COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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Stellar Abstracts

A Study of Coronal Abundances in RS CVn Binaries

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We present *XMM-Newton* data of several RS CVn binary systems. High-resolution X-ray spectra obtained with the Reflection Grating Spectrometers have been interpreted simultaneously with the European Photon Imaging Camera spectra. Highly active stars show a depletion of elements with a low first ionization potential (FIP) relative to high-FIP elements, whereas intermediately active binaries show either no FIP bias or a possible solar-like FIP effect. We find that the low-FIP abundance ratios to oxygen vary with the coronal average temperature whereas the ratios for high-FIP elements stay constant. Since we observe that the absolute Fe (low-FIP) abundance increases with decreasing activity, this suggests that the abundances of elements with low FIP vary with the coronal activity level. Compared with laboratory measurements of the intensity ratios of the Fe XVII $\lambda\lambda$ 15.01 and 15.26 Å lines, the coronal plasmas are in the optically thin regime.

Accepted by A&A

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*Beppo*SAX Observations of CF Tucanae and TY Pyxidis

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We present the results of *Beppo*SAX observations of the RS CVn binary systems CF Tuc and TY Pyx. A long-duration flare was detected on CF Tuc just at the beginning of the observation; a second smaller flare occurred about half a period later. The light curve of TY Pyx shows a significant orbital modulation of the quiescent emission with possible evidence for eclipses, and strong flares. We find that the coronae of the two stars are very similar: both systems have quiescent temperatures of ~ 10 and $20-25$ MK, with only a factor of two difference in the emission measures. During the flares, temperatures of $\sim 30-40$ MK are reached; these temperatures are not high enough to give detectable hard X-ray emission in the PDS. Both stars have subsolar coronal metallicities: we confirm the very low coronal abundance of CF Tuc ($Z \sim 0.1-0.2\,Z_{\odot}$), while for TY Pyx we find $Z \sim 0.5-0.6\,Z_{\odot}$. For both stars the coronal metallicities are in good agreement with their measured photospheric abundances.

Accepted by A&A

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Radial-velocity Survey of Members and Candidate Members of the TW Hydrae Association

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We report our spectroscopic observations of stars belonging to the young nearby group known as the TW Hydrae association, as well as of a number of potential members of the association identified in kinematic and X-ray surveys. Multiple radial velocity measurements were obtained for each object, several of which turn out to be multiple systems. Orbital solutions are presented for 3 double-lined binaries, one single-lined binary, and a double-lined triple system, all with short periods. Effective temperatures and projected rotational velocities are presented for each visible object. None of the candidate members of the association in our sample is confirmed as a true member. The large fraction of close binaries among the candidate members has to do with their selection based on X-ray emission from ROSAT, which tends to favor the inclusion of tidally-locked systems that are active but not necessarily young.

Accepted by AJ

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Rotation and Differential Rotation in Field F- and G-type Stars

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We present a detailed study of rotation and differential rotation analyzing high resolution high S/N spectra of 142 F-, G- and early K-type field stars. Using Least Squares Deconvolution we obtain broadening profiles for our sample stars and use the Fourier transform method to determine projected rotational velocities $v\,\sin i$. Distributions of rotational velocities and periods are studied in the HR-diagram. For a subsample of 32 stars of spectral type F0–G0 we derive the amount of differential rotation in terms of $\alpha = (\Omega_{\mathrm{Equator}} - \Omega_{\mathrm{Pole}})/\Omega_{\mathrm{Equator}}$. We find evidence for differential rotation in ten of the 32 stars. Differential rotation seems to be more common in slower rotators, but deviations from rigid rotation are also found in some fast rotators. We search for correlations between differential rotation and parameters relevant for stellar activity and show indications against strong differential rotation in very active stars. We derive values of ΔP and $\Delta\Omega$, which support a period dependence of differential rotation. Derived lap times $2\pi/\Delta\Omega$ are of the order of 20 d and contradict the assumption that constant lap times of the order of the solar one (~ 130 d) are the

rule on stars which are thought to harbour magnetic dynamos.

