactic giant HII region NGC 3603 (distance 6 kpc). The clumpy ring around Sher #25 appears to be tilted by 64° against the plane of the sky. Its semi-major axis (position angle ≈ 165°) is 6.″9 long, which corresponds to a ring diameter of 0.4 pc. The bipolar outflow filaments, presumably located above and below the ring plane on either side of Sher #25, show a separation of ≈ 0.5 pc from the central star.

High-resolution spectra show that the ring has a systemic velocity of $V_{LSR} = +19$ km s^{-1} and a de-projected expansion velocity of 20 km s^{-1}, and that one of the bipolar filaments has an outflow speed of ∼83 km s^{-1}. The spectra also show high [NII]/Hα ratio, suggestive of strong N enrichment. Sher #25 must be an evolved blue supergiant (BSG) past the red supergiant (RSG) stage. We find that the ratio of equatorial to polar mass-loss rate during the red supergiant phase was ≈ 16. We discuss the results in the framework of RSG–BSG wind evolutionary models.

We compare Sher #25 to the progenitor of SN 1987 A, which it resembles in many aspects.

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Hot Evolved Objects in Different Parent Galaxies: The Stellar Winds of Three Planetary Nebula Nuclei in the Large Magellanic Cloud

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Three planetary nebulae in the Large Magellanic Cloud were observed with the Faint Object Spectrograph onboard the Hubble Space Telescope. Their central stars display P Cygni-like features in the ultraviolet. We modeled these profiles to derive the stellar wind velocities. The wind velocities of the LMC planetary nebula nuclei are comparable to those of some Galactic counterparts, but other Galactic objects of similar temparatures exist with higher wind velocities. One object, LMC-SMP 61, has a Wolf-Rayet (WR) type central star. For this nucleus we derived a wind velocity of − 1600 km s^{-1} and an upper limit to the mass loss rate of $\dot{M} \leq 7 \times 10^{-7}$ $M_{\odot}$yr^{-1} from the He and C lines. The observed

continuum emission in the UV and optical range is modeled with a combination of stellar and nebular contributions, yielding independent determinations of stellar and nebular quantities. The sample is numerically too limited for a significant comparison between LMC and Galactic PNNi populations, but represents the first exploration of mass loss properties of *evolved* stellar objects beyond the Milky Way.

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Constraints on the Geometry of Circumstellar Envelopes: Optical Interferometric and Spectropolarimetric Observations of 7 Be Stars

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We have obtained contemporaneous optical interferometry and spectropolarimetry of seven Be stars. The interferometry was done using both continuum and narrow Hα line filters to observe the circumstellar envelope emission. The envelopes of all seven stars were resolved interferometrically in Hα. Of these seven stars, the envelopes of four were not circularly symmetric, and showed clear evidence of elongation. The position angles of the major axis of the elongation were in good agreement with the disk orientation inferred from the intrinsic polarization data, which samples material within a few stellar radii, and also agreed with previous results from the radio, which samples material out as far as 100 stellar radii but at lower resolution. This finding indicates that the envelope alignment persists over two orders of magnitude in radius.

Minimum inclination angle estimates from the interferometry are presented for six of the seven stars. Under the assumption that the envelopes are fairly thin circularly symmetric disks, there is a straightforward explanation of the interferometric results. The stars with the greatest elongations, ζ Tau, ϕ Per, and ψ Per, are seen nearly equator-on; γ Cas is seen at a more intermediate latitude, consistent with previous results; and 48 Per and η Tau, which are only slightly asymmetric, are nearly pole-on. β CMi had insufficient coverage to determine whether its envelope is asymmetric. These results are consistent with independent indications of the inclinations based on the polarimetry. Spectral diagnostics have been used in the past to classify Be stars as pole-on or as shell stars (usually interpreted to indicate an equator-on orientation). Our inclination angle for 48 Per is consistent with its pole-on classification by Slettebak, and the three equator-on stars have all been previously classified as shell stars. However, both γ Cas and η Tau have also been previously classified as shell stars, but we find that they have intermediate and pole-on orientations, respectively. We interpret this finding as evidence that, while equator-on stars may preferentially be shell stars, not all shell stars are actually equator-on.

