COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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TABLE OF CONTENTS

Coolnews on the Web

The current and previous issues of *Coolnews* are available on the following web page in pdf, postscript, and Latex format: **http://casa.colorado.edu/∼skinners/coolnews.html**

Stellar Abstracts

Images of Gravitational and Magnetic Phenomena Derived from 2D Back-Projection Doppler Tomography of Interacting Binary Stars

Mercedes T. Richards[1,2], Alexander S. Cocking[1], John G. Fisher,[1] and Marshall J. Conover[1]

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We have used 2D back-projection Doppler tomography as a tool to examine the influence of gravitational and magnetic phenomena in interacting binaries which undergo mass transfer from a magnetically-active star onto a non-magnetic main sequence star. This multi-tiered study of over 1300 time-resolved spectra of 13 Algol binaries involved calculations of the predicted dynamical behavior of the gravitational flow and the dynamics at the impact site, analysis of the velocity images constructed from tomography, and the influence on the tomograms of orbital inclination, systemic velocity, orbital coverage, and shadowing. The Hα tomograms revealed eight sources: chromospheric emission, a gas stream along the gravitational trajectory, a star-stream impact region, a bulge of absorption or emission around the mass-gaining star, a Keplerian accretion disk, an absorption zone associated with hotter gas, a disk-stream impact region, and a hot spot where the stream strikes the edge of a disk. We described several methods used to extract the physical properties of the emission sources directly from the velocity images, including S-wave analysis, the creation of simulated velocity tomograms from hydrodynamic simulations, and the use of synthetic spectra with tomography to sequentially extract the separate sources of emission from the velocity image. In summary, the tomography images have revealed results that cannot be explained solely by gravitational effects: chromospheric emission moving with the

mass-losing star, a gas stream deflected from the gravitational trajectory, and alternating behavior between stream state and disk state. Our results demonstrate that magnetic effects cannot be ignored in these interacting binaries.

Accepted by ApJ, in press, to appear October 20, 2014

For preprints contact: mrichards@astro.psu.edu

For preprints via ftp or WWW: http://arxiv.org/abs/1408.0224

Gaia-ESO Survey: The Analysis of High-resolution UVES Spectra of FGK-type Stars

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The Gaia-ESO Survey is obtaining high-quality spectroscopic data for about 10^5 stars using FLAMES at the VLT. UVES high-resolution spectra are being collected for about 5000 FGK-type stars. These UVES spectra are analyzed in parallel by several state-of-the-art methodologies. Our aim is to present how these analyses were implemented, to discuss their results, and to describe how a final recommended parameter scale is defined. We also discuss the precision (method-to-method dispersion) and accuracy (biases with respect to the reference values) of the final parameters. These results are part of the Gaia-ESO 2nd internal release and will be part of its 1st public release of advanced data products. The final parameter scale is tied to the one defined by the Gaia benchmark stars, a set of stars with fundamental atmospheric parameters. A set of open and globular clusters is used to evaluate the physical soundness of the results. Each methodology is judged against the benchmark stars to define weights in three different regions of the parameter space. The final recommended results are the weighted-medians of those from the individual methods. The recommended results successfully reproduce the benchmark stars atmospheric parameters and the expected Teff-log g relation of the calibrating clusters. Atmospheric parameters and abundances have been determined for 1301 FGK-type stars observed with UVES. The median of the method-to-method dispersion of the atmospheric parameters is 55 K for Teff, 0.13 dex for log g, and 0.07 dex for [Fe/H]. Systematic biases are estimated to be between 50-100 K for Teff, 0.10-0.25 dex for log g, and 0.05-0.10 dex for [Fe/H]. Abundances for 24 elements were derived: C, N, O, Na, Mg, Al, Si, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Y, Zr, Mo, Ba, Nd, and Eu. The typical method-to-method dispersion of the abundances varies between 0.10 and 0.20 dex.

