COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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TABLE OF CONTENTS

Stellar Abstracts

High-Resolution Spectroscopy of the Yellow Hypergiant ρ Cassiopeiae from 1993 Through the Outburst of 2000-2001

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We present an overview of the spectral variability of the peculiar F-type hypergiant ρ Cas, obtained from our long-term monitoring campaigns over the past 8.5 years with four spectrographs in the northern hemisphere. Between 2000 June and September an exceptional variability phase occurred when the V-brightness dimmed by about a full magnitude. The star recovered from this deep minimum by 2001 April. It is the third outburst of ρ Cas on record in the last century. We observe TiO absorption bands in high-resolution near-IR spectra obtained with the Utrecht Echelle Spectrograph during the summer of 2000. TiO formation in the outer atmosphere occurred before the deep brightness minimum. Atmospheric models reveal that the effective temperature decreases by at least 3000 K, and the TiO shell is driven supersonically with $\dot{M}\simeq 5.4\times10^{-2}\ M_{\odot}\,yr^{-1}$. Strong episodic mass loss and TiO have also been observed during the outbursts of 1945-47 and 1985-86.

A detailed analysis of the exceptional outburst spectra is provided, by comparing with high-resolution optical spectra of the early M-type supergiants μ Cep (Ia) and Betelgeuse (Iab). During the outburst, central emission appears above the local continuum level in the split Na D lines. A prominent optical emission line spectrum appears in variability phases of fast wind expansion. The radial velocity curves of Hα, and of photospheric metal absorption lines signal a very extended, and velocity stratified dynamic atmosphere. The outburst spectra indicate the formation of a low-temperature, optically thick circumstellar gas shell of $3\times10^{-2}\ M_{\odot}$ during 200 d, caused by dynamic instability of the upper atmosphere of this pulsating massive supergiant near the Eddington luminosity limit. We observe that the

mass-loss rate during the outburst is of the same order of magnitude as has been proposed for the outbursts of η Carinae. We present calculations that correctly predict the outburst time-scale, whereby the shell ejection is driven by the release of hydrogen ionization-recombination energy.

Accepted by ApJ

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Evolution of Lithium Beyond the Solar Age: A Li Survey of the Old Open Cluster NGC 188

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We have determined Li abundances for 11 G–type stars in the 6–8 Gyr old open cluster NGC 188. These data significantly enlarge the number of cluster stars with Li measurements, allowing us to extend the investigation of Li depletion in open clusters to ages well beyond the age of the Sun. We have also inferred the cluster metallicity which turns out to be solar. We find that solar–type stars in NGC 188 are only slightly more Li depleted than the much younger Hyades and no more Li depleted than stars of similar temperature in the 2–4 Gyr younger cluster M 67. At variance with M 67, NGC 188 members show virtually no scatter in their Li abundances. Surprisingly, no solar–type star in NGC 188 appears as Li depleted as the Sun or as the most Li depleted stars in M 67. We discuss the implications of these results for mechanisms of internal mixing and Li depletion in main sequence stars.

Accepted by A&A

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The X-ray Luminosity Distributions Of The High-Metallicity Open Cluster Blanco 1

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We present X-ray Luminosity Distributions (XLDs) of late-type members (dF, dG, dK, dM) of the Blanco 1 cluster, based on ROSAT-HRI data and new astrometric-photometric membership obtained from the GSC-II project. For the first time we present the XLD of dM stars of this cluster. The high metallicity of Blanco 1 allows us to investigate the role of chemical composition on the coronal emission of late-type stars. Comparison between X-ray Luminosity Distributions of Blanco 1 and Pleiades, NGC 2516 and α Per suggests a possible metallicity effect in dM stars.