Our results show that the Hα emission region extends up to about twelve stellar radii, possibly depending on spectral type. The size of this region correlates with the equivalent width of the Hα emission. Our results also provide strong constraints for allowed models of Be star envelopes. In particular, for ζ Tau, we derive an upper limit to the disk opening angle of 20°, which limits the vertical extent of the envelope. We also find that the polarization position angle is perpendicular to the interferometric major axis in all cases. This rules out envelope models that are both optically and geometrically thick, since these models produce polarization parallel to the plane of the disk. We conclude that results from the combined interferometry and polarimetry strongly favor the disk paradigm for Be stars over mildly ellipsoidal models.

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Multi-Periodicity of ζ Ophiuchi From Multi-Site Observations

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We present results from simultaneous multi-site high-resolution spectroscopic and photometric observations of ζ Ophiuchi (HD149757) taken in 1993 May. Our spectroscopic data include about 100 hours of continuous monitoring of the star.

The line-profile variations of He I λ6678, which are characterized by features traveling from blue to red, are well reproduced by two large amplitude sinusoids and other sinusoids with smaller amplitudes. The period of the sinusoid with the largest amplitude is 2.018 hr (f_1) which differs from the 2.43 hr of previous publications, although it is possible that 2.43 hr is an alias of 2.018 hr. The period of the second largest amplitude is, in agreement with previous studies, 3.337 hr (f_2). Periods of smaller amplitude sinusoids are 2.432 hr (f_3), 1.257 hr (f_1+f_2), 1.008 hr ($2f_1$), 2.107 hr (f_4), 1.293 hr (f_2+f_4), 1.668 hr ($2f_2$), all of which have some relation to the two main periods. The two principal periods have close superperiods of about 10.05 hr. We discuss the commensurability and other features of the periodicity.

Our photometric observations, though limited, confirm again the very small amplitude of the light variations which are close to their detection limit. No counterpart of the 2.018 hr and 3.337 hr periods can be detected.

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Combined stellar structure and atmosphere models for massive stars IV. The impact on the ionization structure of single star H II regions

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We study the impact of modern stellar atmospheres that take into account the effects of stellar winds, departures from LTE and line blanketing ("*CoStar*" models) on the ionization structure of H II regions. Results from a large grid of photoionization models are presented. Due to a flatter energy distribution in the He I continuum, compared to the widely used Kurucz models, generally higher ionic ratios are obtained.

We find that N^+/O^+ and Ne^{++}/O^{++} can be safely used as direct indicators of N/O and Ne/O abundance ratios in H II regions, over a wide range of astrophysical situations.

The roughly constant observed value of Ne^{++}/O^{++} ionic ratios in Galactic H II regions is naturally reproduced by photoionization models using *CoStar* fluxes, while Kurucz models at solar metallicity fail to reproduce this behaviour. This gives support to ionizing fluxes from non–LTE atmospheres including stellar winds and line blanketing. However, we also point out that tests of stellar atmosphere models from observations of H II regions are hampered by a lack of strong constraints on the ionization parameter.

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Cross-correlation characteristics of OB stars from IUE spectroscopy

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We present a catalogue of homogeneous measures of line-width parameter, $v_{\rm e} \sin i$, for 373 O-type stars and early-B supergiants (including the separate components of 25 binary and 3 triple systems), produced by cross-correlating high-resolution, short-wavelength IUE spectra against a 'template' spectrum of τ Sco. We also tabulate terminal velocities. There are no O supergiants in our sample with $v_{\rm e} \sin i < 65$ km s^{-1}, and no supergiants earlier than B5 with $v_{\rm e} \sin i < 50$ km s^{-1}, confirming that an important line-broadening mechanism in addition to rotation must be present in these objects. A calibration of the area under the cross-correlation peak against spectral type is used to obtain estimates of continuum intensity ratios of the components in 28 spectroscopically binary or multiple systems. At least seven SB2 systems show evidence for the 'Struve-Sahade effect', a systematic variation in relative line strength as a function of orbital phase. The stellar-wind profiles of the most rapid rotator in our sample, the O9 III: n* star HD 191423 ($v_{\rm e} \sin i = 436$ km s^{-1}), show it to have a 'wind compressed disk' similar to that of HD 93521; this star, and other rapid rotators, are good candidates for studies of non-radial pulsation.