Accepted by A&A

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For preprints via ftp or WWW: http://arxiv.org/abs/1409.0568

Evidence from Stellar Rotation of Enhanced Disc Dispersal: (I) The Case of the Triple Visual System BD$-$21 1074 in the β Pictoris Association

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The early stage of stellar evolution is characterized by a magnetic coupling between a star and its accretion disc, known as a star-disc locking mechanism. The disc-locking prevents the star to spin its rotation up, and its timescale depends on the disc lifetime, which should not be longer than about 10 Myr. Some mechanisms can significantly shorten this lifetime, allowing a few stars to start spinning up much earlier than other stars and increasing the observed rotation period dispersion among coeval stars. In the present study, we aim to investigate how the properties of the circumstellar environment can shorten the disc lifetime, more specifically the presence of a close stellar companion. We

have identified a few multiple stellar systems, composed of stars with similar masses, which belong to associations with a known age. Since all parameters that are responsible for the rotational evolution, with the exception of environment properties and initial stellar rotation, are similar for all components, we expect that significant differences among the rotation periods can only arise from differences in the disc lifetimes. A photometric timeseries allowed us to measure the rotation periods of each component, while high-resolution spectra provided us with the fundamental parameters, $v \sin i$ and chromospheric line fluxes. In the present study, we have collected timeseries photometry of BD$-$21 1074, a member of the 21-Myr old β Pictoris association, and measured the rotation periods of its brightest components A and B. They differ significantly, and the component B, which has a closer companion C, rotates faster than the more distant and isolated component A. It also displays a slightly higher chromospheric activity level. Since components A and B have similar mass, age, and initial chemical composition, we can ascribe the rotation period difference to either different initial rotation periods or different disc-locking phases arising from the presence of the close companion C. that has accelerated the disc dispersal of the component B, making shorter the lifetime of its disc, and the duration of the star-disc locking phase. In the specific case of BD$-$21 1074, the second scenario seems to be more favored. However, a statistically meaningful sample is yet needed to be able to infer which scenario is more likely. In our hypothesis of different disc-locking phase, any planet orbiting this star, if found by future investigations, is likely formed very rapidly owing to a gravitational instability mechanism, rather than core accretion. Only a large difference of initial rotation periods alone could account for the observed period difference, leaving comparable disc lifetimes.

Accepted by A&A

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For preprints via WWW: arXiv:1408.5719

Generalized Investigation of the Rotation-Activity Relation: Favouring Rotation Period Instead of Rossby Number

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Magnetic activity in Sun-like and low-mass stars causes X-ray coronal emission, which is stronger for more rapidly rotating stars. This relation is often interpreted in terms of the Rossby number, i.e., the ratio of rotation period to convective overturn time. We reconsider this interpretation on the basis of the observed X-ray emission and rotation periods of 821 stars with masses below $1.4\,M_\odot$. A generalized analysis of the relation between X-ray luminosity normalized by bolometric luminosity, L_X/L_{bol}, and combinations of rotational period, P, and stellar radius, R, shows that the Rossby formulation does not provide the solution with minimal scatter. Instead, we find that the relation $L_X/L_{bol} \propto P^{-2}R^{-4}$ optimally describes the non-saturated fraction of the stars. This relation is equivalent to $L_X \propto P^{-2}$, indicating that the rotation period alone determines the total X-ray emission. Since L_X is directly related to the magnetic flux at the stellar surface, this means that the surface flux is determined solely by the star's rotation and is independent of other stellar parameters. While a formulation in terms of a Rossby number would be consistent with these results if the convective overturn time scales exactly as $L_{bol}^{-1/2}$, our generalized approach emphasizes the need to test a broader range of mechanisms for dynamo action in cool stars.

Accepted by ApJ

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For preprints via ftp or WWW: http://arxiv.org/abs/1408.6175

Photometric Stellar Parameters for Asteroseismology and Galactic Studies

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Asteroseismology has the capability of delivering stellar properties which would otherwise be inaccessible, such as radii, masses and thus ages of stars. When coupling this information with classical determinations of stellar parameters, such as metallicities, effective temperatures and angular diameters, powerful new diagnostics for both stellar and Galactic studies can be obtained. I review how different photometric systems and filters carry important information on classical

stellar parameters, the accuracy at which those parameters can be derived, and summarize some of the calibrations available in the literature for late-type stars. Recent efforts in combining classical and asteroseismic parameters are discussed, and the uniqueness of their intertwine is highlighted.

To appear in: Proc. of the workshop *Asteroseismology of Stellar Populations in the Milky Way*, Astrophysics and Space Science Proceedings, (eds. A. Miglio, L. Girardi, P. Eggenberger, J. Montalban). Invited Review.