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Deconstructing HD 28867

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The 3" pair of B9 stars, HD 28867, is one of the brightest X-ray sources in the Taurus-Auriga star forming region. In this multi-wavelength study, we attempt to deduce the source of the X-ray emission. We show that the East component is the X-ray source. The East component has a near-IR excess and displays narrow absorption lines in the optical, both of which are consistent with a cool stellar companion. This companion is one of the brightest low mass pre-main sequence stars in Tau-Aur; at 2 μm it and the B9 star are equally bright. We see evidence for radial velocity variability in the cool component of $>$34 km s^{-1}. It is not visible in K band speckle imaging, which constrains the companion to lie within 14 AU of the B star.

We also report on a possible fourth member of the group, an M1 star 18" south of HD 28867.

Submitted to AJ

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Nearby Young Stars

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We present the results of an extensive all-sky survey of nearby stars of spectral type F8 or later in a systematic search of young (zero-age main sequence) objects. Our sample has been derived by cross-correlating the ROSAT All-Sky Survey and the TYCHO catalog, yielding a total of 754 candidates distributed more or less randomly over the sky. Follow-up spectroscopy of these candidate objects has been performed on 748 of them. We have discovered a tight kinematic group of ten stars with extremely high lithium equivalent widths that are presumably younger than the Pleiades, but again distributed rather uniformly over the sky. Furthermore, about 43 per cent of our candidates have detectable levels of lithium, thus indicating that these are relatively young objects with ages not significantly above the Pleiades age.

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Solar Abstracts

Oscillations in the Wings of Sunspot Transition Region Lines

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We explore a new approach to the investigation of optically thin emission lines by comparing the intensity variations in opposite wings of the spectral lines and apply the method to investigate the oscillations above sunspots. The observations show that it is easier to detect the 3 min oscillations above sunspots in the short wavelength ('blue') wing than in the long wavelength ('red') wing of the lines. The observed oscillations are compatible with the spectral line signatures of upwardly propagating acoustic waves.

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Inversion of the Intensity-Magnetic Field Relationship in Solar Active Regions

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We discuss the relationship between the EUV spectral line intensities and the photospheric magnetic flux in solar active regions. Since the histograms of the magnetic flux density in active region plages can be approximated by an exponential function, the equation describing how the observed total line intensity integrated over an active region area arises from the magnetic field, can be approximated by a Laplace integral. We use this property to solve an inverse problem and derive a function relating the line intensity from individual loops to the photospheric magnetic flux density at their footpoints. We propose a simple model in which the intensity of a coronal line Fe XVI 360.8 Å in an individual coronal loop is proportional to the footpoint magnetic flux density to the power of δ and explore how well the value of δ is constrained by the observations. Using EUV spectra from the Coronal Diagnostic Spectrometer (CDS) on SOHO and magnetograms from SOHO Michelson Doppler Imager for 26 active regions without sunspots, we find that the value of δ depends on the magnetic flux density threshold used to define active region magnetic area. When even the weakest fields are included, we obtain $\delta = 1.3$, where $1.0 < \delta < 1.6$ with 90% confidence. This result can be used to provide constraints on coronal heating models.

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Lost Sunspot Cycle in the Beginning of Dalton Minimum: New Evidence and Consequences

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We have recently suggested that one solar cycle was lost in the beginning of the Dalton minimum during 1790s (Usoskin et al., A&A, 370, L31, 2001). Earlier, this cycle has been combined with the preceding activity to form the exceptionally long solar cycle 4 in 1784-1799 with an irregular phase evolution. Here we show that historical data of auroral occurrence provide independent evidence for the existence of the new cycle. Using a heliospheric model we demonstrate that ^{10}Be or any other cosmogenic isotope data do not exclude the possibility of a new cycle. We also discuss the other implications of the new cycle for solar activity, in particular the cycle length distribution and the Waldmeier relation between the cycle amplitude and the length of the ascending and descending phase. Including the new cycle also restores the Gnevyshev-Ohl rule of cycle pairing and removes the phase catastrophe in the beginning of the Dalton minimum.