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Inference of Steady Stellar Wind $v(r)$ Laws from Optically Thin Emission Lines I. Idealised Analysis for the Profile of a Single Line

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The form of the profile $F_{\lambda_0}(\Delta\lambda)$ of an emission line from a steady spherical wind of velocity profile $v(r)$ is derived for the case when optical depths are small, when stellar occultation of the wind is neglected, and when $v(r)$ is highly supersonic. It is shown how the resulting integral equation for $v(r)$, given $F_{\lambda_0}(\Delta\lambda)$ can be inverted to yield $v(r)$ if the line emissivity function $j(r)$ is known.

Solutions are demonstrated for simulated data in the case of a recombination line ($j \propto n^2$) for various trial forms of $v(r)$. The solution is unique provided $\mathrm{d}v/\mathrm{d}r$ does not change sign anywhere and is remarkably stable against noise in the $F_{\lambda_0}(\Delta\lambda)$ data. The analysis is idealised in the sense that the stellar mass loss rate $\dot{M}$ and distance D are assumed known, the solution being then carried out in scaled dimensionless variables. The absolute r-scale of the solution for given $F_{\lambda_0}(\Delta\lambda)$ scales as $(\dot{M}/D)^2$. If this quantity is known the method also yields the stellar radius.

To appear in A & A

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Fundamental parameters, helium abundance and distance of X Persei

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We present spectral observations of the Be/X-ray binary system X Persei/4U 0352+30 taken during the recent (1989–1991) low luminosity disk-less phase. On the basis of new spectroscopic and photometric data the following self-consistent values of effective temperature $T_{\rm eff}$, surface gravity g and interstellar absorption A_v for the visible component of the system are determined: $T_{\rm eff}$= 29500 ± 1500 K, log g = 4.0 ± 0.2 and A_v = 1.05 ± 0.02. The corresponding spectral classification of the star is B0 V. The helium overabundance He/H = 0.19 is found, as well as the enhanced nitrogen abundance log ε(N) ≈ 8.4. Two possible explanations of the He excess are proposed (a) internal enrichment of the outer layers of a massive star by CNO-cycle products because of a mixing on the main sequence evolutionary phase or (b) external accretion during the evolution of a massive close binary.

The star has a rotational velocity $v \sin i$= 215 ± 10 km s^{-1} and is located at a distance d = 700 ± 300 pc. The X-ray flux corresponding to this revised distance is of the order of 1–2 10^{34} erg s^{-1} in the normal state, and around 10^{35} erg s^{-1} in the only bright state observed (1974–75). Non-LTE analysis of more recently obtained high resolution profiles of the HeII λ 4686 line shows that there is no evidence for additional heating during the high luminosity phase.

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Observations of the recent disc loss in X Persei : photometry and polarimetry

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We present optical and infrared photometric observations of the Be/X-ray binary system X Persei/4U0352+30 during the past decade, covering the entire phase change from Be to OB star and back. Intrinsic colours are derived based on observations during the disk-less phase, giving E(B–V)=0.36±0.02, $(B–V)_0$=–0.22±0.02 and $(U–B)_0$=–1.05±0.02, suggesting a B0V star at a distance of 900pc±300pc and an extinction of A_v=1.16±0.03. We find evidence for only one variable component, presumed to be the disc. We present measurements of the intrinsic polarisation, and an estimate of the interstellar polarisation. Polarimetric observations reveal major changes in the degree of polarisation, indicating the reformation of a scattering envelope around the star, but these are inconsistent with the predictions of standard Be envelopes models, possibly as a result of geometrical effects.

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Three Massive Binaries and the Struve-Sahade Effect

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Application of cross-correlation methods to the determination of radial velocities from high-resolution *IUE* spectra of AO Cas, Plaskett's Star, and 29 (UW) CMa has highlighted once again the problems, noted in particular by Struve and Sahade, in which the strength and profile of of spectral features depends strongly on phase, generally being stronger during approach to the observer. While measurements of the more luminous component generally provide a reasonable orbital solution, those of the weaker one (and perhaps the more massive) are dynamically unsafe, especially for Plaskett's Star and 29 CMa. A brief discussion of possible causes is given together with encouragement for serious attempts to model a phenomenon which clearly persists at a lower level in many systems.

