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

The Stellar Activity-Rotation Relationship and the Evolution of Stellar Dynamos

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We present a sample of 824 solar and late-type stars with X-ray luminosities and rotation periods. This is used to study the relationship between rotation and stellar activity and derive a new estimate of the convective turnover time. From an unbiased subset of this sample the power law slope of the unsaturated regime, L_X / L_bol = Ro$^{\beta}$, is fit as β = -2.70 +/- 0.13. This is inconsistent with the canonical β = -2 slope to a confidence of 5 sigma, and argues for an additional term in the dynamo number equation. From a simple scaling analysis this implies $\Delta\Omega/\Omega = \Omega^0.7$, i.e. the differential rotation of solar-type stars gradually declines as they spin down. Super-saturation is observed for the fastest rotators in our sample and its parametric dependencies are explored. Significant correlations are found with both the corotation radius and the excess polar updraft, the latter theory providing a stronger dependence and being supported by other observations. We estimate mass-dependent empirical thresholds for saturation and super-saturation and map out three regimes of coronal emission. Late F-type stars are shown never to pass through the saturated regime, passing straight from super-saturated to unsaturated X-ray emission. The theoretical threshold for

coronal stripping is shown to be significantly different from the empirical saturation threshold (Ro < 0.13), suggesting it is not responsible. Instead we suggest that a different dynamo configuration is at work in stars with saturated coronal emission. This is supported by a correlation between the empirical saturation threshold and the time when stars transition between convective and interface sequences in rotational spin-down models.

Accepted by ApJ

For preprints contact: nwright@cfa.harvard.edu

For preprints via WWW: http://arxiv.org/abs/1109.4634

Assessing the Accuracy of the Gravity Determination in Late-Type Stars with Solar-Like Pulsators

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The frequency of maximum oscillation power measured in dwarfs and giants exhibiting solar-like pulsations provides a precise, and potentially accurate, inference of the stellar surface gravity. An extensive comparison for about 40 well-studied pulsating stars with gravities derived using classical methods (ionisation balance, pressure-sensitive spectral features or location with respect to evolutionary tracks) supports the validity of this technique and reveals an overall remarkable agreement with mean differences not exceeding 0.05 dex (although with a dispersion of up to ∼0.2 dex). It is argued that interpolation in theoretical isochrones may be the most precise way of estimating the gravity by traditional means in nearby dwarfs. Attention is drawn to the usefulness of seismic targets as benchmarks in the context of large-scale surveys.

Accepted by MNRAS Letters

For preprints contact: morel@astro.ulg.ac.be

For preprints via WWW: http://www.ster.kuleuven.be/∼thierry/articles/MN_11_2004_L.pdf

Radiative Hydrodynamics Simulations of Red Supergiant stars. IV. Gray Versus Non-gray Opacities

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Red supergiants are massive evolved stars that contribute extensively to the chemical enrichment of our Galaxy. It has been shown that convection in those stars gives rise to large granules that cause surface inhomogeneities and shock waves in the photosphere. The understanding of their dynamics is crucial to unveil the unknown mass-loss mechanism, their chemical composition and stellar parameters.
We present a new generation of red supergiants simulations with a more sophisticated opacity treatment done with 3D radiative-hydrodynamics CO5BOLD.
In the code, the coupled equations of compressible hydrodynamics and non-local radiation transport are solved in the presence of a spherical potential. The stellar core is replaced by a special spherical inner boundary condition, where the gravitational potential is smoothed and the energy production by fusion is mimicked by a simply producing heat corresponding to the stellar luminosity. All outer boundaries are transmitting for matter and light. The post-processing radiative transfer code OPTIM3D is used to extract spectroscopic and interferometric observables.
We show that the relaxation of the assumption of frequency-independent opacities shows a steeper mean thermal gradient in the optical thin region that affect strongly the atomic strengths and the spectral energy distribution.

Moreover, the weaker temperature fluctuations reduce the incertitude on the radius determination with interferometry. We show that 1D models of red supergiants must include a turbulent velocity calibrated on 3D simulations to obtain the effective surface gravity that mimic the effect of turbulent pressure on the stellar atmosphere. We provide an empirical calibration of the ad-hoc micro- and macroturbulence parameters for 1D models using the 3D simulations: we find that there is not a clear distinction between the different macroturbulent profiles needed in 1D models to fit 3D synthetic lines.

