COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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TABLE OF CONTENTS

Stellar Abstracts 1
Solar Abstracts 4
Low-Mass & Substellar Abstracts 5
Job Opening 7
Abstract Guidelines 8

Stellar Abstracts

Magnetic Activity and Dynamics of Close Binaries

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The connection between orbital period modulation and magnetic activity in close binaries is reviewed with an emphasis on the comparison between observational data for RS CVn systems and recently proposed theoretical models. The orbital period changes occurring on timescales of the order of a few decades can be accounted for by means of a standing torsional Alfven wave in the convection zone of the magnetically active components of such systems. Two resonant excitation mechanisms based on the coupling between the wave and an $\alpha\Omega$ dynamo are discussed from a qualitative point of view.

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XMM-Newton Probes the Stellar Population in Cha I South

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We report on a 30 ksec *XMM-Newton* observation of the central region of the Cha I star forming cloud. We detect the majority of the very-low mass Hα emitters including two bona-fide brown dwarfs (spectral types M7.5 and M8). Spectral analysis of the X-ray bright stars shows that previous X-ray studies in Cha I have underestimated the X-ray luminosities, as a result of simplified assumptions on the spectral shape. In particular, the extinction is variable over the field, such that the choice of a uniform value for the column density is inappropriate. We establish that the X-ray saturation level for the late-type stars in Cha I is located near $L_{\rm x}/L_{\rm bol} \sim 10^{-2.5}$, with a possible decline to $L_{\rm x}/L_{\rm bol} \sim 10^{-3}$ for the lowest mass stars. No dramatic changes in the correlations between X-ray luminosity with age, effective temperature and mass are seen at the substellar boundary, suggesting that the same dynamo mechanism operates in both low-mass stars and brown dwarfs, at least at young ages. The variability of the lowest-mass objects is also similar to that of higher-mass T Tauri stars. A group of strongly absorbed stars with unusual hard X-ray emission is clustered around HD 97048, a HAeBe star and the only confirmed intermediate-mass star in the field. While the X-ray properties of HD 97048 are indistinguishable from its lower-mass neighbors, another presumably A-type star (identified as such based on NIR photometry) stands out as the softest X-ray emitter in the whole sample. This suggests that various X-ray emission mechanisms may be at work in intermediate-mass pre-main sequence stars.

Accepted by A&A

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Chromospheric Models of Solar-Type Stars: The Vaughan-Preston Gap

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We have built different models for stars of the same spectral type than the Sun but with different levels of chromospheric activity, to study the response of the S index of activity built from the emission of the Ca II H and K lines to changes in the chromospheric structure. We found that the fact that there are many stars with either strong o week emission, but few with intermediate values of S, the so called Vaughan-Preston gap, can be due to a discontinuity in the response of the Ca II lines to chromospheric heating. In fact, we are able to reproduce the observed distribution of the number of stars as a function of S.

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The Density of Coronal Plasma in Active Stellar Coronae

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We have analyzed high-resolution X-ray spectra of a sample of 22 active stars observed with the High Energy Transmission Grating Spectrometer on *Chandra* in order to investigate their coronal plasma density. Densities where investigated using the lines of the He-like ions O VII, Mg XI, and Si XIII. Si XIII lines in all stars of the sample are compatible with the low-density limit (i.e. $n_{\rm e} < 10^{13}$ cm^{-3}), casting some doubt on results based on lower resolution EUVE spectra finding densities $n_{\rm e} > 10^{13}$ cm^{-3}. Mg XI lines betray the presence of high plasma densities up to a few 10^{12} cm^{-3} for most of the sources with higher X-ray luminosity ($> 10^{30}$ erg/s); stars with higher $L_{\rm X}$ and $L_{\rm X}/L_{\rm bol}$ tend to have higher densities at high temperatures. Ratios of O VII lines yield much lower densities of a few 10^{10} cm^{-3}, indicating that the "hot" and "cool" plasma resides in physically different structures. In the cases of EV Lac, HD 223460, Canopus, μ Vel, TY Pyx, and IM Peg, our results represent the first spectroscopic estimates of coronal density. No trends in density-sensitive line ratios with stellar parameters effective temperature and surface gravity were found, indicating that plasma densities are remarkably similar for stars with pressure scale heights differing by up to 3 orders of magnitude. Our findings imply remarkably compact coronal structures, especially for the hotter ($\sim$ 7 MK) plasma emitting the Mg XI lines characterized by coronal surface filling factor, $f_{\rm MgXI}$, ranging from 10^{-4} to 10^{-1}, while we find $f_{\rm OVII}$ values from a few 10^{-3} up to $\sim$ 1 for the cooler ($\sim$ 2 MK) plasma emitting the O VII lines. We find $f_{\rm OVII}$ approaches unity at the same stellar surface X-ray flux level as solar active regions, suggesting that these stars become completely covered by active regions. At the same surface flux level, $f_{\rm MgXI}$ is seen to increase more sharply with increasing surface flux. These results appear to support earlier suggestions that hot 10^7 K plasma in active coronae arises from flaring activity, and that this flaring activity increases markedly once the stellar surface becomes covered with active regions. Comparison of our measured line fluxes with theoretical models suggests that significant residual model inaccuracies might be present, and in particular that cascade contributions to forbidden and intercombination lines resulting from dielectronic recombination might be to blame.

