COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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TABLE OF CONTENTS

Stellar Abstracts

Cool Luminous Stars: The Hybrid Nature of Their Infrared Spectra

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We identified a possible origin of the difficulty in abundance analysis of cool luminous stars. We found purely empirically that there is a limit of $\log W/\nu$ = -4.75 (W: equivalent width, ν: wavenumber) above which the observed lines do not follow the line formation theory based on the classical micro-turbulent model and that the abundance analysis can be done only with the lines of $\log W/\nu < -4.75$. The C, O, and their isotopic abundances determined from such weak lines of CO and OH in 23 K - M giant stars are roughly consistent with the predictions of evolutionary models. However, the stronger lines of $\log W/\nu > -4.75$ cannot be analyzed at all by the classical line formation theory. From the behavior of these lines and considering other observations such as the detections of H_2O lines, not only in the late M giants but also in the early M and K giant stars, we found that these lines are badly disturbed by the contamination from an extra molecular layers. We already know that the very strong lines of $\log W/\nu > -4.4$ are contaminated by the contribution from the extra warm molecular layers, but we now show that such contamination should be prevailing not only in the strong low excitation lines but also in the intermediate-strength lines ($-4.75 < \log W/\nu < -4.4$) as well. The reason why these lines cannot be used for determining photospheric abundances is simply because they include the contamination of the non-photospheric origin. Instead they can be new proves of the warm molecular envelope for which little is known yet. An important conclusion is that the infrared spectra of K - M giant stars are a hybrid of at least two components originating in the photosphere and the warm molecular envelope. In the interpretation and analysis of the infrared spectra of cool luminous stars, it is essential to keep their hybrid nature in mind. A more serious problem, however, is how to understand the atmospheric structure responsible to the formation of such a hybrid spectrum.

Accepted by A&A

For preprints contact: ttsuji@ioa.s.u-tokyo.ac.jp (continued →)

For preprints via ftp or WWW: http://arXiv.org/astro-ph/0807.4387

New Triple Systems in the RasTyc Sample of Stellar X-ray Sources

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Context. During the study of a large set of late-type stellar X-ray sources, we discovered a large fraction of multiple systems.
Aims. In this paper we investigate the orbital elements and kinematic properties of three new spectroscopic triple systems as well as spectral types and astrophysical parameters ($T_{\rm eff}$, $\log g$, $v \sin i$, $\log N({\rm Li})$) of their components.
Methods. We conducted follow-up optical observations, both photometric and spectroscopic at high resolution, of these systems. We used a synthetic approach and the cross-correlation method to derive most of the stellar parameters.
Results. We estimated reliable radial velocities and deduced the orbital elements of the inner binaries. The comparison of the observed spectra with synthetic composite ones, obtained as the weighted sum of three spectra of non-active reference stars, allowed us to determine the stellar parameters for each component of these systems. We found all are only composed of main sequence stars.
Conclusions. These three systems are certainly stable hierarchical triples composed of short-period inner binaries plus a tertiary component in a long-period orbit. From their kinematics and/or Lithium content, these systems result to be fairly young.

Accepted by A&A (on July 22, 2008)

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For preprints via ftp or WWW: http://arxiv.org/abs/0807.4470

A Multi-site Campaign to Measure Solar-like Oscillations in Procyon. I. Observations, Data Reduction and Slow Variations