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Comments on the superluminal motion in Cygnus X-3

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Following the recent discovery that Cyg X-3 exhibits superluminal motion, the implications of superluminal expansion and contraction are investigated. We propose that the effect is due to either a propagating photon pattern or to outwardly moving shells illuminated by an intense beam of radiation.

Accepted by MNRAS

Preprints from `R.N.Ogley@open.ac.uk`
or by anonymous ftp to `ftp://yan.open.ac.uk/pub/astro/rno/Preprints/`

Modelling of Infrared emission from Cyg X-3 and the UKIRT IRCAM3 point spread function

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Modelling of the point spread function of the UKIRT IRCAM3 array was conducted in order to test for any extended emission around the X-ray binary Cyg X-3. We found that the point spread function cannot be represented by a simple Gaussian, but modelling of the stars required additional functions, namely Lorrentzian and exponential components. After modelling for the PSF, we found that Cyg X-3 could be represented by two stellar-type profiles, 0.56" apart.

Accepted by Vistas in Astronomy

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A possible origin for X-rays from O stars

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X-ray spectra of hot, massive stars provide convincing evidence for thermal emission that extends far out into their stellar winds. Accordingly, strong shocks were proposed as sources of the X-ray emission, where the shocks result from the line-driven instability. We show from hydrodynamic simulations that the emission from individual shocks which grow out of initially small perturbations may fall one or two orders of magnitude below the observed flux. Instead, we find that mutual collisions of dense shells of gas formed in deep wind regions can lead to shocks with a much stronger emission which almost matches the observed flux.

This model predicts strong variability of the X-ray emission, which is not observed. We propose that – in contrast to the presently assumed spherical symmetry of the wind – the emission stems from a large number of independent, radial cones so that fluctuations average out over the whole emitting

volume.

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Preprints from feld@usm.uni-muenchen.de

Spectroscopic modelling of non-radial pulsation in rotating early-type stars

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A new computer model which simulates non-radial pulsations in rotating early-type stars is presented. The model constructs time-resolved synthetic spectra for a star undergoing multi-mode non-radial pulsation, using a rotationally-distorted stellar grid and intrinsic spectral line profiles calculated from non-LTE model atmospheres. The treatment includes consideration of pulsation-induced velocity fields and temperature, surface-area and surface-normal perturbations. The effects of rotation on the pulsation modes of the star are considered by expressing the perturbed variables as linear combinations of terms proportional to spherical harmonics. Rotation acts to concentrate pulsational activity towards the stellar equator; this equatorial concentration, when combined with gravity darkening, leads to significant differences in the degree of line-profile variability between spectral lines formed at the equator and the pole, for both sectoral *and* tesseral modes. The rotation also leads to the existence of oscillatory quasi-toroidal modes. The use of rotationally-modified velocity fields and temperature perturbations leads to significant changes to the calculated line-profile variability. In contrast, the surface-area and surface-normal perturbations are the more important mechanisms for generating continuum variations, emphasizing the need for a proper treatment of these effects in the modelling of photometric variability.

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The O-type Binary 15 Monocerotis Nears Periastron

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We present new radial velocity measurements for the massive binary 15 Mon which indicate that the system is now very close to periastron (1996.9) in its 24 year orbit. The velocity separation in the coming year may be large enough to permit an accurate estimate of mass ratio. We also present our first astrometric measurement of 15 Mon made with the *Hubble Space Telescope* Fine Guidance Sensors. The FGS transfer functions are consistent with an advanced orbital position close to periastron, and we present preliminary orbital elements for the combined spectroscopic and astrometric orbit.