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The Role of the Time Step and Overshooting in the Modelling of PMS Evolution: The Case of EK Cephei

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EK Cephei (HD 206821) is a unique candidate to test predictions based on stellar evolutionary models. It is a double-lined detached eclipsing binary system with accurate absolute dimensions available and a precise determination of the metallicity. Most importantly for our work, its low mass ($1.12 M_\odot$) component appears to be in the pre-main sequence (PMS) phase.

We have produced detailed evolutionary models of the binary EK Cep using the CESAM stellar evolution code (Morel 1997). A χ^2-minimisation was performed to derive the most reliable set of modelling parameters (age, $\alpha_{\rm A}$, $\alpha_{\rm B}$ and $Y_{\rm i}$). We have found that an evolutionary age of about 26.8 Myrs fits both components in the same isochrone. The positions of EK Cep A and B in the HR diagram are consistent (within the observational uncertainties) with our results.

Our revised calibration shows clearly that EK Cep A is in the beginning of the main sequence, while EK Cep B is indeed a PMS star. Such a combination allows for a precise age determination of the binary, and provides a strict test of the modelling. In particular we have found that the definition of the time step in calculating the PMS evolution is crucial to reproduce the observations. A discussion of the optimal time step for calculating PMS evolution is presented.

The fitting to the radii of both components is a more difficult task; although we managed to do it for EK Cep B, EK Cep A has a lower radius than our best models.

We further studied the effect of the inclusion of a moderate convective overshooting; the calibration of the binary is not significantly altered, but the effect of the inclusion of overshooting can be dramatic in the approach to the main sequence of stars with masses high enough to burn hydrogen through the CNO cycle on the main sequence.

Accepted by A&A

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Solar Abstracts

A Transonic Collisionless Model Of The Solar Wind

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Because of the semi-collisional nature of the solar wind, the collisionless or exospheric approach as well as the hydrodynamic one are both inaccurate. However, the advantage of simplicity makes them useful for enlightening some basic mechanisms of solar wind acceleration. Previous exospheric models have been able to reproduce winds that were already nearly supersonic at the exobase, the altitude above which there are no collisions. In order to allow transonic solutions, a lower exobase has to be considered, in which case the protons are experiencing a non-monotonic potential energy profile. This is done in the present work. In this model, the electron velocity distribution in the corona is assumed non-thermal. Parametric results are presented and show that the high acceleration obtained does not depend on the details of the non-thermal distributions. This acceleration seems, therefore, to be a robust result produced by the presence of a sufficient number of suprathermal electrons. A method for improving the exospheric description is also given, which consists in mapping particle orbits in terms of their invariants of motion.

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Variations in the Solar Luminosity, Radius, and Quadrupole Moment as Effects of a Large-Scale Dynamo in the Solar Convection Zone