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Francois Bouchy,[19] Benoit Mosser,[20] Thierry Appourchaux,[21] Caroline Barban,[20] Gabrielle Berthomieu,[22]
Rafael A. Garcia,[23] Eric Michel,[20] Janine Provost,[22] Sylvaine Turck-Chièze,[23]
Milena Martić,[24] Jean-Claude Lebrun,[24] Jerome Schmitt,[25] Jean-Loup Bertaux,[24]
Alfio Bonanno,[26] Serena Benatti,[27] Riccardo U. Claudi,[27] Rosario Cosentino,[26] Silvio Leccia,[28]
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We have carried out a multi-site campaign to measure oscillations in the F5 star Procyon A. We obtained high-precision velocity observations over more than three weeks with eleven telescopes, with almost continuous coverage for the central ten days. This represents the most extensive campaign so far organized on any solar-type oscillator. We describe in detail the methods we used for processing and combining the data. These involved calculating weights for the velocity time series from the measurement uncertainties and adjusting them in order to minimize the noise level of the combined data. The time series of velocities for Procyon shows the clear signature of oscillations, with a plateau of excess power that is centred at 0.9 mHz and is broader than has been seen for other stars. The mean amplitude of the radial modes is $38.1 \pm 1.3\,\mathrm{cm\,s^{-1}}$ (2.0 times solar), which is consistent with previous detections from the ground and by the WIRE spacecraft, and also with the upper limit set by the MOST spacecraft. The variation of the amplitude during the observing campaign allows us to estimate the mode lifetime to be $1.5^{+1.9}_{-0.8}$ d. We also find a slow variation in the radial velocity of Procyon, with good agreement between different telescopes. These variations are remarkably similar to those seen in the Sun, and we interpret them as being due to rotational modulation from active regions on the stellar surface. The variations appear to have a period of about 10 days, which presumably equals the stellar rotation period or, perhaps, half of it. The amount of power in these slow variations indicates that the fractional area of Procyon covered by active regions is slightly higher than for the Sun.

Accepted by ApJ

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For preprints via ftp or WWW: http://arxiv.org/abs/0807.3794

Observed vs. Predicted Stellar Flux Distributions of Solar-type Stars

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I have compared the low-resolution spectrophotometric fluxes in the visible spectral region of F and G type MARCS 2008 model atmospheres to 6 spectrophotometric data bases of the Sun and stars. These observational data bases disagree with each other concerning the overall red/blue flux balances on the several percent scale for the same objects. There is, however, no systematic overall trend between MARCS model fluxes and these observations taken together and therefore no reason to suspect any problem with the MARCS overall spectrum balance. The results strongly suggest, however, that there are systematic errors in the UV and blue opacities used in the construction of the model atmospheres. These errors appear in wavelength regions with widths of some 50-150 Å. Similar uncertainties are found also in other independent libraries of synthetic model atmosphere fluxes.

I also highlight a number of unidentified spectral features with unusual shapes in spectra of the Sun and solar-type stars.

Accepted by Physica Scripta (continued →)

For preprints via ftp or WWW: http://marcs.astro.uu.se/documents/publications/flux1.pdf

The Chromospherically Active Binary Star EI Eridani. I. Absolute Dimensions

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We present a detailed determination of the astrophysical parameters of the chromospherically active binary star EI Eridani. Our new radial velocities allow to improve the set of orbital elements and reveal long-term variations of the barycentric velocity. A possible third-body orbit with a period of ≈ 19 years is presented. Absolute parameters are determined in combination with the *Hipparcos* parallax. EI Eri's inclination angle of the rotational axis is confined to $56^\circ \pm 4^\circ$, its luminosity class IV is confirmed by its radius of 2.37 ± 0.12 $R_\odot$. A comparison to theoretical stellar evolutionary tracks suggests a mass of 1.09 ± 0.05 $M_\odot$ and an age of ≈ 6.15 Gyr. The present investigation is the basis of our long-term Doppler imaging study of its stellar surface.

Accepted by AN (Astronomical Notes)

For preprints contact: awashuettl@aip.de

For preprints via ftp or WWW: http://www.aip.de/∼wasi/preprint/AN2008_Washuettl_EIEri1.pdf

The Moderate Magnetic Field of the Flare Star Proxima Centauri

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We report moderate magnetic flux of $450\,\mathrm{G} < Bf < 750\,\mathrm{G}$ (3σ) on the nearby M5.5 flare star Proxima Centauri. A high resolution UVES spectrum was used to measure magnetic flux from Zeeman broadening in absorption lines of molecular FeH around $1\,\mu$m. The magnetic flux we find is relatively weak compared with classical strong flare stars, but so are Proxima's flaring rates and actual emission levels. We compare what is known about the rotation rate, Rossby number, and activity levels in this star to relations between these quantities that are being developed more generally for M dwarfs. We conclude that the magnetic flux is higher than the best estimates of the Rossby number from period measurements. On the other hand, the activity levels of Proxima Centauri are at the high end of what could be expected based on the measured field, but not so high as to exceed the natural scatter in these relations (other stars lie along this high envelope as well).

