COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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Coolnews on the Web

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Stellar Abstracts

A Spectroscopic Survey of the Youngest Field Stars in the Solar Neighborhood II. The Optically Faint Sample

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Star formation in the solar neighborhood is mainly traced by young stars in open clusters, associations, and in the field, which can be identified, for example, by their X-ray emission. The determination of stellar parameters for the optical counterparts of X-ray sources is crucial for a full characterization of these stars. This work extends the spectroscopic study of the *RasTyc* sample, obtained by the cross-correlation of the TYCHO and ROSAT All-Sky Survey catalogs, to stars fainter than $V = 9.5$ mag and aims to identify sparse populations of young stars in the solar neighborhood. We acquired 625 high-resolution spectra for 443 presumably young stars with four different instruments in the northern hemisphere. The radial and rotational velocity ($v\sin i$) of our targets were measured by means of the cross-correlation technique, which is also helpful to discover single-lined (SB1), double-lined spectroscopic binaries (SB2), and multiple systems. We used the code ROTFIT to perform an MK spectral classification and to determine the atmospheric parameters ($T_{\rm eff}$, $\log g$, [Fe/H]) and $v\sin i$ of the single stars and SB1 systems. For these objects, we used the spectral subtraction of slowly rotating templates to measure the equivalent widths of the Hα and Li I 6708 Å

lines, which enabled us to derive their chromospheric activity level and lithium abundance. We made use of *Gaia* DR1 parallaxes and proper motions to locate the targets in the Hertzsprung-Russell (HR) diagram and to compute the space velocity components of the youngest objects. We find a remarkable percentage (at least 35 %) of binaries and multiple systems. On the basis of the lithium abundance, the sample of single stars and SB1 systems appears to be mostly ($\sim$60 %) composed of stars younger than the members of the UMa cluster. The remaining sources are in the age range between the UMa and Hyades clusters ($\sim$20 %) or older ($\sim$20 %). In total, we identify 42 very young (PMS-like) stars, which lie above or very close to the Pleiades upper envelope of the lithium abundance. A significant percentage ($\sim$12 %) of evolved stars (giants and subgiants) is also present in our sample. Some of these stars ($\sim$36 %) are also lithium rich (A(Li)$>$ 1.4).

Accepted by A&A

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For preprints via WWW: https://arxiv.org/abs/1801.00671

The lithium-Rotation Connection in the 125 Myr-old Pleiades Cluster

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The evolution of lithium abundance over a star's lifetime is indicative of transport processes operating in the stellar interior. We revisit the relationship between lithium content and rotation rate previously reported for cool dwarfs in the Pleiades cluster. We derive new LiI 670.8 nm equivalent width measurements from high-resolution spectra obtained for low-mass Pleiades members. We combine these new measurements with previously published ones, and use the Kepler/K2 rotational periods recently derived for Pleiades cool dwarfs to investigate the lithium-rotation connection in this 125 Myr-old cluster. The new data confirm the correlation between lithium equivalent width and stellar spin rate for a sample of 51 early K-type members of the cluster, where fast rotating stars are systematically lithium-rich compared to slowly rotating ones. The correlation is valid for *all* stars over the (J-K_s) color range 0.50-0.70 mag, corresponding to a mass range from about 0.75 to 0.90 $M_\odot$, and may extend down to lower masses. We argue that the dispersion in lithium equivalent widths observed for cool dwarfs in the Pleiades cluster reflects an intrinsic scatter in lithium abundances, and suggest that the physical origin of the lithium dispersion pattern is to be found in the pre-main sequence rotational history of solar-type stars.

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For preprints via WWW: http://adsabs.harvard.edu/abs/2017arXiv171206525B

Synthetic Stellar Photometry - II. Testing the Bolometric Flux Scale, and Tables of Bolometric Corrections for the Hipparcos/Tycho, Pan-STARRS1, SkyMapper and JWST Systems

