COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

No. 113 — July 2005 Editor: Steve Skinner (coolnews@jila.colorado.edu)

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Stellar Abstracts

Slingshot Prominences Above Stellar X-ray Coronae

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We present a new model for the coronal structure of rapidly rotating solar-type stars. The presence of prominences trapped in co-rotation 2 to 5 stellar radii above the stellar surface has been taken as evidence that the coronae of these stars must be very extended. The observed surface magnetic fields, however, cannot contain X-ray emitting gas out to these distances. We present an alternative model: that these prominences are trapped in long thin loops embedded not in the X-ray corona, but in the wind. Above coronal helmet streamers, oppositely-directed wind-bearing field lines reconnect to form closed loops which then fill up with gas that was originally part of the wind. We demonstrate that static equilibria exist for these loops at a range of pressures and temperatures. The maximum loop height falls as the rotation rate increases, but rises as the loop temperature decreases. For a solar-mass star with rot ation period 0.5 days, whose X-ray corona extends $1R_\star$ above the surface, loops at temperatures of 10^4K can extend out to $5R_\star$.

Accepted by MNRAS

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Impact of Non-uniform Surface Magnetic Fields on Stellar Winds

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Observations of active stars reveal highly non-uniform surface distributions of magnetic flux. Theoretical models considering magnetised stellar winds however often presume uniform surface magnetic fields, characterised by a single magnetic field strength. The present work investigates the impact of non-uniform surface magnetic field distributions on the stellar mass and angular momentum loss rates as well as on the effective Alfvénic radius of the wind. Assuming an axial symmetric and polytropic magnetised wind, the approach of Weber & Davis (1967) is extended to non-equatorial latitudes to quantify the impact of latitude-dependent magnetic field distributions over a large range of stellar rotation rates and thermal wind properties. Motivated by recent observational results, the analytically prescribed field patterns are dominated by magnetic flux concentrations at intermediate and high latitudes. The global stellar mass loss rates are found to be rather insensitive to non-uniformities of the surface magnetic field. Depending on the non-uniformity of the field distribution, the angular momentum loss rates deviate in contrast at all rotation rates between −60% and 10% from the Weber & Davis-values, and the effective Alfvénic radii up to about ±25%. These large variations albeit equal amounts of total magnetic flux indicate that a classification of stellar surface magnetic fields through a single field strength is insufficient, and that their non-uniformity has to be taken into account. The consequences for applications involving magnetised stellar winds are discussed in view of the rotational evolution of solar-like stars and of the observational determination of their mass loss rates using the terminal velocity and ram pressure of the wind. For rapidly rotating stars the latitudinal variation of the wind ram pressure is found to exceed, depending on the actual field distribution on the stellar surface, over two orders of magnitude. The assumption of a spherical symmetric wind geometry may therefore lead to a significant over- or underestimation of the stellar mass loss rate.

Accepted by A&A

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For preprints via WWW: http://arxiv.org/abs/astro-ph/0506173

On the Nature of Lithium-rich Giant Stars: Constraints from Beryllium Abundances

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We have derived beryllium abundances for 7 Li-rich giant ($A(Li) > 1.5$) stars and 10 other Li-normal giants with the aim of investigating the origin of the Lithium in the Li-rich giants. In particular, we test the predictions of the engulfment scenario proposed by Siess & Livio (1999), where the engulfment of a brown dwarf or one or more giant planets would lead to simultaneous enrichment of ^{7}Li and ^{9}Be. We show that regardless of their nature, none of the stars studied in this paper were found to have detectable beryllium. Using simple dilution arguments we show that engulfment of an external object as the *sole* source of Li enrichment is ruled out by the Li and Be abundance data. The present results favor the idea that Li has been produced in the interior of the stars by a Cameron-Fowler process and brought up to the surface by an extra mixing mechanism.

Accepted by A&A

For preprints via ftp or WWW: http://www.edpsciences.org/articles/aa/pdf/forthpdf/aa1805-04_forth.pdf

Modeling a Coronal Loop Heated by MHD-turbulence Nanoflares

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We model the hydrodynamic evolution of the plasma confined in a coronal loop, 30000 km long, subject to the heating of nanoflares due to intermittent magnetic dissipative events in the MHD turbulence produced by loop footpoint motions. We use the time-dependent distribution of energy dissipation along the loop obtained from a hybrid shell model, occurring for a magnetic field of about 10 G in corona; the relevant heating per unit volume along the loop is used in the Palermo-Harvard loop plasma hydrodynamic model. We describe the results focussing on the effects produced by the most intense heat pulses, which lead to loop temperatures between 1 and 1.5 MK.

Accepted by ApJ *For preprints contact*: reale@astropa.unipa.it

Detection of X-ray Emission from β Pictoris with XMM-Newton: A Cool Corona, a Boundary Layer or What ?

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β Pictoris (HR 2020) is the most prominent prototype of stars with circumstellar disks and has generated particular interest in the framework of young planetary systems. Given its spectral type A5, stellar activity is not expected. Nevertheless, resonance lines of C III and O VI typical for a chromosphere and transition region have been unambiguously detected with FUSE. We present results from an XMM-Newton observation of β Pic and find evidence for X-ray emission. In particular, we detected an emission of O VII at 21.6 Å with the MOS detectors. These findings present a challenge for the development of both stellar activity and disk models. We discuss and investigate various models to explain the observed emission including the presence of a cool corona and a boundary layer.