Accepted by A&A Letters

For preprints via WWW: http://arxiv.org/abs/0808.2986

Lithium Depletion and the Rotational History of Exoplanet Host Stars

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Israelian et al. (2004) reported that exoplanet host stars are lithium depleted compared to solar-type stars without detected massive planets, a result recently confirmed by Gonzalez (2008). We investigate whether enhanced lithium depletion in exoplanet host stars may result from their rotational history. We develop rotational evolution models for slow and fast solar-type rotators from the pre-main sequence (PMS) to the age of the Sun and compare them to the distribution of rotational periods observed for solar-type stars between 1 Myr and 5 Gyr. We show that slow rotators develop a large degree of differential rotation between the radiative core and the convective envelope, while fast rotators evolve with little core-envelope decoupling. We suggest that strong differential rotation at the base of the convective envelope is responsible for enhanced lithium depletion in slow rotators. We conclude that Li-depleted exoplanet host stars were slow rotators on the zero-age main sequence (ZAMS) and argue that slow rotation results from a long-lasting star-disk interaction during the PMS. Altogether, this suggests that long-lived disks (≥ 5 Myr) may be a necessary condition for massive planet formation/migration. (continued →)

Accepted by A&A

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Solar Abstracts

Explosive Events and the Evolution of the Photospheric Magnetic Field

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Transition region explosive events have long been suggested as direct signatures of magnetic reconnection in the solar atmosphere. In seeking further observational evidence to support this interpretation, we study the relation between explosive events and the evolution of the solar magnetic field as seen in line–of–sight photospheric magnetograms. We find that about 38% of events show changes of the magnetic structure in the photosphere at the location of an explosive event over a time period of 1 h. We also discuss potential ambiguities in the analysis of high sensitivity magnetograms.

Accepted by ApJ

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http://www.journals.uchicago.edu/action/ showFutureArticles?journalCode=apj&issueType=accepted

Highly Ionized Fe X-ray Lines at Energies 7.7–8.6 keV

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Fe XXV lines at 1.85 Å (6.70 keV) and nearby Fe XXIV satellites have been widely used for determining the temperature of the hottest parts of solar flare and tokamak plasmas, though the spectral region is crowded and the lines are blended during flare impulsive stages. The aim of this work is to show that similarly excited Fe lines in the 7.7–8.6 keV (1.44–1.61 Å) region have the same diagnostic capability with the advantage of not being so crowded. Spectra in the 7.7–8.6 keV range are synthesized using the CHIANTI spectral package for conditions (temperature, turbulent velocities) appropriate to solar flares. The calculated spectra show that the Fe lines in the 7.7–8.6 keV are well separated even when turbulent velocities are present, and Fe XXIV/Fe XXV line ratios should therefore provide valuable tools for diagnosing flares and tokamak plasmas. Fe lines in the 7.7–8.6 keV range are ideal for the measurement of flare temperature and for detecting the presence of low-energy nonthermal electrons present at flare impulsive stages. An indication of what type of instruments to observe this region is given.