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The effect of large-scale magnetic fields generated by the solar dynamo on the irradiance of the Sun and stratification of the solar convection zone is studied using a numerical model of a spherical axisymmetric dynamo. This model provides a joint description of the generation of large-scale magnetic fields, differential rotation, and convective heat transfer taking into account energy transformations associated with the large-scale magnetic fields, as well as the stratification of the convection zone. The model develops a self-consistent approach to analyzing solar luminosity variations, based on the conservation of the energy of the large-scale magnetic fields and turbulent flows. The results indicate that the increase in the solar luminosity near the maximum of the cycle is mainly due to the dissipation of the energy of magnetic fields escaping to above the photosphere, with the partial conversion of this energy into radiation. In addition, near-photospheric magnetic fields strongly affect the latitudinal nonuniformity of the cyclic variations in the radiative flux. The large-scale magnetic field also influences the hydrostatic equilibrium of the convection zone and gives rise to 11-year variations in the sound speed with a relative amplitude of $\sim 10^{-3}$. The cyclic magnetic activity generates oscillations in the quadrupole moment with an amplitude of $\sim 4.5 \cdot 10^{-9} GM_{\odot}/R_{\odot}$. According to our estimates, the variations in the solar radius are very small, $\sim 10^{-6} R_{\odot}$. Our numerical model is used to estimate the variations in the orbital periods of close binaries whose primaries have the same spectral class as the Sun. Modulation of the centrifugal force by torsional oscillations can provide a plausible explanation for variations in the orbital periods of the companion stars in these systems.

To appear in Astronomy Reports Vol. 48, No. 5, 2004, pp. 418-432.

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Low-Mass & Substellar Abstracts

The Effect of Evaporation on the Evolution of Close-in Giant Planets

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We include the effect of evaporation in our evolutionary calculations of close-in giant planets, based on a recent model for thermal evaporation taking into account the XUV flux of the parent star (Lammer et al. 2003). Our analysis leads to the existence of a critical mass for a given orbital distance $m_{\rm crit}(a)$ below which the evaporation timescale becomes shorter than the thermal timescale of the planet. For planets with initial masses below $m_{\rm crit}$, evaporation leads to a rapid expansion of the outer layers and of the total planetary radius, speeding up the evaporation process. Consequently, the planet does not survive as long as estimated by a simple application of mass loss rates without following consistently its evolution. We find out that the transit planet HD 209458b might be in such a dramatic phase, although with an extremely small probability. As a consequence, we predict that, after a certain time, only planets above a value $m_{\rm crit}(a)$ should be present at an orbital distance a of a star. For planets with initial masses above $m_{\rm crit}$, evaporation does not affect the evolution of the radius with time.

Accepted by A&A Letters

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Rotation Periods for Very Low Mass Stars in the Pleiades

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We present the results of a photometric monitoring campaign for very low mass (VLM) members of the Pleiades. Periodic photometric variability was detected for nine VLM stars with masses between 0.08 and $0.25\,M_\odot$. These variations are most likely caused by co-rotating, magnetically induced spots. In comparison with solar-mass stars, the photometric amplitudes are very low (<0.04 mag), implying that either the fraction of the spot-covered area, the asymmetry of the spot distribution, or the contrast between spots and photospheric environment decreases with mass. From our lightcurves, there is evidence for temporal evolution of the spot patterns on timescales of about two weeks. The rotation periods range from 2.9 h to 40 h and tend to increase linearly with mass. Compared with more massive stars, we clearly see a lack of slow rotators among VLM objects. The rotational evolution of VLM stars is investigated by evolving the previously published periods for very young objects (Scholz & Eislöffel 2004) forward in time, and comparing them with those observed here in the Pleiades. We find that the combination of spin-up by pre-main sequence contraction and exponential angular momentum loss through stellar winds is able to reproduce the observed period distribution in the Pleiades. This result may be explained as a consequence of convective, small-scale magnetic fields.

Accepted by A&A

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The 2MASS Wide-Field T Dwarf Search. III. Seven New T Dwarfs and Other Cool Dwarf Discoveries

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We present the discovery of seven new T dwarfs identified in the Two Micron All Sky Survey. Low-resolution (R$\sim$150) 0.8–2.5 μm spectroscopy obtained with the IRTF SpeX instrument reveal the characteristic H_2O and CH_4 bands in the spectra of these brown dwarfs. Comparison to spectral standards observed with the same instrument enable us to derive classifications of T3 to T7 for the objects in this sample. Moderate-resolution (R$\sim$1200) near-infrared spectroscopy for a subset of these discoveries reveal K I line strengths consistent with previously observed trends with spectral type. Follow-up imaging observations provide proper motion measurements for these sources, ranging from $< 0''1$ to $1''55$ yr^{-1}. One object, 2MASS 0034+0523, has a spectrophotometric distance placing it within 10 pc of the Sun. This source also exhibits a depressed K-band peak reminiscent of the peculiar T dwarf 2MASS 0937+2931, and may be a metal-poor or old, high-mass brown dwarf. We also present low resolution SpeX data for a set of M and L-type dwarf, subdwarf, and giant comparison stars used to classify 59 additional candidates identified as background stars. These are primarily M5-M8.5 dwarfs, many exhibiting H I Paschen γ, but include three candidate ultracool M subdwarfs and one possible early-type L subdwarf.