Accepted by A&A

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For preprints via WWW: http://arxiv.org/pdf/1109.3619v1

A Study of X-ray Flares -II. RS CVn Type Binaries

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We present an analysis of seven flares detected from five RS CVn-type binaries (UZ Lib, σ Gem, λ And, V711 Tau and EI Eri) observed with XMM-Newton observatory. The quiescent state X-ray luminosities in the energy band of 0.3-10.0 keV of these stars were found to be $10^{30.7-30.9}$ erg s^{-1}. The exponential decay time in all the sample of flares range from ~ 1 to 8 hrs. The luminosity at peak of the flares in the energy band of 0.3-10.0 keV were found to be in the range of $10^{30.8} - 10^{31.8}$ erg s^{-1}. The great sensitivity of the XMM-EPIC instruments allowed us to perform time resolved spectral analysis during the flares and also in the subsquent quiescent phases. The derived metal abundances of coronal plasma were found to vary during the flares observed from σ Gem, V771 Tau and EI Eri. In these flares elemental abundances found to be enhanced by factors of $\sim 1.3 - 1.5$ to the quiescent states. In most of the flares, the peak temperature was found to be more than 100 MK whereas emission measure increased by factors of 1.5 - 5.5. Significant sustained heating was present in the majority of flares. The loop lengths (L) derived for flaring structure were found to be of the order of 10^{10-11} cm and are smaller than the stellar radii ($R_\star$) i.e. $L/R_\star \leq 1$. The flare from σ Gem showed a high and variable absorption column density during the flare.

Accepted by MNRAS, in press

For preprints contact: jeewan@aries.res.in

For preprints via WWW: http://arxiv.org/pdf/1110.2008v1

Low-Mass and Substellar Abstracts

Orbit of the Young Very Low-mass Spectroscopic Binary CHXR 74

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The pre-main sequence star CHXR 74 (M4.25) in Chamaeleon I was detected a few years ago to be a very low-mass spectroscopic binary. Determination of its mass would provide a valuable dynamical mass measurement at young ages in the poorly constrained mass regime of $< 0.3\,M_\odot$. We carried out follow-up radial velocity monitoring with UVES/VLT between 2008 and 2011 and high-resolution adaptive optic assisted imaging with NACO/VLT in 2008 with the aim to constrain the binary orbit. We present an orbital solution of the system based on the combined radial velocity data set which spans more than eleven years of UVES monitoring for CHXR 74. The best-fit Kepler model has an orbital period of 13.1 years, zero eccentricity, and a radial velocity semi-amplitude of $2.2\,\mathrm{km\,s^{-1}}$. A companion mass $M_2 \sin i$ (which is a lower limit due to the unknown orbital inclination i) of $0.08\,M_\odot$ is derived by using a model-dependent mass estimate for the primary of $0.24\,M_\odot$. The binary separation ($a_1 \sin i + a_2$) for an inclination of 90° is 3.8 AU which corresponds to 23 mas. Complementary NACO/VLT images of CHXR 74 were taken with the aim to directly resolve the binary. While there are marginal signs of an extended PSF, we have no convincing companion

detected to CHXR 74 in the NACO images. From the non-detection of the companion together with a prediction of the binary separation at the time of the NACO observations, we derive an upper limit for the K-band brightness ratio of the two binary components of 0.5. This allows us to estimate an upper limit of the companion mass of $0.14\,\mathrm{M}_\odot$ by applying evolutionary models. Thus, we have confirmed that CHXR 74 is a very low-mass spectroscopic binary and constrained the secondary mass to lie within the range of about 0.08 and $0.14\,\mathrm{M}_\odot$. We predict an astrometric signal of the primary between 0.2 and 0.4 mas when taking into account the luminosity of the companion. The GAIA astrometric mission might well be able to solve the astrometric orbit of the primary and in combination with the presented radial velocity data to determine an absolute companion mass.