Accepted by A&A

For preprints contact: kjhp@mssl.ucl.ac.uk

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Low-Mass and Substellar Abstracts

Evidence for a Turnover in the IMF of Low Mass Stars and Sub–stellar Objects: Analysis from an Ensemble of Young Clusters

M. Andersen[1], M. R. Meyer[2], J. Greissl[2] and A. Aversa[2]

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We present a combined analysis of the low–mass Initial Mass Function (IMF) for seven star forming regions. We first demonstrate that the ratios of stars to brown dwarfs are consistent with a single underlying IMF. Assuming the underlying IMF is the same for all seven clusters and by combining the ratio of stars to brown dwarfs from each cluster we constrain the shape of the brown dwarf IMF and find it to be consistent with a log–normal IMF. This provides the strongest constraint yet that the sub–stellar IMF turns over ($\frac{dN}{dM} \propto M^{-\alpha}$, $\alpha < 0$). Published in ApJ Letters: 2008 August 20, Vol. 683, No. 2: pp. L183- L186

For preprints contact: mortena@ipac.caltech.edu

Cross-Listed Abstracts (Pre-Main Sequence Stars)

Editor's Note: The abstracts below are being cross-listed with the *Star Formation Newsletter.*

Optical Spectroscopy of X-ray Sources in the Taurus Molecular Cloud: Discovery Of Ten New Pre-main Sequence Stars

L. Scelsi[1], G. Sacco[3,1], L. Affer[1,2], C. Argiroffi[2], I. Pillitteri[2], A. Maggio[1] and G. Micela[1]

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We have analyzed optical spectra of 25 X-ray sources identified as potential new members of the Taurus Molecular Cloud (TMC), in order to confirm their membership to this star forming region. Fiftyseven candidate members were previously selected among the X-ray sources in the XEST survey, having a 2MASS counterpart compatible with a pre-main sequence star based on color-magnitude and color-color diagrams. We obtained high-resolution optical spectra for 7 of such candidates with the SARG spectrograph at the TNG telescope, which were used to search for lithium absorption and to measure the Hα line and the radial and rotational velocities; 18 low-resolution optical spectra obtained with the instrument DOLORES for other candidate members were used for spectral classification, for Hα measurements, and to assess membership together with IR color-color and color-magnitude diagrams and additional information from the X-ray data. We found that 3 sources show lithium absorption, with equivalent widths (EWs) of $\sim 500\,$mÅ, broad spectral line profiles, indicating rotational velocities of $\sim 20 - 40\,\mathrm{km\,s^{-1}}$, radial velocities consistent with those for known members, and Hα emission. Two of them are classified as new weak-lined T Tauri stars, while for the third star (XEST-26-062) the EW ($\sim -9\,$Å) of the Hα line and its broad asymmetric profile clearly indicate this source is a classical T Tauri star. Fourteen sources observed with DOLORES are M-type stars. Fifteen sources show Hα emission; 6 of them have spectra that indicate surface gravity lower than in main sequence stars, and their de-reddened positions in IR color-magnitude diagrams are consistent with their derived spectral type and with pre-main sequence models at the distance of the TMC. The K-type star XEST-11-078 is confirmed as new member on the basis of the strength of the Hα emission line. Overall, we confirm membership to the TMC for 10 out of 25 X-ray sources observed in the optical; 3 sources remain as uncertain cases.

Accepted by A&A

For preprints contact: scelsi@astropa.unipa.it (continued →)

For preprints via ftp or WWW: http://www.astropa.unipa.it/Library/preprint.html

Turbulence-driven Polar Winds from T Tauri Stars Energized by Magnetospheric Accretion

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Pre-main-sequence stars are observed to be surrounded by both accretion flows and some kind of wind or jet-like outflow. Recent work by Matt and Pudritz has suggested that if classical T Tauri stars exhibit stellar winds with mass loss rates about 0.1 times their accretion rates, the wind can carry away enough angular momentum to keep the stars from being spun up unrealistically by accretion. This paper presents a preliminary set of theoretical models of accretion-driven winds from the polar regions of T Tauri stars. These models are based on recently published self-consistent simulations of the Sun's coronal heating and wind acceleration. In addition to the convection-driven MHD turbulence (which dominates in the solar case), we add another source of wave energy at the photosphere that is driven by the impact of plasma in neighboring flux tubes undergoing magnetospheric accretion. This added energy, determined quantitatively from the far-field theory of MHD wave generation, is sufficient to produce T Tauri-like mass loss rates of at least 0.01 times the accretion rate. While still about an order of magnitude below the level required for efficient angular momentum removal, these are the first self-consistent models of T Tauri winds that agree reasonably well with a range of observational mass loss constraints. The youngest modeled stellar winds are supported by Alfvén wave pressure, they have low temperatures ("extended chromospheres"), and they are likely to be unstable to the formation of counterpropagating shocks and clumps far from the star.

