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Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 296$^{\text{th}}$ issue of the AGB Newsletter. We're just four issues away from the 300$^{\text{th}}$! Please send contributions (text, pictures, drawings...) to astro.agbnews@keele.ac.uk

This month's *Food for Thought* is a rephrased suggestion by Pierre Darriulat from Vietnam. If you want to comment, or have a suggestion yourself, feel welcome to write to astro.agbnews@keele.ac.uk and we will endeavour to include it in the newsletter's editorial.

The next issue is planned to be distributed around the 1$^{\text{st}}$ of April.

Editorially Yours,
Jacco van Loon, Ambra Nanni and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Planetary or stellar companions only complicate the circumstellar envelopes of red giants or supergiants through their gravity

Reactions to this statement or suggestions for next month's statement can be e-mailed to astro.agbnews@keele.ac.uk (please state whether you wish to remain anonymous)

Refereed Journal Papers

H -band temperature and metallicity indicators for cool giants: empirical relations in Bayesian framework

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We explored here the near-infrared H-band atmospheric window aiming to provide quantitative diagnostic tools for deriving stellar parameters, for instance, effective temperature ($T_{\rm eff}$) and metallicity ([Fe/H]), of cool giants ($T_{\rm eff} < 5000$ K) using low-resolution spectra. We obtained 177 cool giants from the X-Shooter spectral library covering a wider metallicity range (-2.35 dex < [Fe/H] < 0.5 dex) than in earlier works. Degrading the spectral resolution to $R \sim 1200$, we estimated equivalent widths of several important spectral features, and the behaviour of spectral features with stellar parameters are studied. Also, the empirical relations for deriving $T_{\rm eff}$ and [Fe/H] are established in the Bayesian framework. We found that ^{12}CO at 1.56 μm and 1.62 μm, and ^{12}CO + Mg I at 1.71 μm are the best three $T_{\rm eff}$ indicators with a typical accuracy of 153 K, 123 K and 107 K, respectively. The cubic Bayesian model provides the best metallicity estimator with a typical accuracy of 0.22 dex, 0.28 dex, and 0.24 dex for FeH at 1.62 μm, ^{12}CO at 1.64 μm, and Fe I at 1.66 μm, respectively. We also showed a detailed quantitative metallicity dependence of $T_{\rm eff}$–EWs correlations defining three metallicity groups, supersolar ([Fe/H] > 0.0 dex), solar (-0.3 dex < [Fe/H] < 0.3 dex), and subsolar ([Fe/H] < -0.3 dex), from Hierarchical Bayesian modelling. The difference between the solar and subsolar relationship is statistically significant, but such difference is not evident between the solar and supersolar groups.

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Asteroseismology of overmassive, undermassive, and potential past members of the open cluster NGC 6791

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We perform an asteroseismic investigation of giant stars in the field of NGC 6791 with previous indications of atypical evolution. The analysis uses observations from *Kepler* and Gaia in combination with ground-based photometry, a literature radial-velocity study, and measurements of eclipsing binaries in the cluster. We derive mass, radius, effective temperature, evolutionary stage, and apparent distance modulus of each target. Among the investigated cluster giants we find clear evidence of overmassive and undermassive members, and non-members with strong hints of potential past membership. Our results indicate that about 10 per cent of the red giants in the cluster have experienced mass transfer or a merger. High-resolution high-S/N spectroscopic follow-up could confirm potential past membership of the non-members, and reveal whether certain element abundances might expose the non-standard evolution of overmassive and undermassive stars. If so, field stars of similar type could be identified as what they are, i.e. overmassive or undermassive stars, and not mistakenly classified as younger or older than they are.

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Transients from the cataclysmic deaths of cataclysmic variables