and the name of journal, for example: Accepted by A&A

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For preprints via WWW: http://www.mpia.de/homes/joergens/publications/chxr74_rev2.pdf

Theory Abstracts

Analytical Approximations to Numerical Solutions of Theoretical Emission Measure Distributions

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Emission line fluxes from cool stars are widely used to establish an apparent emission measure distribution, $Emd_{\rm app}(T_{\rm e})$, between temperatures characteristic of the low transition region and the low corona. The true emission measure distribution, $Emd_{\rm t}(T_{\rm e})$, is determined by the energy balance and geometry adopted and, with a numerical model, can be used to predict $Emd_{\rm app}(T_{\rm e})$, to guide further modelling. The scaling laws that exist between coronal parameters arise from the dimensions of the terms of the energy balance equation. Here, analytical approximations to numerical solutions for $Emd_{\rm t}(T_{\rm e})$ are presented, which show how the constants in the scalings laws are determined. The apparent emission measure distributions show a minimum value at some $T_{\rm o}$ and a maximum at the mean coronal temperature $T_{\rm c}$ (although in some stars, emission from active regions can contribute). It is shown that, for the energy balance and geometry adopted, the analytical values of the emission measure and electron pressure at $T_{\rm o}$ and $T_{\rm c}$, depend on only three parameters: the stellar surface gravity and the values of $T_{\rm o}$ and $T_{\rm c}$. The results are tested against full numerical solutions for ϵ Eri (K2 V) and are applied to Procyon (α CMi; F5 IV/V). The analytical solutions can be used to restrict the required range of full numerical solutions, to check the assumed geometry and to show where the adopted energy balance may not be appropriate.

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.*

X-ray Emission From Protostellar Jet HH 154: The First Evidence Of A Diamond Shock?

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X-ray emission from about 10 protostellar jets has been discovered and it appears as a feature common to the most energetic jets. Although X-ray emission seems to originate from shocks internal to jets, the mechanism forming these shocks remains controversial. One of the best-studied X-ray jets is HH 154, which has been observed by Chandra over a time base of about 10 years. We analyze the Chandra observations of HH 154 by investigating the evolution of its X-ray source. We show that the X-ray emission consists of a bright stationary component and a faint elongated component. We interpret the observations by developing a hydrodynamic model describing a protostellar jet originating from a nozzle and compare the X-ray emission synthesized from the model with the X-ray observations. The model takes into account the thermal conduction and radiative losses and shows that the jet/nozzle leads to the formation of a diamond shock at the nozzle exit. The shock is stationary over the period covered by our simulations and generates an X-ray source with luminosity and spectral characteristics in excellent agreement with the observations. We conclude that the X-ray emission from HH 154 is consistent with a diamond shock originating from a nozzle through which the jet is launched into the ambient medium. We suggest that the physical origin of the nozzle could be related to the dense gas in which the HH 154 driving source is embedded and/or to the magnetic field at the jet launching/collimation region.

Appeared in: ApJ, 2011, 737, 54

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Analytical Star Formation Rate from Gravoturbulent Fragmentation

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We present an analytical determination of the star formation rate (SFR) in molecular clouds, based on a time-dependent extension of our analytical theory of the stellar initial mass function (IMF). The theory yields SFR's in good agreement with observations, suggesting that turbulence *is* the dominant, initial process responsible for star formation. In contrast to previous SFR theories, the present one does not invoke a density threshold for star formation; instead, the SFR *continuously* increases with gas density, naturally yielding two different characteristic regimes, thus two different slopes in the SFR vs gas density relationship, in excellent agreement with observational determinations. Besides the complete SFR derivation, we also provide a simplified expression, which reproduces reasonably well the complete calculations and can easily be used for quick determinations of the SFR in cloud environments. A key property at the heart of both our complete and simplified theory is that the SFR involves a *density-dependent dynamical time*, characteristic of each collapsing (prestellar) overdense region in the cloud, instead of one single mean or critical freefall timescale. Unfortunately, the SFR also depends on some ill-determined parameters, such as the core-to-star mass conversion efficiency and the crossing timescale. Although we provide estimates for these parameters, their uncertainty hampers a precise quantitative determination of the SFR, within less than a factor of a few.