Accepted by A&A

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X-rays in the Orion Nebula Cluster: Constraints on the Origins of Magnetic Activity in Pre-main Sequence Stars

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A recent observation of the Orion Nebula Cluster with the ACIS instrument on board the *Chandra* X-ray Observatory detected 1075 sources (Feigelson et al. 2002), 525 of which are pre-main sequence (PMS) stars with measured bulk properties (bolometric luminosities, masses, ages and disk indicators). Nearly half of these stars have photometrically measured rotational periods. This provides a uniquely large and well-defined sample to study the dependence of magnetic activity on bulk properties for stars descending the Hayashi tracks.

The following results are obtained: (1) X-ray luminosities L_t in the $0.5 - 8$ keV band are strongly correlated with bolometric luminosity with average ratio $\log L_t/L_{bol} = -3.8$ for stars with masses $0.7 < M < 2$ $M_\odot$, an order of magnitude below the main sequence saturation level; (2) the X-ray emission drops rapidly below this level in some or all stars with $2 < M < 3$ $M_\odot$; (3) the presence or absence of infrared circumstellar disks has no apparent relation to X-ray levels; and (4) X-ray luminosities exhibit a slight rise as rotational periods increase from 0.4 to 20 days. This last finding stands in dramatic contrast to the strong anticorrelation between X-rays and period seen in main sequence stars.

The absence of a strong X-ray/rotation relationship in PMS stars, and particularly the high X-ray values seen in some very slowly rotating stars, is a clear indication that the mechanisms of magnetic field generation differ from those operating in main sequence stars. The most promising possibility is a turbulent dynamo distributed throughout the deep convection zone, but other models such as $\alpha - \Omega$ dynamo with 'supersaturation' or relic core fields are not immediately excluded. The drop in magnetic activity in intermediate-mass stars may reflect the presence of a significant radiative core. The evidence does not support X-ray production in large-scale star-disk magnetic fields.

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Editor's Note: The above abstract on pre-main sequence stars has also been submitted to the *Star Formation Newsletter* and is being cross-listed in *Coolnews* since it may be of general interest to cool star researchers studying rotation and magnetic activity.

Solar Abstracts

An EUV Bright Point As Seen by SUMER, CDS, MDI and EIT On-board SoHO

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This paper presents the formation, evolution and decay of a coronal bright point via a spectroscopic analysis of its transition region counterpart and the evolution of the underlying magnetic bipole during 3 days of almost continuous

observations. The data were obtained with various instruments on-board SoHO, including the SUMER spectrograph in the transition region line S VI 933.40 Å, CDS in the He I 584.33, O V 629.73 and Mg IX 368.06 Å lines, plus MDI and EIT. The existence of the coronal feature is strongly correlated with the evolution of the underlying bipolar region. The lifetime of the bright point from the moment when it was first visible in the EIT images until its complete disappearance was $\sim$ 18 hrs. Furthermore, the bright point only became visible at coronal temperatures when the two converging opposite magnetic polarities were $\sim$ 7 000 km apart. As far as the temporal coverage of the data permits, we found that the bright point disappeared at coronal temperatures after a full cancellation of one of the magnetic polarities. The spectroscopic analysis reveals the presence of small-scale ($\sim$ 6 arcsec) transient brightenings within the bright point with a periodicity of $\sim$ 6 min. The Doppler shift in the bright point was found to be in the range of -10 to 10 kms^{-1} although it is dominated by a red-shifted emission which is associated with regions characterized by stronger 'quiet' Sun photospheric magnetic flux. Small-scale brightenings within the bright point show velocity variations in the range 3 – 6 kms^{-1}. In general the bright point has a radiance $\sim$ 4 times higher than that of the network. No relation was found between the bright point and the UV explosive event phenomena.