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For preprints via ftp or WWW: http://arxiv.org/abs/astro-ph/0402325

Low Mass Stars, Brown Dwarf Candidates and the Mass Function of the Young Open Cluster NGC 2547

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We present a catalogue of R_cI_cZ photometry over an area of 0.855 square degrees, centred on the young open cluster NGC 2547. The survey is substantially complete to limits of $R_c = 21.5$, $I_c = 19.5$, $Z = 19.5$. We use the catalogue to define a sample of NGC 2547 candidates with model-dependent masses of about 0.05-1.0 $M_{\odot}$. After correcting for incompleteness and estimating contamination by foreground field dwarfs, we investigate the mass function of the cluster, its binary content, and search for evidence of mass segregation among the lower mass stars. There is ample evidence for mass segregation between high ($> 3\,M_{\odot}$) and lower mass stars, but over the range $0.1 < M < 0.7\,M_{\odot}$, the data are consistent with no further mass segregation. By fitting King profiles we conclude that at least 60 percent of the low-mass stellar population are contained within our survey. The cluster mass function is remarkably similar to the Pleiades for $0.075 < M < 0.7\,M_{\odot}$. Because of its age ($\simeq 30$ Myr), we demonstrate that this mass function is robust to a number of systematic uncertainties likely to affect older and younger clusters and is therefore one of the best available estimates for the initial mass function in young disc populations. For $0.05 < M < 0.075\,M_{\odot}$ there is some evidence for a deficit of brown dwarfs in NGC 2547 compared with other clusters. This deficit may extend to lower masses or may only be a dip, perhaps caused by an imperfect understanding of the mass-magnitude relationship at temperatures of around 2800 K. Incompleteness in both our survey, and the luminosity functions from which we estimate contamination by foreground objects, leave this question open. The binary fraction for systems with mass ratios greater than about 0.5 is 20-35 per cent for M-dwarfs in NGC 2547, quite consistent with that found in the field and other young clusters. The full photometric catalogue and our lists of candidate cluster members are made available in electronic format.

Accepted by MNRAS

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JOB OPENING

Astronomer / Astrophysicist
Thüringer Landessternwarte Tautenburg (Germany)

Thüringer Landessternwarte Tautenburg (TLS) is looking for a young astronomer/astrophysicist to be employed as soon as possible. The staff position is initially for three years. Applications from all areas of astronomy are welcome. However, preference will be given to applicants working in fields closely related to the research areas of TLS. These include extrasolar planets (radial velocity and transit searches), star formation, stellar oscillations, gamma ray bursts, and active galaxies. Scientists working in observations or theory will be considered.

The Thüringer Landessternwarte operates a 2-m-telescope in Tautenburg, which can be used in Schmidt-, Cassegrain-, or Coudé-mode. The telescope is equipped with state of the art post-focus instruments for wide-field imaging, low- and high-resolution spectroscopy.

Duties: Successful observational applicants are expected to conduct independent research programs using the 2-m-telescope in Tautenburg, as well as international observatories. We expect such an applicant to partly support the operation of the telescope and its instruments. The successful theory applicant should be able to collaborate with observational astronomers at the institute.

Requirements: Applicants should have a PhD in astronomy, astrophysics, or physics. A demonstrated ability to conduct independent research is highly desirable.

Applications should include a CV, a publication list, a short summary of research interests, a statement of research plans while at TLS, and three letters of reference. Applications will be reviewed starting 1 July and will continue until a suitable candidate is found. Applications can be sent via post to:

Prof. Dr. Artie Hatzes
Thüringer Landessternwarte
Sternwarte 5
D - 07778 Tautenburg
Germany

or via email to artie@tls-tautenburg.de

The contract can start as early as 1 September 2004.
Payment is according to the BAT-O IIa payment scheme of civil servants in Germany.

We especially encourage female applicants to apply for the job.
Handicapped persons of equal qualification will be preferred.
More information about the Thüringer Landessternwarte can be found under http://www.tls-tautenburg.de.

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.***