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The puzzling Luminous Blue Variable-like object HD 5980 in the Small Magellanic Cloud

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We have observed the exceptional SMC star HD 5980 during several runs from 1989 to 1995 at ESO La Silla. CASPEC at the 3.6 m telescope and EMMI in echelle and long slit modes at NTT were used for spectroscopy. Sub-arcsecond images were obtained using SUSI at NTT and also an adaptive optics system at the 3.6 m telescope. In all our spectra taken before 1994 September HD 5980 shows a spectral type of WN 6. The 1994 September spectra were taken shortly after the maximum of the visual light-curve of the LBV-like phenomenon (Bateson & Jones 1994) and about one month before the observations of Barbá et al. (1995). Near maximum visual brightness, HD 5980 displays a WN 11-like spectrum with the He I lines and the Balmer lines Hδ and Hγ showing well-developed P Cyg profiles. The sub-arcsecond images ($0''.17$ FWHM), through the near infrared bands J, H, and K, obtained in 1993 and 1996, show no stellar components down to 6.7 mag fainter than HD 5980 in K at a separation of $1''.0$ and the 3σ level. For a separation of $0''.3$ this upper bound is 4.1 mag fainter than HD 5980. The observed behavior of this object raises serious problems for our comprehension of the LBV phenomenon in the conventional scenarios of massive star evolution. The present observations cover a crucial period in the evolution of HD 5980 and will therefore be helpful for better understanding this peculiar object especially during its outburst as well as the evolution of W-R stars in general.

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or by anonymous ftp to ftp.obspm.fr, cd transit/heydari, file hd5980.ps.Z

Reviews

Massive stars observed with the GHRS

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A review of the contribution of the GHRS to our understanding of very massive stars is presented. The important role of mass loss is discussed in view of the recent discovery of high mass loosing core-hydrogen burning Wolf-Rayet-like stars in the 30 Doradus ionizing cluster R136a and of very similar stars in the galactic cluster NGC 3603. Evolutionary scenarios accounting for a main sequence Wolf-Rayet or Wolf-Rayet-like phase are compared with these observations. We propose that very massive stars ($M_{\rm i} \gtrsim 100 M_{\odot}$) may start out their lives as Of/WN-type stars.

The predictive power of the theory of line driven winds is critically investigated. The theoretically expected dependence of mass loss on metallicity is discussed and compared to observations of galactic, LMC and SMC stars. We find that $\dot{M} \propto Z^{2/3}$, which is a somewhat stronger dependence than the canonical value of 1/2. The importance of multiple scattering effects in solving the current problems in the radiative driving of high density winds is pointed out.

To appear in *The Scientific Impact of the GHRS,* **eds. J.C. Brandt, C.C. Petersen, T.B. Ake, ASP Conf. Ser.**
Preprints from `alex@homie.gsfc.nasa.gov`
or by anonymous ftp to `homie.gsfc.nasa.gov` *in* `pub` *file* `GHRS_review.ps`

Poster Papers

Infrared emission around Cyg X-3

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We present UKIRT infrared images of the X-ray binary Cygnus X-3. We address the possibility of extended infrared emission and show that it could be either warm circumstellar material or a star near the binary's line of sight.

Proceedings of the IAU Colloquium 163, Accretion phenomena and Associated outflows.
Preprints from `R.N.Ogley@open.ac.uk`
or by anonymous ftp to `ftp://yan.open.ac.uk/pub/astro/rno/Preprints/`

Book

Light Curves of Variable Stars
A Pictorial Atlas

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[2] Centre de Données Astronomiques de Strasbourg (CDS), Strasbourg, France

This volume provides a complete reference on variable stars. It presents a wealth of typical light and colour curves (almost 200 in all) together with an up-to-date description of each class and subclass of variables as defined in the *General Catalogue of Variable Stars* (giving observational characteristics, historical background and current understanding of the astrophysical processes responsible for the variability). It serves the needs of variable-star researchers, as well as graduate students and teachers.

Table of contents:

Cambridge University Press 1996. ISBN 0-521-39016-8

Meetings

Cyclical Variability in Stellar Winds:
Recent Developments and Future Applications

Preliminary announcement:
ESO workshop planned for October 14 - 17, 1997, at ESO Headquarters in Garching bei München, Germany.

Scope:
Variability is a fundamental property of stellar winds. In recent years it has become clear that in many cases the observed variations are cyclical. This is a property that hot- *and* cool-star winds seem to have in common, despite the differences in the physics of their respective driving mechanisms.

Topics to be discussed:

- Observations of cyclical wind variability (hot and cool stars)
- Deep-seated processes affecting the emergence of the wind
- Theoretical developments
- Multi-site campaigns (MUSICOS)
- Future developments

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