Accepted by ApJ Letters

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For preprints via WWW:: http://arxiv.org/pdf/1110.0033

Announcement: New Book

Handbook of X-ray Astronomy

Keith Arnaud[1], Randall Smith[2], and Aneta Siemiginowska[2]

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Modern x-ray data, available through online archives, are important for many astronomical topics. However, using these data requires specialized techniques and software. Written for graduate students, professional astronomers and researchers who want to start working in this field, this book is a practical guide to x-ray astronomy. The handbook begins with x-ray optics, basic detector physics and CCDs, before focusing on data analysis. It introduces the reduction and calibration of x-ray data, scientific analysis, archives, statistical issues and the particular problems of highly extended sources. The book describes the main hardware used in x-ray astronomy, emphasizing the implications for data analysis. The concepts behind common x-ray astronomy data analysis software are explained. The appendices present reference material often required during data analysis.

Publisher: Cambridge University Press (November 30, 2011), Hardcover: 206 pages, ISBN-10: 0521883733, ISBN-13: 978-0521883733

Upcoming Meeting

17th Cambridge Workshop on Cool Stars, Stellar Systems and the Sun (Cool Stars 17)

24 - 29 June 2012

Barcelona, Spain

SECOND ANNOUNCEMENT

The 17th Cambridge Workshop on Cool Stars, Stellar Systems and the Sun (Cool Stars 17) will be held at the World Trade Center in Barcelona, Spain between June 24 - 29, 2012. The opening reception will be on Sunday evening, June 24. Science sessions will run from Monday, June 25 through Friday, June 29. The morning plenary sessions will focus on fundamental parameters and formation of cool stars and brown dwarfs, magnetic fields and activity, the solar-stellar connection, evolved stars and hot-cool stars connection, and cool stars as exoplanet hosts. As usual, there will be afternoon Splinter Sessions on topics to be proposed by meeting attendees, as well as ample space and time for displaying and viewing posters.

For more information check out our website, which is now available at:

http://www.coolstars17.net

Proposals are now being solicited for afternoon splinter sessions.

The splinter proposal guidelines are available on the website at

http://www.coolstars17.net/cs17/16/Splinter_sessions.

Splinter proposals are due by December 16, 2011.

The complete list science topics and invited speakers, as well as the meeting registration page will be available by the end of the month.

We look forward to seeing you in Barcelona in late June, 2012!

JOB OPENING

Project Manager
CRIRES Spectrograph Upgrade
Thüringer Landessternwarte (Germany)

The Thüringer Landessternwarte Tautenburg seeks to fill a fixed-term position for Project Manager as part of a BMBF funded project for an upgrade to CRIRES, a high resolution infrared echelle spectrogaph mounted on the VLT. The Project Manager will: 1) Provide managerial leadership and oversight among the consortium partners for the design and construction of the upgrade; 2) Work closely with ESO who will have leadership over the entire upgrade project; 3) Will be responsible for setting schedules and the time line for design reviews; 4) Ensure that resources of the project are used effectively; 5) Prepare the appropriate documents related to the upgrade; And 6) ensure the successful commissioning of the instrument on the VLT at Paranal.

The requirements are an advanced degree in Physics, Astronomy, or Engineering. It is prefereed that applicants with astronomy and physics degrees have a strong engineering and instrumental background. Experience in infrared spectroscopy is strongly desired as well as an ability to lead a multi-disciplinary team of engineers, optical designers, machinists, and scientists. The appointment will be for 2 years with a possibility for a third year pending the successful completion of all design reviews, and final approval by ESO. The salary is based on the German public service scale (TV-L). Applicants should send a Curriculum Vitae, statement of experience and the names of two people who can be contacted for references electronically to: artie@tls-tautenburg.de. All applications received by 30 November 2011 will be given full consideration. Applications will be accepted until a suitable candidate is found.
Additional information at:
http://www.tlstautenburg.de/tls_d.php?category=jobs_d/ Contact: Artie Hatzes; email: artie@tls-tautenburg.de
Thüringer Landessternwarte Tautenburg, Sternwarte 5, D-07778, Tautenburg, Germany

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.***