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We explore the observational appearance of the merger of a low-mass star with a white dwarf (WD) binary companion. We are motivated by recent work finding that multiple tensions between the observed properties of cataclysmic variables (CVs) and standard evolution models are resolved if a large fraction of CV binaries merge as a result of unstable mass transfer. Tidal disruption of the secondary forms a geometrically thick disk around the WD, which subsequently accretes at highly super-Eddington rates. Analytic estimates and numerical hydrodynamical simulations reveal that outflows from the accretion flow unbind a large fraction $\gtrsim 90\%$ of the secondary at velocities $\sim$ 500–1000 km s^{-1} within days of the merger. Hydrogen recombination in the expanding ejecta powers optical transient emission lasting about a month with a luminosity $\gtrsim 10^{38}$ erg s^{-1}, similar to slow classical novæ and luminous red novae (LRN) from ordinary stellar mergers. Over longer timescales the mass accreted by the WD undergoes hydrogen shell burning, inflating the remnant into a giant of luminosity $\sim$ 300–5000 L$_\odot$, effective temperature $T_{\rm eff} \approx 3000$ K and lifetime $\sim 10^4$–10^5 yr. We predict that $\sim 10^3$–10^4 Milky Way giants are CV merger products, potentially distinguishable by atypical surface abundances. We explore whether any Galactic historical slow classical novæ are masquerading CV mergers by identifying four such post-nova systems with potential giant counterparts for which a CV merger origin cannot be ruled out. We address whether the historical transient CK Vul and its gaseous/dusty nebula resulted from a CV merger.

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The ionization energies of dust-forming metal oxide clusters

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Stellar dust grains are predominantly composed of mineralic, anorganic material forming in the circumstellar envelopes of oxygen-rich AGB stars. However, the initial stage of the dust synthesis, or its nucleation, is not well understood. In particular, the chemical nature of the nucleating species, represented by molecular clusters, is uncertain. We investigate the vertical and adiabatic ionization energies of four different metal-oxide clusters by means of density functional theory. They include clusters of magnesia $(MgO)_n$, silicon monoxide $(SiO)_n$, alumina $(Al_2O_3)_n$, and titania $(TiO_2)_n$ with stoichiometric sizes of $n = 1$–8. The magnesia, alumina and titania clusters show relatively little variation in their ionization energies with respect to the cluster size n, ranging from 7.1–8.2 eV for $(MgO)_n$, 8.9–10.0 eV for $(Al_2O_3)_n$, and 9.3–10.5 eV for $(TiO_2)_n$. In contrast, the $(SiO)_n$ ionization energies decrease with size n, starting from 11.5 eV for $n = 1$, and decreasing to 6.6 eV for $n = 8$. Therefore, we set constraints on the stability limit for neutral metal-oxide clusters to persist ionization through radiation or high temperatures and for the nucleation to proceed via neutral–neutral reactions.

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Gas and dust from extremely metal-poor AGB stars

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Context: The study of stars evolving through the asymptotic giant branch (AGB) proves crucial in several astrophysical contexts, given the important feedback provided by these objects to the host system, in terms of the gas, poured into the interstellar medium after being exposed to contamination from nucleosynthesis processes, and the dust formed in their wind. Most of the studies conducted so far have been focused on AGB stars with solar and sub-solar chemical composition, whereas the extremely metal-poor domain has been poorly explored.
Aims: We study the evolution of extremely metal-poor AGB stars, with metallicities down to [Fe/H] $= -5$, to understand the main evolutionary properties, the efficiency of the processes able to alter their surface chemical composition and to determine the gas and dust yields.
Methods: We calculate two sets of evolutionary sequences of stars in the 1–7.5 $M_\odot$ mass range, evolved from the pre-main sequence to the end of the AGB phase. To explore the extremely metal-poor chemistries we adopted the metallicities $Z = 0.00003$ and $Z = 0.0000003$ which correspond, respectively to [Fe/H] $= -3$ and [Fe/H] $= -5$. The results from stellar evolution modelling are used to calculate the yields of the individual chemical species. We also modelled dust formation in the wind, to determine the dust produced by these objects.
Results: The evolution of AGB stars in the extremely metal-poor domain explored here proves tremendously sensitive to the initial mass of the star. Stars of initial mass below 2 $M_\odot$ experience several third dredge-up events, which favour the gradual surface enrichment of ^{12}C and the formation of significant quantities of carbonaceous dust, of the order of ~ 0.01 $M_\odot$. The ^{13}C and nitrogen yields are found to be significantly smaller than in previous explorations of low-mass, metal-poor AGB stars, owing to the weaker proton ingestion episodes experienced during the initial AGB phases. Stars with initial mass above 5 $M_\odot$ experience hot bottom burning and their surface chemistry reflects the equilibria of a very advanced proton-capture nucleosynthesis; little dust production takes place in their wind. Intermediate mass stars experience both third dredge-up and hot bottom burning: they prove efficient producers of nitrogen, which is formed by proton captures on ^{12}C nuclei of primary origin dredged-up from the internal regions.