Accepted by A&A

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Low-Mass and Substellar Abstracts

Statistical Properties of Exoplanets
II. Metallicity, Orbital Parameters, and Space Velocities

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In this article we present a detailed spectroscopic analysis of more than 50 extra-solar planet host stars. Stellar atmospheric parameters and metallicities are derived using high resolution and high S/N spectra. The spectroscopy results, added to the previous studies, imply that we have access to a large and uniform sample of metallicities for about 80 planet hosts stars. We make use of this sample to confirm the metal-rich nature of stars with planets, and to show that the planetary frequency is rising as a function of the [Fe/H]. Furthermore, the source of this high metallicity is shown to have most probably an "primordial" source, confirming previous results. The comparison of the orbital properties (period and eccentricity) and minimum masses of the planets with the stellar properties also reveal some emerging but still not significant trends. These are discussed and some explanations are proposed. Finally, we show that the planet host stars included in the CORALIE survey have similar kinematical properties as the whole CORALIE volume-limited planet search sample. Planet hosts simply seem to occupy the metal-rich envelope of this latter population.

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First Radius Measurements of Very Low Mass Stars with the VLTI

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We present 4 very low mass stars radii measured with the VLTI using the 2.2μm VINCI test instrument. The observations were carried out during the commissioning of the 104-meter-baseline with two 8-meter-telescopes. We measure angular diameters of 0.7-1.5 mas with accuracies of 0.04-0.11 mas, and for spectral type ranging from M0V to M5.5V. We determine an empirical mass-radius relation for M dwarfs based on all available radius measurements. The

observed relation agrees well with theoretical models at the present accuracy level, with possible discrepancy around 0.5-0.8 $M_{\odot}$ that needs to be confirmed. In the near future, dozens of M dwarfs radii will be measured with 0.1-1% accuracy, with the VLTI, thanks to the improvements expected from the near infrared instrument AMBER. This will bring strong observational constraints on both atmosphere and interior physics.

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For preprints via WWW: http://fr.arXiv.org/abs/astro-ph/0211647

Ph.D. Thesis Abstract

Energetic Particles and Plasma Instabilities in Solar Flares

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Ph.D degree awarded: November 2002

Many astrophysical sources including our Sun exhibit signatures of non-thermal particles which manifest themselves in emissions at various wavelengths. While those are the only source of information in most astrophysical plasmas, the Sun allows us to incorporate *in situ* measurements of the solar wind to the analysis. Moreover, due to its proximity many features can be spatially resolved. Solar flares therefore offer the most comprehensive source of information on particle acceleration and provide a link between astrophysical and laboratory plasmas. These observations in conjunction with theoretical modeling may reveal the basic mechanisms of particle acceleration on the Sun, and by extension also in other astrophysical plasmas.

The work presented starts with the analysis of radio observations of the Sun. So-called type III bursts, radio signatures from escaping electron beams on 'open' field lines, associated with narrow band metric spike emission have been analyzed to corroborate the interpretation of dynamic spectra in terms of signatures of the particle acceleration region. The radio spike emission is thought to be closely related to the acceleration mechanism and should therefore spatially coincide with the origin of the trajectory of the type III producing electrons. It was found that in all of the analyzed events the spike sources are always located at positions coinciding with the expected locations obtained from extrapolating the electron trajectories to lower altitudes. In one of the events, two subsequent type III bursts originated in the same source region allowing us to determine the acceleration region very accurately by intersecting the two trajectories. The findings strongly support the generic flare picture, where the energy release takes place in the corona above magnetic loop structures.

While this analysis yields insight into the spatial location of the acceleration region, the nature and properties of the accelerating process are addressed in the rest of the work. Candidates for the accelerating process can roughly be divided into three broad classes: *parallel DC electric fields*, *shocks* or *stochastic acceleration by plasma waves*. The different aspects of each class have not been addressed in detail in this work. A broad approach was chosen instead by trying to extract the main feature(s) common to all members of the above classes. This allows us to derive general plasma properties without choosing a specific scenario. The main common feature that was found is an anisotropy $T_{\perp} < T_{\|}$ that builds up in the course of the acceleration process in the velocity distribution function of the electrons ($\|$ and $\perp$ here refer to the directions relative to the background magnetic field). Such an alignment along the background

magnetic field may cause the acceleration to cease. As a consequence, many of the aforementioned accelerators need a pitch-angle scattering process that erodes the anisotropy by redistributing the particle energies isotropically.