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For preprints via ftp or WWW: http://arxiv.org/abs/1409.2272

Project Website: http://www.mso.anu.edu.au/saga

Chemical Tagging of the Ursa Major Moving Group

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Stellar kinematic groups are kinematical coherent groups of stars which might share a common origin. These groups spread through the Galaxy over time due to tidal effects caused by Galactic rotation and disc heating. However, the chemical information survives these processes. The information provided by the analysis of chemical elements can reveal the origin of these kinematic groups. Here we investigate the origin of the stars that belong to the Ursa Major (UMa) Moving Group (MG) We present high-resolution spectroscopic observations obtained from three different spectrographs of kinematically selected FGK stars of the Ursa Major moving group.Stellar atmospheric parameters ($T_{\rm eff}$, $\log g$, ξ, and [Fe/H]) were determined using our own automatic code (StePar) which makes use of the sensitivity of iron equivalent widths (EWs) measured in the spectra. We critically compare the StePar results with other methods ($T_{\rm eff}$ values derived using the infrared flux method (IRFM) and $\log g$ values based on Hipparcos parallaxes). We derived the chemical abundances of 20 elements, and their [X/Fe] ratios of all stars in the sample. We perform a differential abundance analysis with respect to a reference star of the UMa MG (HD 115043). We have also carried out a systematic comparison of the abundance pattern of the Ursa Major MG and the Hyades SC with the thin disc stellar abundances. Our chemical tagging analysis indicates that the Ursa Major MG is less affected by field star contamination than other moving groups (such as the Hyades SC). We find a roughly solar iron composition [Fe/H] = 0.03 ± 0.07 dex for the finally selected stars, whereas the [X/Fe] ratios are roughly sub-solar except for super-solar Barium abundance.

We conclude that 29 out of 44 (i.e. 66%) candidate stars share a similar chemical composition. In addition, we find that the abundance pattern of the Ursa Major MG is different from that of the Hyades SC.

Accepted by A&A

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Low-Mass and Substellar Abstracts

The Low Mass Star and Sub-stellar Populations of the 25 Orionis Group

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We present the results of a survey of the low mass star and brown dwarf population of the 25 Orionis group. Using optical photometry from the CIDA Deep Survey of Orion, near IR photometry from the Visible and Infrared Survey Telescope for Astronomy and low resolution spectroscopy obtained with Hectospec at the MMT, we selected 1246 photometric candidates to low mass stars and brown dwarfs with estimated masses within $0.02 \lesssim M/M_{\odot} \lesssim 0.8$ and spectroscopically confirmed a sample of 77 low mass stars as new members of the cluster with a mean age of $\sim$7 Myr. We have obtained a system initial mass function of the group that can be well described by either a Kroupa power-law function with indices $\alpha_3 = -1.73 \pm 0.31$ and $\alpha_2 = 0.68 \pm 0.41$ in the mass ranges $0.03 \leq M/M_{\odot} \leq 0.08$ and $0.08 \leq M/M_{\odot} \leq 0.5$ respectively, or a Scalo log-normal function with coefficients $m_c = 0.21^{+0.02}_{-0.02}$ and $\sigma = 0.36 \pm 0.03$ in the mass range $0.03 \leq M/M_{\odot} \leq 0.8$. From the analysis of the spatial distribution of this numerous candidate sample, we have confirmed the East-West elongation of the 25 Orionis group observed in previous works, and rule out a possible southern extension of the group. We find that the spatial distributions of low mass stars and brown dwarfs in 25 Orionis are statistically indistinguishable. Finally, we found that the fraction of brown dwarfs showing IR excesses is higher than for low mass stars, supporting the scenario in which the evolution of circumstellar discs around the least massive objects could be more prolonged.