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SOFIA/FORCAST monitoring of the dust emission from R Aqr: start of the eclipse

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We present mid-infrared (mid-IR) spectra from our continued monitoring of R Aquarii, the nearest symbiotic Mira,

using the Stratospheric Observatory for Infrared Astronomy (SOFIA). New photometric and spectroscipic data were obtained with the Faint Object infraRed CAmera for the SOFIA Telescope in 2018 and 2019 after the system had started its "eclipse," during which it became two magnitudes fainter in the visual. The mid-IR flux, in particular the 10-μm silicate feature, has strengthened compared with the previous cycles. Radiative transfer models for the circumstellar dust emission were calculated for the new spectra, and recalculated for those previously obtained using more appropriate values of the near-IR magnitudes to constrain the properties of the asymptotic giant branch spectra heating the dust. The modeling shows that the luminosity dependence on pulsation phase is not affected by the onset of the eclipse, and that the increase in the mid-IR flux is due to a higher dust density. The models also confirm our earlier results that micron-size grains are present, and that no changes in the grain composition are required to explain the variations in the spectra.

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Electron conduction opacities at the transition between moderate and strong degeneracy: uncertainties and impacts on stellar models

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Electron conduction opacities are one of the main physics inputs for the calculation of low- and intermediate-mass stellar models. A critical question considers how to devise a bridge when calculating both moderate and strong degeneracy, which are necessarily performed adopting different methods. The density-temperature regime at the boundary between moderate and strong degeneracy is, in fact, crucial for modelling the helium cores of red giant branch stars and the hydrogen-helium envelopes of white dwarfs. Prompted by newly published, improved calculations of electron thermal conductivities and opacities for moderate degeneracy, we study different, physically motivated prescriptions to bridge these new computations with well-established results in the regime of strong degeneracy. We find that these varied prescriptions have a sizable impact on the predicted He-core masses at the He-flash (up to 0.01 $M_\odot$ for initial total masses far from the transition to non-degenerate He-cores and up to ~ 0.04 $M_\odot$ for masses around the transition), the tip of the red giant branch (up to ~ 0.1 mag), and the zero-age horizontal branch luminosities (up to 0.03 dex for masses far from the transition and up to ~ 0.2 dex around the transition), and white dwarf cooling times (up to 40–45% at high luminosities, and up to $\sim 25\%$ at low luminosities). Current empirical constraints on the tip of the red giant branch and the zero age horizontal branch absolute magnitudes do not yet allow for the definitive exclusion of any of these alternative options for the conductive opacities. Tests against observations of slowly-cooling faint WDs in old stellar populations will need to be performed to see whether they are capable of setting some more stringent constraints on bridging calculations of conductive opacities for moderate and strong degeneracy.

Published in Astronomy & Astrophysics

DEATHSTAR: nearby AGB stars with the Atacama Compact Array – II. CO envelope sizes and asymmetries: the S-type stars

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Aims: We aim to constrain the sizes of, and investigate deviations from spherical symmetry in, the CO circumstellar envelopes (CSEs) of 16 S-type stars, along with an additional 7 and 4 CSEs of C-type and M-type AGB stars, respectively.
Methods: We map the emission from the CO $J = 2$–1 and 3–2 lines observed with the Atacama Compact Array (ACA) and its total power (TP) antennas, and fit with a Gaussian distribution in the uv- and image planes for ACA-only and TP observations, respectively. The major axis of the fitted Gaussian for the CO(2–1) line data gives a first estimate of the size of the CO-line-emitting CSE. We investigate possible signs of deviation from spherical symmetry by analysing the line profiles and the minor-to-major axis ratio obtained from visibility fitting, and by investigating the deconvolved images.
Results: The sizes of the CO-line-emitting CSEs of low-mass-loss-rate (low-MLR) S-type stars fall between the sizes of the CSEs of C-stars, which are larger, and those of M-stars, which are smaller, as expected because of the differences in their respective CO abundances and the dependence of the photodissociation rate on this quantity. The sizes of the low-MLR S-type stars show no dependence on circumstellar density, as measured by the ratio of the MLR to terminal outflow velocity, irrespective of variability type. The density dependence steepens for S-stars with higher MLRs. While the CO(2–1) brightness distribution size of the low-density S-stars is in general smaller than the predicted photodissociation radius (assuming the standard interstellar radiation field), the measured size of a few of the high-density sources is of the same order as the expected photodissociation radius. Furthermore, our results show that the CO CSEs of most of the S-stars in our sample are consistent with a spherically symmetric and smooth outflow. For some of the sources, clear and prominent asymmetric features are observed which are indicative of intrinsic circumstellar anisotropy.
Conclusions: As the majority of the S-type CSEs of the stars in our sample are consistent with a spherical geometry, the CO envelope sizes obtained in this paper will be used to constrain detailed radiative transfer modelling to directly determine more accurate MLR estimates for the stars in our sample. For several of our sources that present signs of deviation from spherical symmetry, further high-resolution observations would be necessary to investigate the nature of, and the physical processes behind, these asymmetrical structures. This will provide further insight into the mass-loss process and its related chemistry in S-type AGB stars.