A linearized kinetic approach was chosen for a stability analysis of such an anisotropic electron population to plasma waves. It was established that the Electron Firehose instability (EFI) has to be expected during solar flares. Left-hand circularly polarized electromagnetic waves with frequencies around the proton gyrofrequency (EF waves) are non-resonantly excited by the electrons. The response of two different plasma components to the excited waves was investigated: *i)* The kinetic response of the electron population to the instability and *ii)* the acceleration and enrichment of ^{3}He have been analyzed analytically and by test particle simulations. It was found that the electrons experience a translation to higher pitch-angles in velocity space in the presence of a field of EF waves. The EFI is therefore a viable agent for the required pitch-angle scattering. From the latter work it is learned that ^{3}He can be readily accelerated by EF waves to the required energies or even beyond. Moreover, the spectral properties of the EF wave spectrum result in an enhancement of the abundance of ^{3}He above ^{4}He, reproducing the observations of various spacecraft.

The EFI as an inherent component of bulk electron acceleration provides therefore two major ingredients to flare particle acceleration: it can pitch-angle scatter electrons to higher perpendicular velocities and therefore enable efficient acceleration and it is able to accelerate and enrich ^{3}He via EF waves. Both aspects are explained as an inherent feature of the acceleration process of electrons in solar flares.

Thesis-related Publications: ApJ, 582, in Press; A&A 371, 333; A&A 351, 741

JOB OPENING

Tenure Track Faculty Position in Solar Physics

Rice University
Houston, TX

The Physics and Astronomy Department at Rice University expects a new tenure-track assistant professorship in the area of solar physics. The Department seeks a scientist with demonstrated expertise in observations, theory, or computer simulations of the plasma dynamics of the Sun and its corona. The chosen individual will be expected to teach at the undergraduate and graduate levels, to develop a course in solar physics, and to advise graduate students in that area. The successful candidate will have the opportunity to form collaborations with existing departmental research programs (http://physics.rice.edu), which include magnetospheric physics, space weather, and the astrophysics of Sun-like stars. A curriculum vitae, statement of research interests, and four letters of reference should be addressed to Dr. Richard Wolf, Chair of the Solar-Physics Search Committee, Department of Physics and Astronomy, Rice University MS-108, Houston, TX 77005. To receive full consideration, application materials should reach Rice by December 15, 2002. Rice University is an Equal-Opportunity/Affirmative-Action Employer. Minority and women candidates are especially encouraged to apply.

JOB OPENING

Postdoctoral Fellow/Research Fellow in Stellar Astrophysics
Research School of Astronomy and Astrophysics (RSAA)
Canberra, Australia

The Research School of Astronomy and Astrophysics is seeking a Postdoctoral Fellow/Research Fellow for a three-year position to work on theoretical or observational aspects of the first stars and the chemical enrichment of the Universe together with Dr. Martin Asplund, Prof. Mike Bessell and Prof. John Norris. The successful candidate will join a vigorous international collaboration with direct access to excellent observing (e.g. AAT, Gemini, VLT, and Subaru) and supercomputing facilities.

The project involves both discovery of the most metal-poor stars with medium-resolution spectroscopic surveys, abundance analyses using high-resolution spectra from 4-8m telescopes, and development of state-of-the-art 3D hydrodynamical model atmospheres. For the theoretical parts we seek candidates with a strong background in numerical hydrodynamics, radiative transfer or non-LTE calculations, while the observational aspects require experience in stellar spectroscopy, data reduction and abundance analysis techniques. The successful candidate will be encouraged also to pursue an independent research program.

The appointment will be as Postdoctoral Fellow (Level A) or Research Fellow (Level B) within the salary range $AUD47,721-$AUD57,494 per annum plus re-location allowance. The Australian National University offers a generous superannuation package.

Applicants are advised to refer to the RSAA website: http://www.mso.anu.edu.au/.

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Prof. John Norris, tel: (61) 2 61258034, e-mail: jen@mso.anu.edu.au

Selection criteria and information on how to apply must be sought before applying from http://www.anu.edu.au/hr/jobs/ or the Executive Officer, RSAA, telephone (61) 2 6125 0203, or email: Theresa.Gallagher@anu.edu.au

Closing date: 8 January 2003.

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

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