Accepted by MNRAS

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Cross-Listed Abstracts (Pre-Main Sequence Stars)

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

Accretion and Outflow in the Proplyd-like Objects Near Cygnus OB2

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Cygnus OB2 is the most massive association within 2 kpc from the Sun, hosting hundreds of massive stars, thousands of young low mass members, and some sights of active star formation in the surrounding cloud. Recently, 10 photoevaporating proplyd-like objects with tadpole-shaped morphology were discovered in the outskirts of the OB association, approximately 6-14 pc away from its center. The classification of these objects is ambiguous, being either evaporating residuals of the parental cloud which are hosting a protostar inside, or disk-bearing stars with an evaporating disk, such as the evaporating proplyds observed in the Trapezium Cluster in Orion. In this paper we present a study based on low resolution optical spectroscopic observations made with the Optical System for Imaging and low Resolution Integrated Spectroscopy (OSIRIS), mounted on the 10.4 m Gran Telescopio CANARIAS (GTC), of two of these protostars. The spectrum of one of the objects shows evidence of accretion but not of outflows. In the latter object, the spectra show several emission lines indicating the presence of an actively accreting disk with outflow. We present estimates of the mass loss rate and the accretion rate from the disk, showing that the former exceeds the latter as observed in other known objects with evaporating disks. We also show evidence of a strong variability in the integrated flux observed in these objects, as well as in the accretion and outflow diagnostics.

Accepted by ApJ

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Simulations of Magnetoconvection in Cool Main-sequence Stars

Benjamin Beeck

Thesis work conducted at: Institute for Astrophysics, University of Göttingen, Germany and Max Planck Institute for Solar System Research, Göttingen, Germany

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Ph.D dissertation directed by: Manfred Schüssler and Ansgar Reiners

Ph.D degree awarded: June 2014

In this thesis, the magnetoconvective processes in the near-surface layers of cool main-sequence stars were studied in 24 three-dimensional local "box-in-a-star" simulations. For each of six sets of stellar parameters corresponding to spectral types F3V – M2V including the solar case (G2V), one non-magnetic and three magnetic simulations with an initially vertical and homogeneous field of 20, 100, and 500 G were performed.

Analogous to the solar example, hot upwellings (granules) and a network of cool downflows evolve. In the magnetic case, the magnetic flux is advected by the granular outflows and concentrated in the intergranular lane network, where it causes local depressions in the optical surface and impedes the convective flows. This leads to the formation of small bright and larger dark structures. In the upper photospheres, the magnetic field considerably modifies the non-radiative heating processes in all simulated stars.

A granule segmentation and tracking algorithm was developed and the granulation was analysed for the non-magnetic and some magnetic runs. The sizes and lifetimes of granules agree with observations in the solar case. A marginal influence of the magnetic field on the statistical properties of granules was found.

For a few wavelength passbands, the centre-to-limb variation of the intensity and its rms contrast were calculated on the basis of snapshots from the simulations. The limb darkening in the non-magnetic case agrees relatively well with the limb darkening derived from 1D atmospheres. The deviations of the different magnetic cases from the non-magnetic case are large due to a brightening of the limb by magnetic flux concentrations appearing as "faculae".

Synthetic spectral line profiles were calculated for the simulated stars. A disc-integration including differential rotation was carried out in order to study the effects of the three-dimensional atmospheric structure on spectral line profiles. A dependence of the line bisector shapes on differential rotation parameter and inclination was found. The impact of the magnetic field on the Stokes I component of some Zeeman-sensitive lines was analysed. While in M-type stars the Zeeman effect substantially broadens the lines for an average surface field strength of 500 G, in hotter stars the modified atmospheric structure (due to the field) has a strong additional impact on the line profiles, e. g. line weakening due to ionisation. This can considerably impair magnetic field measurements as it usually leads to narrower line profiles. Moreover, the correlation between magnetic field and velocity field leads to a net Doppler shift of spectral lines.

Although the simulations presented in this thesis only cover parts of the phenomena of stellar surface magnetism (excluding, e. g., starspots and bipolar active regions), they are an essential step towards a physically comprehensive description of magnetoconvective processes in stars, which is needed, e. g. for the improvement of inversion methods and the correct interpretation of spectroscopic observations.

Thesis-related Publications: A&A 558 A48; A&A 558 A49

Thesis Download: http://hdl.handle.net/11858/00-1735-0000-0022-5EC8-D

Upcoming Meeting

Third Announcement

Swift: 10 Years of Discovery

2 - 5 December 2014

Rome, Italy

Webpage: http://www.brera.inaf.it/Swift10/

Email: swift10years@brera.inaf.it

The meeting *Swift: 10 years of Discovery* will be held on December 2-5, 2014 in Rome, Italy, at the Sapienza University, Faculty of Arts and Humanities. This meeting will celebrate 10 years of Swift successes and will cover recent advances, both from the observational and theoretical sides on our knowledge of the high-energy transient Universe.