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We use MARCS model atmosphere fluxes to compute synthetic colours, bolometric corrections and reddening coefficients for the Hipparcos/Tycho, Pan-STARRS1, SkyMapper and *JWST* systems. Tables and interpolation subrou-

tines are provided to transform isochrones from the theoretical to various observational planes, to derive bolometric corrections, synthetic colours and colour-temperature relations at nearly any given point of the HR diagram for 2600 K $\leq$ $T_{\rm eff}$ $\leq$ 8000 K, and different values of reddening in 85 photometric filters. We use absolute spectrophotometry from the CALSPEC library to show that bolometric fluxes can be recovered to $\sim$ 2 percent from bolometric corrections in a single band, when input stellar parameters are well known for FG dwarfs at various metallicities. This sole source of uncertainty impacts interferometric $T_{\rm eff}$ to $\simeq$ 0.5 percent (or 30 K at the solar temperature). Uncertainties are halved when combining bolometric corrections in more bands, and limited by the fundamental uncertainty of the current absolute flux scale at 1 percent. Stars in the RAVE DR5 catalogue are used to validate the quality of our MARCS synthetic photometry in selected filters across the optical and infrared range. This investigation shows that extant MARCS synthetic fluxes are able to reproduce the main features observed in stellar populations across the Galactic disc.

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For preprints via WWW: https://arxiv.org/abs/1801.05508

Tables and interpolation routines at:
https://github.com/casaluca/bolometric-corrections

Cracking the Conundrum of F-Supergiant Coronae

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Chandra X-ray and *HST* far-ultraviolet (FUV) observations of three early-F supergiants have shed new light on a previous puzzle involving a prominent member of the class: α Persei (HD 20902: F5 Ib). The warm supergiant is a moderately strong, hard coronal ($T \sim 10^7$ K) X-ray source, but has ten times weaker "sub-coronal" Si IV 1393 Å ($T \sim 8 \times 10^4$ K) emissions than early-G supergiants of similar high-energy properties. The α Per X-ray excess speculatively was ascribed to a close-in hyperactive G-dwarf companion, which could have escaped previous notice, lost in the glare of the bright star. However, a subsequent dedicated multi-wavelength imaging campaign failed to find any evidence for a resolved secondary. The origin of the α Per high-energy dichotomy then devolved to: (1) an *unresolved* companion; or (2) intrinsic coronal behavior. Exploring the second possibility, the present program has found that early-F supergiants do appear to belong to a distinct coronal class, characterized by elevated X-ray/FUV ratios, although sharing some similarities with Cepheid variables in their transitory X-ray "high states." Remarkably, the early-F supergiants now are seen to align with the low-activity end of the X-ray/FUV sequence defined by late-type dwarfs, suggesting that the disjoint behavior relative to the G supergiants might be attributed to thinner outer atmospheres on the F types, as in dwarfs, but in this case perhaps caused by a weakened "ionization valve" effect due to overly warm photospheres.

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For preprints via WWW: http://arxiv.org/abs/1802.02552

Effects of Variable Thermal Diffusivity on the Structure of Convection

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The multiscale flow structure in the solar convection zone – the coexistence of such features as the granules, mesogranules, supergranules and giant cells – has not yet been properly understood. Here, the possible role of one physical factor – variations in the thermal diffusivity – in the formation of a multiscale convection structure is investigated. Thermal convection in a plane horizontal fluid layer is numerically simulated. The temperature dependence of thermal diffusivity is chosen so as to produce a sharp kink in the static temperature profile near the upper layer boundary. As a result, the magnitude of the (negative) static temperature gradient dTs/dz, being small over the most part of the layer thickness, reaches large values in a thin boundary sublayer. To identify the structures on different scales, we apply a smoothing procedure and spectral processing to the temperature field. The flow is found to be a superposition of three cellular structures with three different characteristic scales. The largest (first-scale) convection cells, with central upflows, fill the whole layer thickness; most of these cells are divided by bridges, or isthmuses, into a few smaller (second-scale) ones, which are localised in the upper portion of the layer; finally, there are numerous tiny (third-scale) features that dot the horizontal sections of the layer located near its upper boundary and exhibit a tendency of gathering in the intercellular lanes of the first-scale cells. The third-scale cellular structures are advected by the first-scale and second-scale convective flows. The spatial spectrum of the flow does not directly indicate the presence of the second-scale and third-scale structures; however, they can be selected by using our processing techniques. On the whole, the simulated flow pattern qualitatively resembles that observed on the Sun.