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Spin–orbit misalignment from triple-star common envelope evolution

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I study the triple-star common envelope evolution (CEE) of a tight binary system that is spiralling in inside a giant envelope and launches jets that spin-up the envelope with an angular momentum component perpendicular to the orbital angular momentum of the triple-star system. This occurs when the orbital plane of the tight binary system and that of the triple-star system are inclined to each other, so the jets are not along the triple-star orbital angular momentum. The merger of the tight binary stars also tilts the envelope spin direction. If the giant is a red supergiant (RSG) star that later collapses to form a black hole (BH), the BH final spin is misaligned with the orbital angular momentum. Therefore, the CEE of neutron star (NS) or BH tight binaries with each other or with one main-sequence star (MSS) inside the envelope of an RSG, where the jets power a common envelope jets supernova event, might end with an NS/BH–NS/BH close binary system with spin-orbit misalignment. Such binaries can later merge to be gravitational wave sources. I list five triple-star scenarios that might lead to spin-orbit misalignments of NS/BH–NS/BH binary systems, two of which predict that the two spins should be parallel to each other. In the case of a tight binary system of two MSSs inside an asymptotic giant branch star, the outcome is an additional non-spherical component to the mass-loss with the formation of a 'messy' planetary nebula.

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Seimei KOOLS-IFU mapping of the gas and dust distributions in Galactic planetary nebulæ: the case of IC 2165

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We investigated the physical and chemical properties of the gas and dust components in a carbon-rich planetary nebula (PN) IC 2165 using two-dimensional emission-line maps with superior resolution. The extinction map is generated in a self-consistent and assumption-free manner. The circumstellar gas-to-dust mass ratio (GDR) map ranges radially from 1210 in the central nebula filled with hot gas plasma to 120 near the ionization front. The determined GDR is comparable to ~ 400, which is commonly adopted for carbon-rich asymptotic giant branch (AGB) stars, and ~ 100 for interstellar medium. Except for the inner regions, the GDR in IC 2165 is nearly the same as in such AGB stars, indicating that most dust grains withstand the harsh radiation field without being destroyed. The gas and dust mass distributions concentrated in the equatorial plane may be related to the non-isotropic mass loss during the AGB phase and nebula shaping. The spatial distributions of electron densities/temperatures and ionic/elemental abundances were investigated herein. We determined 13 elemental abundances using point-spread-function-matched spatially integrated multiwavelength spectra extracted from the same aperture. Their values are consistent with values predicted by a theoretical model for stars of initially 1.75 $M_\odot$ and $Z = 0.003$. Finally, we constructed the photoionization model using our distance measurement to be consistent with all derived quantities, including the GDR, gas and dust masses, and post-AGB evolution. Thus, we demonstrate the capability of the Kyoto Okayama Optical Low-dispersion Spectrograph with optical-fibre Integral Field Unit (KOOLS-IFU) and how the spatial variation of the gas and dust components in PNe derived from IFU observations can help understand the evolution of the circumstellar/interstellar medium.