Geophys.Res.Lett., v.29, 2002 (DOI:10.1029/2002GL015640)

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Low-Mass and Substellar Abstracts

A Mass for the Extrasolar Planet Gl 876b Determined from *Hubble Space Telescope* Fine Guidance Sensor 3 Astrometry and High-Precision Radial Velocities

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We report the first astrometrically determined mass of an extrasolar planet, a companion previously detected by Doppler spectroscopy. Radial velocities first provided an ephemeris with which to schedule a significant fraction of the *HST* observations near companion peri- and apastron. The astrometry residuals at these orbital phases exhibit a systematic deviation consistent with a perturbation due to a planetary mass companion. Combining *HST* astrometry with radial velocities, we solve for the proper motion, parallax, perturbation size, inclination, and position angle of the line of nodes, while constraining period, velocity amplitude, longitude of periastron, and eccentricity to values determined from radial velocities. We find a perturbation semi-major axis and inclination, $\alpha = 0.25 \pm 0.06$ mas, $i = 84° \pm 10°$, and absolute parallax, $\pi_{abs} = 214.6 \pm 0.2$ mas. Assuming that the mass of the primary star is $M_* = 0.32 M_\odot$, we find the mass of the planet, Gl 8 76b, $M_b = 1.89 \pm 0.34 M_{Jup}$.

Accepted by ApJL

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For preprints via ftp or WWW: http://arXiv.org/abs/astro-ph/0212101

Research Announcement

A New Double-Lined Spectroscopic Binary (... Have Binary, Need Orbit)

Vincent Woolf, George Wallerstein, and Suzanne Hawley of the University of Washington report the discovery that LHS 537 is a double-lined spectroscopic binary. They do not expect to be assigned the necessary observing time to determine the period and orbit. The star appears in the catalog of J. Gizis, 1997, AJ, 113, 806.

Openings for Ph.D. Students

Ph.D. Student Openings and Research Assistantships
Astronomy Group
University of Texas at Arlington

The Astronomy Group at the Department of Physics, University of Texas at Arlington (Dallas-Fort Worth Metroplex) has one or more openings for Ph.D. students. The Astronomy Group has a broad range of research interests, including solar and stellar physics, magnetohydrodynamics, extra-solar planets, orbital stability analysis and chaos, stellar habitable zones and astrobiology. Research assistantships are available.

Applicants should indicate their interest directly to

Prof. Manfred Cuntz
Department of Physics
Science Hall
University of Texas at Arlington
Arlington, TX 76019-0059

Email: cuntz@uta.edu

and should arrange for two letters of recommendation. Offer available until position(s) are filled.

Abstract Guidelines

Abstracts for *COOLNEWS* are solicited for papers that have been recently accepted by or submitted to refereed journals, and for recent Ph.D. theses. Abstracts for conference proceedings articles are *not* posted in *COOLNEWS*. The subject matter should pertain directly to cool stars (spectral types F,G,K,M or L), substellar objects, or the sun. Both theoretical and observational abstracts are appropriate.

Abstracts dealing with cool pre-main-sequence (PMS) stars will generally not be included in *COOLNEWS*, since they are already covered by the *Star Formation Newsletter*. Exceptions to this rule will be considered if the subject matter is truly cross-disciplinary. If you wish to submit a cross-disciplinary abstract on PMS stars, then first submit it to the *Star Formation Newsletter*. After doing so, submit the abstract to *COOLNEWS* accompanied by a short e-mail stating that it has already been submitted to the *Star Formation Newsletter*, and summarizing why it will be of interest to the cool star/solar community at large.

A monthly call for abstracts will be issued and abstracts received by the last day of the month will usually appear in the following month's newsletter. Announcements of general interest to the cool star and solar communities may also be submitted for posting in the newsletter. These might include (but are not restricted to) the following: (i) *Job Openings* directed toward cool star or solar researchers, (ii) announcements of *Upcoming Meetings*, (iii) announcements of *Upcoming Observing Campaigns* for which participation is solicited from the community at large, (iv) reviews of *New Books*, and (v) *General Announcements* that provide or request research-related information. Please send all correspondence to the editor at coolnews@jila.colorado.edu. Abstract templates and back issues can be obtained from the COOLNEWS Web-page at

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