Accepted by Physics Letters A

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For preprints via WWW: https://arxiv.org/abs/1604.02543

On the Origin of the Double-Cell Meridional Circulation in the Solar Convection Zone

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Recent advances in helioseismology, numerical simulations and mean-field theory of solar differential rotation have shown that the meridional circulation pattern may consist of two or more cells in each hemisphere of the convection zone. According to the mean-field theory the double-cell circulation pattern can result from the sign inversion of a nondiffusive part of the radial angular momentum transport (the so-called Λ-effect) in the lower part of the solar convection zone. Here, we show that this phenomenon can result from the radial inhomogeneity of the Coriolis number, which depends on the convective turnover time. We demonstrate that if this effect is taken into account then the solar-like differential rotation and the double-cell meridional circulation are both reproduced by the mean-field model. The model is consistent with the distribution of turbulent velocity correlations determined from observations by tracing motions of sunspots and large-scale magnetic fields, indicating that these tracers are rooted just below the shear layer.

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For preprints via ftp or WWW: https://arxiv.org/abs/1708.03073

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

Resolving the Inner Arcsecond of the RY Tau Jet with *HST*

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Faint X-ray emission from hot plasma ($T_x > 10^6$ K) has been detected extending outward a few arcseconds along the optically-delineated jets of some classical T Tauri stars including RY Tau. The mechanism and location where the jet is heated to X-ray temperatures is unknown. We present high spatial resolution *Hubble Space Telescope* (*HST*) far-ultraviolet long-slit observations of RY Tau with the slit aligned along the jet. The primary objective was to search for C IV emission from warm plasma at $T_{CIV} \sim 10^5$ K within the inner jet ($<1''$) that cannot be fully-resolved by X-ray telescopes. Spatially-resolved C IV emission is detected in the blueshifted jet extending outward from the star to $1''$ and in the redshifted jet out to $0''.5$. C IV line centroid shifts give a radial velocity in the blueshifted jet of -136 ± 10 km s^{-1} at an offset of $0''.29$ (39 au) and deceleration outward is detected. The deprojected jet speed is subject to uncertainties in the jet inclination but values >200 km s^{-1} are likely. The mass-loss rate in the blueshifted jet is at least $\dot{M}_{jet,blue} = 2.3 \times 10^{-9}$ M$_\odot$ yr^{-1}, consistent with optical determinations. We use the *HST* data along with optically-determined jet morphology to place meaningful constraints on candidate jet-heating models including a hot-launch model in which the jet is heated near the base to X-ray temperatures by an unspecified (but probably magnetic) process, and downstream heating from shocks or a putative jet magnetic field.

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For preprints via WWW: https://arxiv.org/abs/1801.08568

Research Notes

Alpha Centauri at a Crossroads

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Everything you ever wanted to know about the coronal X-ray cycles of α Centauri A (G2 V) and B (K1 V), the nearest sunlike stars; including a discussion of "Breakthrough StarShot," a crazy, if not also visionary, plan to send a swarm of nanobot spacecraft to α Cen by the end of the century, to reconnoiter potentially habitable planets. The article distills the results of historical and recent X-ray studies of the system, in a perhaps more accessible fashion than the typical journal presentation.

Published by: *Chandra* Newsletter Issue 24

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For preprints via WWW: http://cxc.harvard.edu/newsletters/news_24/index.html

Alpha Centauri Beyond the Crossroads

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Alpha Centauri is a nearby (1.3 pc) hierarchical triple consisting of an eccentric binary of sunlike dwarfs, "A" (G2 V) and "B" (K1 V) in an 80 year orbit, circled at great distance ($\sim 10^4$ au) by "C" (dM6; aka Proxima). Subject of this Research Note is a long term effort to record the coronal (1 MK) soft X-ray counterparts of the starspot cycles of α Cen AB with the *Chandra* High Resolution Camera (HRC-I). Semi-annual monitoring, which began in 2005, has continued to 2017.82, including seven additional 10 ks HRC-I pointings since the last published observation (circa 2014). The cooler, but more "active," B component has shown a systematic 8 yr oscillation, somewhat shorter than the Sun's 11 yr, although the most recent cycle appears to be faster than the previous one. More sunlike A, on the other hand, has displayed a much longer variation, perhaps twice solar ($\sim$ 20 yr). Alternatively, the star might have a shorter cycle, but experienced an over-long minimum during the 2005−2010 time frame, something like the Sun's unexpected extended minimum 2007−2010. In the recent HRC pointings, α Cen A appears to have reached a maximum, and now is declining rapidly, closely shadowing the rise and fall of current solar Cycle 24.