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Spectroscopic evidence for a large spot on the dimming Betelgeuse

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During October 2019 and March 2020, the luminous red supergiant Betelgeuse demonstrated an unusually deep minimum of its brightness. It became fainter by more than one magnitude and this is the most significant dimming observed in the recent decades. While the reason for the dimming is debated, pre-phase of supernova explosion, obscuring dust, or changes in the photosphere of the star were suggested scenarios. Here, we present spectroscopic studies of Betelgeuse using high-resolution and high signal-to-noise ratio near-infrared spectra obtained at Weihai Observatory on four epochs in 2020 covering the phases of during and after dimming. We show that the dimming episode is caused by the dropping of its effective temperature by at least 170 K on 2020 January 31, that can be attributed to the emergence of a large dark spot on the surface of the star.

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Morpho-kinematic properties of Wolf–Rayet planetary nebulæ

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The majority of planetary nebulæ (PNe) show axisymmetric morphologies, whose causes are not well understood. In this work, we present spatially resolved kinematic observations of 14 Galactic PNe surrounding Wolf–Rayet ([WR]) and weak emission-line stars (*wels*) based on the Hα and [N II] emission taken with the Wide Field Spectrograph on the ANU 2.3-m telescope. Velocity-resolved channel maps and position–velocity diagrams, together with archival *Hubble* Space Telescope (HST) and ground-based images, are employed to construct three-dimensional morpho-kinematic models of 12 objects using the program SHAPE. Our results indicate that these 12 PNe mostly have elliptical morphologies with either open or closed outer ends. Interior shell orientations in NGC 6578 and NGC 6629 kinematic maps, as well as the compact ($\leq 6''$) PNe Pe 1-1, M 3-15, M 1-25, Hen 2-142, and NGC 6567, are consistent with the elliptically symmetric morphologies seen in high-resolution HST images. Point-symmetric knots in Hb 4 exhibit deceleration with distance from the central star that could be due to shock collisions with the ambient medium. Velocity dispersion maps of Pe 1-1 also disclose the shock interaction between its collimated outflows and the interstellar medium. Collimated bipolar outflows are also visible in the position–velocity diagrams of M 3-30, M 1-32, and M 3-15, which are reconstructed by tenuous prolate ellipsoids extending upwardly from dense equatorial regions in the kinematic models. The formation of aspherical morphologies and collimated outflows in these PNe could be related to the stellar evolution of hydrogen-deficient [WR] and *wels* nuclei that requires further investigation.

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The rapidly evolving AGB star, V Hya: ALMA finds a multi-ring circus with high-velocity outflows

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We have observed the mass-losing carbon star V Hya that is apparently transitioning from an AGB star to a bipolar planetary nebula, at an unprecedented angular resolution of $\sim 0\farcs4$–$0\farcs6$ with the Atacama Large Millimeter/submillimeter Wave Array (ALMA). Our ^{13}CO and ^{12}CO ($J = 3$–2 and $J = 2$–1) images have led to the discovery of a remarkable set of six expanding rings within a flared, warped Disk structure Undergoing Dynamical Expansion (DUDE) that lies in the system's equatorial plane. We also find, for the first time, several bipolar, high-velocity outflows, some of which have parabolic morphologies, implying wide opening angles, while one (found previously) is clumpy and highly collimated. The latter is likely associated with the high-velocity bullet-like ejections of ionized gas from V Hya; a possible molecular counterpart to the oldest of the four bullets can be seen in the ^{12}CO images. We find a bright, unresolved central source of continuum emission (FWHM size $\lesssim$165 au); about 40% of this emission can be produced in a standard radio photosphere, while the remaining 60% is likely due to thermal emission from very large (mm-sized) grains, having mass $\gtrsim 10^{-5}$ M$_\odot$. We have used a radiative transfer model to fit the salient characteristics of the DUDE's ^{13}CO and ^{12}CO emission out to a radius of $8''$ (3200 au) with a flared disk of mass 1.7×10^{-3} M$_\odot$, whose expansion velocity increases increases very rapidly with radius inside a central region of size ~ 200 au, and then more slowly outside it, from 9.5 to 11.5 km s^{-1}. The DUDE's underlying density decreases radially, interspersed with local increases that represent the observationally well-characterised innermost three rings.