The invited speakers list is now completed and a preliminary program has been posted on the meeting web pages at:

http://www.brera.inaf.it/Swift10/

Contributed talks will be balanced after abstract selection.

We remind you that September 30, 2014 is the deadline for abstract submission and early bird fee.

Regards,

Patrizia Caraveo, Neil Gehrels, Gianpiero Tagliaferri

Third Announcement

Polarimetry: From the Sun to Stars and Stellar Environments

30 Nov. - 5 Dec. 2014

Punta Leona, Costa Rica

https://www2.hao.ucar.edu/events/IAUS305

UPCOMING DEADLINES:

NEW abstract submission deadline: September 12, 2014.

In order for your paper to be considered for inclusion in the scientific program, please submit your abstract by 12 September 2014. Follow the tab Submit Abstract at the above website.

Early registration deadline: September 12, 2014

The registration fees increase after September 12, 2014. Furthermore, the Symposium is limited to 150 participants. Attendees will guarantee participation when they pay their registration fee. Follow the tab Registration at the above website. If you have already submitted a registration for the Symposium but have not paid the registration fee, you may reach the registration payment site indicated at the top of the Registration page.

Lodging registration and payment deadline: October 31, 2014

Aside from the block of rooms reserved for the Symposium, the Punta Leona resort is fully booked. Therefore, participants should reserve their rooms at Punta Leona as soon as possible. Reserve your rooms by following the instructions under the Rooms/Meals tab at the above website. Please reserve your room either by telephone or email, and provide the offer code CORPUCR to receive the accommodation discount for the Symposium.

Transportation between the airport (SJO) and Punta Leona:

The Symposium will provide transportation from the Juan Santamaria International Airport (SJO, near San Jose, the capitol city of Costa Rica) to the meeting venue at Punta Leona on 29 and 30 November; and return to the airport on 5 and 6 December 2014. In order to schedule the transportation, the LOC needs information on your arrival and departure times at SJO. At your earliest convenience, please provide your flight itinerary. The above website contains a form for this purpose under the tab Shuttle Transport. Also, if you do not require transportation, please so indicate on that form.

Visas:

Costa Rica does not require visas for shortterm visitors from many countries. However, everyone should check with the Costa Rica Embassy in their respective countries to determine if a visa is required. It may take some time to acquire your visa, so if you need one, please apply for the visa as soon as possible. If you need a letter of invitation for your visa, please send the request to:
info_IAUS305@hao.ucar.edu.

Ph.D. Program
Astronomy and Cosmic Physics
Max Planck Research School, Univ. of Heidelberg
Heidelberg, Germany

Applications are invited for the doctoral program of the *International Max Planck Research School for Astronomy & Cosmic Physics* at the University of Heidelberg (IMPRS-HD)

Starting summer/autumn 2015.

The scientific environment in Heidelberg provides outstanding research facilities with access to ground-based and space telescopes as well as high-performance computers.

The following institutions of the Max Planck Society and Heidelberg University take part in IMPRS-HD:

Max Planck Institute for Astronomy, Max Planck Institute for Nuclear Physics, Astronomisches Rechen-Institut, Institute of Theoretical Astrophysics, Landessternwarte Koenigstuhl, Heidelberg Institute of Theoretical Studies

A wide range of astrophysical topics is covered in Heidelberg, among them: planet & star formation, metal-poor stars, extrasolar planets & substellar objects, astrometry, formation, evolution & dynamics of galaxies; active galactic nuclei & massive black holes, gravitational lensing, cosmology & structure formation, high energy astrophysics, cosmic rays & search for non-baryonic dark matter, instrumentation for astronomy & astro-particle physics.

IMPRS-HD offers several fellowships within the graduate program. We invite highly-qualified students aiming for a doctoral degree in astrophysics to apply by:

November 17, 2014 for the academic year starting Sept. 2015

An earlier start of the research work is possible.

Applicants are generally required to expect a MSc (or equivalent) in Physics or Astronomy, including an extensive MSc thesis and a very good physics background. For further information about IMPRS Heidelberg and details of the application procedure, we refer to our web-site at

http://www.mpia.de/imprs-hd/

IMPRS-HD is an independent part of the Heidelberg Graduate School of Fundamental Physics.

With kind regards, Christian Fendt

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.***