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For preprints via WWW: http://iopscience.iop.org/article/10.3847/2515-5172/aaa88f/meta

The Mass–Luminosity Relation for a Refined Set of Late-K / M Dwarfs

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In this short paper, we deduce the mass-luminosity relationship for a sample of K (and M) dwarfs based on the data set previously published by Mann et al. (2013) [ApJ, 779, 188]. The stars have previously also been used as a calibration sample for more distant late-type stars, including *Kepler* candidate objects. A relationship $L \propto M^{n(M)}$ is given, where $n(M)$ constitutes a fourth-order polynomial. The approximation $n(M)$ as obtained avoids the discontinuity typically occurring at 0.43 $M_\odot$. It should be noted that the relation should be considered work in progress. Additional efforts are needed especially for the realm of M dwarfs.

Published by Research Notes of the AAS

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For preprints via WWW: http://iopscience.iop.org/article/10.3847/2515-5172/aaaa67

Upcoming Meeting

ESO Workshop: A Revolution in Stellar Physics with Gaia and Large Surveys

3 - 7 September 2018

Warsaw, Poland

Contact: revolution@camk.edu.pl

SECOND ANNOUNCEMENT

The workshop will focus on discussions about the advances in our understanding of stellar physical processes made possible by combining the exquisite astrometry and photometry of Gaia with data of other large photometric, spectroscopic, and asteroseismic stellar surveys. These combined data will permit detailed studies of stellar physics to a level that is unprecedented in the history of stellar astrophysics.

The second release (DR2) of Gaia data is planned for April 2018. With the DR2 data available, the workshop will be a perfect moment to showcase Gaia's synergy with other surveys, discuss early science achievements and future developments.

REGISTRATION and ABSTRACT SUBMISSION:

Registration and abstract submission are now open with deadline April 15, 2018. Registration fee is 1050 PLN (250 EUR) for payment before June 01, 2018. Notification of talk selection is expected by mid-May.

FINANCIAL SUPPORT:

Partial financial support can be offered for a small number of early-career researchers (PhD students and young postdocs). A justification for the financial request has to be sent together with the registration by the same deadline of April 15, 2018. Notification of financial support is expected by mid-May.

VENUE:

The workshop will take place at the building of the Library of the Warsaw University (Dobra street 56/66, Warsaw, Poland). The Library is located between the Vistula river and the Royal route (Krakowskie Przedmie?cie street). Hotels and restaurants can be found within walking distance.

ACCOMMODATION:

Participants are asked to arrange their own accommodation. There are many hotels located in the center of Warsaw including most international chains.

INVITED SPEAKERS:

- Babusiaux, Carine (Universit Grenoble Alpes, France);
- Bergemann, Maria (Max-Planck Institute for Astronomy, Germany);
- Charbonnel, Corinne (Geneva Observatory, Switzerland);

- Covey, Kevin (Western Washington University, USA);
- Eyer, Laurent (University of Geneva, Switzerland);
- Feiden, Gregory (University of North Georgia, USA);
- Gänsicke, Boris (University of Warwick, UK);
- Girardi, Leo (Padova Observatory, Italy);
- Hillenbrand, Lynne (Caltech, USA);
- Huber, Daniel (University of Hawaii, USA);
- Karakas, Amanda (Monash University, Australia);
- Korn, Andreas (Uppsala University, Sweden);
- Limongi, Marco (Rome Observatory, Italy);
- Soszyński, Igor (University of Warsaw, Poland);
- Toonen, Silvia (University of Amsterdam, Netherlands).

SOC: Ekström, Sylvia (Geneva Observatory, Switzerland); Handler, Gerald (CAMK, Poland); Hussain, Gaitee (ESO Garching); Degl'Innocenti, Scilla (University of Pisa, Italy); Jeffries, Rob (Keele University, UK); Lennon, Danny (ESA); Miglio, Andrea (University of Birmingham, UK); Pasquini, Luca (ESO Garching); Randich, Sofia (INAF/Arcetri, Italy); Smiljanic, Rodolfo (CAMK, Poland); Udalski, Andrzej (University of Warsaw, Poland).

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 bimonthly call for abstracts will be issued. 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.***