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Core-collapse supernova simulations and the formation of neutron stars, hybrid stars, and black holes

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We investigate observable signatures of a first-order quantum chromodynamics (QCD) phase transition in the context of core-collapse supernovæ. To this end, we conduct axially symmetric numerical relativity simulations with multi-energy neutrino transport, using a hadron–quark hybrid equation of state (EOS). We consider four nonrotating progenitor models, whose masses range from 9.6 to 70 M$_\odot$. We find that the two less-massive progenitor stars (9.6 and 11.2 M$_\odot$) show a successful explosion, which is driven by the neutrino heating. They do not undergo the QCD phase transition and leave behind a neutron star. As for the more massive progenitor stars (50 and 70 M$_\odot$), the proto-neutron star (PNS) core enters the phase transition region and experiences the second collapse. Because of a sudden stiffening of the EOS entering to the pure quark matter regime, a strong shock wave is formed and blows off the PNS envelope in the 50 M$_\odot$ model. Consequently the remnant becomes a quark core surrounded by hadronic matter, leading to the formation of the hybrid star. However, for the 70 M$_\odot$ model, the shock wave cannot overcome the continuous mass accretion and it readily becomes a black hole. We find that the neutrino and gravitational wave (GW) signals from supernova explosions driven by the hadron–quark phase transition are detectable for the present generation of neutrino and GW detectors. Furthermore, the analysis of the GW detector response reveals unique kHz signatures, which will allow us to distinguish this class of supernova explosions from failed and neutrino-driven explosions.

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Conference Paper

The brighter phase of Betelgeuse since 2017

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The great dimming of Betelgeuse in February 2020, was accounted starting with the ATel #13341 of 8$^{\mathrm{th}}$ December 2019, and a second dust-cloud minimum occurred in August 2020 ATel #13982. After that the luminosity of Betelgeuse underwent small (0.1 mag) oscillations around the visual magnitude 0.65; now the star had a rapid rising particularly evident in the last weeks, reaching Procyon in luminosity near magnitude 0.3. This is the brighter phase after 2017, five years, in fair agreement with the modulating period of Betelgeuse of 5.9 years. The Purkinje effect, which enhances red stars' luminosity to the naked eye, has been avoided in the visual observations with quick-look techniques and with the differential analysis with Aldebaran, of the same color. Airmass corrections have been always included (AAVSO database – https://www.aavso.org/lcg – SGQ, MFB and SRX codes). The V-band observations showed an overall 0.006 mag d^{-1} rising in the last 7 weeks (AAVSO-VOL code). This could be the maximum phase before reaching a new minimum next June 2022, if the pulsations are in phase with the usual period of 1.2 years. The V-band observations in daytime (AAVSO-NOT code) monitored the star in June–August 2021 providing a seamless lightcurve, and this technique can provide data for the forthcoming minimum. Anyway the present rising is not in phase with respect to the 2020's one, accounted in ATel #13601 on March 31, within the usual (until 2020 at least) pulsational regime of 1.2 years. Some evidences of such behavior have been already presented at the XVI Marcel Grossmann Meeting HR1 session, online at https://youtu.be/VmbrE2gYmOM in July 2021, with interesting observational and theoretical discussions.

Oral contribution, published in MGM XVI 2022 – ATel #15240
Available from https://www.astronomerstelegram.org/?read=15240

Announcement

EAS2022 Special Session #22: A magnifying glass on circumbinary exoplanets: their formation and evolution throughout the H–R diagram

Dear Colleagues,

This year's European Astronomical Society annual meeting (EAS 2022) will be held 27 June – 1 July 2022 in Valencia, Spain. On Friday 01/07/22 we will be hosting a special session titled: "A magnifying glass on circumbinary exoplanets: their formation and evolution throughout the H–R diagram"

The session aims to gather specialists from all sub-fields in circumbinary planet science, and will be split into three blocks:

- Circumbinary planet formation

- Main sequence circumbinary planets
- Circumbinary planets beyond the main sequence

We invite applications for talks and scientific posters that fall into any of these categories, including any other work which could be applied to circumbinary planet science. The deadline for abstract submission is 01/03/22.

Registration is open now with the deadline for regular registration on 26/06/22. There are also discounted early bird (29/04/22) registrations available. The ability to apply for fee waivers and/or grants for the conference is available with the same deadline as for abstract submissions (01/03/22). Further details can be found on the session's webpage.

The session is dedicated to Prof. Dr. Wilhelm ("Willy") Kley who recently passed away while preparing the organization of this session.

All the best,
Jacques Kluska on behalf of the scientific organizers

See also https://eas.unige.ch/EAS2022/session.jsp?id=SS22