Accepted by ApJ (December 10, 2008)

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For preprints via ftp or WWW: http://arXiv.org/abs/0808.2250

Announcements

Lecture Notes: Introduction to Non-LTE Radiative Transfer and Atmospheric Modeling

Eugene H. Avrett[1]

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Contents: Basic Equations; Monochromatic Scattering; Line Radiation; Two-Level-Atom Solutions; Numerical Methods; Including Bound-Free Transitions; Multilevel Atoms; Solving the Bound-Free Equations; The On-The-Spot Approximation; The Strömgren Radius; N-Level Resonance Continuum Equations; Resonance Continuum with Incident Radiation; Determining the Electron Density; The Negative Hydrogen Ion; Energy Balance Equations; The Grey Atmosphere; Continuum Opacities; Line Opacities; Hydrostatic Equilibrium; Time Variations, Mass Flows, and Particle Diffusion; Putting It All Together.

Posted on The Cosmic Portal: http://www.digitaluniverse.net/cosmos/
and at http://www.cfa.harvard.edu/∼ avrett

For further information: avrett@cfa.harvard.edu

JOB OPENING

Postdoctoral Position

Abundance Peculiarities in Stellar Atmospheres

Institute of Astronomy and Astrophysics, Université Libre de Bruxelles

Brussels, Belgium

Applications are invited for a Postdoctoral Research position at the Institute of Astronomy and Astrophysics (IAA) of the Université Libre de Bruxelles, Belgium.

We are looking for candidates having a good background in radiative transfer in stellar atmospheres, preferably with expertise in non-LTE and/or three-dimensional radiative hydrodynamical modeling.

The successful candidate will participate in a research project entitled "Heavy elements in the universe: stellar evolution, nucleosynthesis and abundance determinations". This research group involves a dozen researchers, with a broad but coherent range of expertise, including derivation of surface abundances in low- and solar-metallicity cool stars - studied through high-resolution spectroscopy and dedicated model atmospheres - as well as nuclear astrophysics, nucleosynthesis, stellar evolution, mixing processes and hydrodynamical modeling.

The team has a priviledged access to the HERMES high-resolution spectrograph (first light: early 2009).

Within the team, the successful candidate will pursue a research program aiming at understanding abundance patterns in stars with peculiar abundances. Depending on the candidate's expertise, his research will focus on one or more stellar classes among the following: low- and solar-metallicity cool stars (Miras, S and C stars, carbon-enriched metal-poor stars), as well as Ap stars. This ambitious research program will require the use and/or development of efficient tools (non-LTE, dynamical atmospheres, stratified atmospheres).

The position is available from october 2008 on and is for 2 years initially, with the possibility of extension to a third year.

Further information is available from:

Alain Jorissen: ajorisse@astro.ulb.ac.be
Sophie Van Eck: svaneck@astro.ulb.ac.be
Institut d'Astronomie et d'Astrophysique (IAA): http://www.astro.ulb.ac.be/
IAA Staff: http://www.astro.ulb.ac.be/Html/staff.html
HERMES spectrograph: http://hermes.ster.kuleuven.ac.be/
Universite Libre de Bruxelles: http://www.ulb.ac.be/

Interested applicants should send (by electronic or regular mail) a curriculum vitae, a list of publications, a one-page maximum statement of research interests and contact information for three references to:

Alain Jorissen
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Applications will be considered until the position is filled. All applications received by Sept. 30th, 2008 will receive equal consideration.

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

`http://casa.colorado.edu/~skinners/coolnews.html .`

*** Please send abstracts in the body of the message and *not* as attachments.***