Accepted by A&A

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For preprints via ftp or WWW: http://www.hs.uni-hamburg.de/DE/Ins/Per/Hempel/mhempel/xraybp.pdf

Modelling the Chromosphere and Transition Region of ϵ Eri (K2 V)

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Measurements of ultraviolet line fluxes from Space Telescope Imaging Spectrograph and *Far-Ultraviolet Spectroscopic Explorer* spectra of the K2-dwarf ϵ Eri are reported. These are used to develop new emission measure distributions and semi-empirical atmospheric models for the chromosphere and lower transition region of the star. These models are the most detailed constructed to date for a main-sequence star other than the Sun. New ionisation balance calculations, which account for the effect of finite density on dielectronic recombination rates, are presented for carbon, nitrogen, oxygen and silicon. The results of these calculations are significantly different from the standard Arnaud & Rothenflug ion balance, particularly for alkali-like ions. The new atmospheric models are used to place constraints on possible First Ionisation Potential (FIP) related abundance variations in the lower atmosphere and to discuss limitations of single-component models for the interpretation of certain optically thick line fluxes.

Accepted by MNRAS

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Solar Abstracts

Seismic Analysis of the Second Ionization Region of Helium in the Sun: I. Sensitivity Study and Methodology

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The region of the second ionization of helium in the Sun is a narrow layer near the surface. Ionization induces a local change of the adiabatic exponent Γ_1, which produces a characteristic signature in the frequencies of p-modes. By adapting the method developed by Monteiro, Christensen-Dalsgaard and Thompson (1994), we propose a methodology for determining the properties of this region by studying such a signature in the frequencies of oscillation.

Using solar data we illustrate how the signal from the helium ionization zone can be isolated. Using solar models with different physics – theory of convection, equation of state and low temperature opacities – we establish how the characteristics of the signal depend on the different aspects contributing to the structure in the ionization layer. We further discuss how the method can be used to measure the solar helium abundance in the envelope and to constrain the physics affecting this region of the Sun.

The potential usefulness of the method we propose is shown. It may complement other inversion methods developed to study the solar structure and to determine the envelope helium abundance.

Accepted by MNRAS

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The Dynamical Disconnection of Sunspots from Their Magnetic Roots

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After a dynamically active emergence phase, magnetic flux at the solar surface soon ceases to show strong signs of the subsurface dynamics of its parent magnetic structure. This indicates that some kind of disconnection of the emerged flux from its roots in the deep convection zone should take place. We propose a mechanism for the dynamical disconnection of the surface flux based upon the buoyant upflow of plasma along the field lines. Such flows arise in the upper part of a rising flux loop during the final phases of its buoyant ascent towards the surface. The combination of the pressure buildup by the upflow and the cooling of the upper layers of an emerged flux tube by radiative losses at the surface lead to a progressive weakening of the magnetic field in several Mm depth. When the field strength has become sufficiently low, convective motions and the fluting instability disrupt the flux tube into thin, passively advected flux fragments, thus providing a dynamical disconnection of the emerged part from its roots. We substantiate this scenario by considering the quasi-static evolution of a sunspot model under the effects of radiative cooling, convective energy transport, and pressure buildup by a prescribed inflow at the bottom of the model. For inflow speeds in the range shown by simulations of thin flux tubes, we find that the disconnection takes place in a depth between 2 and 6 Mm for disconnection times up to 3 days.

Accepted by A&A

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For preprints via ftp or WWW: http://xxx.lanl.gov/abs/astro-ph/0506654

An Infrared Coronagraphic Survey for Substellar Companions

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We have used the F160W filter ($1.4 - 1.8\ \mu$m) and the coronagraph on the Near-InfraRed Camera and Multi-Object Spectrometer (NICMOS) on the Hubble Space Telescope (HST) to survey 45 single stars with a median age of 0.15 Gyr, an average distance of 30 pc, and an average H-magnitude of 7 mag. For the median age we were capable of detecting a 30 $M_{Jupiter}$ companion at separations between 15 and 200 AU. A 5 $M_{Jupiter}$ object could have been detected at 30 AU around 36% of our primaries. For several of our targets that were less than 30 Myr old, the lower mass limit was as low as a Jupiter mass, well into the high mass planet region. Results of the entire survey include the proper motion verification of five low-mass stellar companions, two brown dwarfs (HR7329B and TWA5B) and one possible brown dwarf binary (Gl 577B/C).

Accepted by AJ

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For preprints via ftp or WWW: http://arXiv.org/abs/astro-ph/0506358

Upcoming Meeting

Cool Stars 14

Pasadena, CA

6 - 10 November 2006

The 14th Cambridge workshop on Cool Stars, Stellar Systems, and the Sun (CSW14) will be held in Pasadena, CA, on 6 - 10 November 2006. Mark your calendars and save the date!

The CSW14 web page has been established at

http://ssc.spitzer.caltech.edu/mtgs/cs14/

CSW14 is scheduled to be held in Pasadena in late 2006, and to be jointly hosted by the Spitzer Science Center and the Michelson Science Center. CSW14 will also double as the 2006 Spitzer Science Center November workshop. Topics that have been central to the previous Cool Stars meetings - stellar activity indicators, the solar-stellar connection, PMS stars and stellar evolution, brown dwarfs, and helio- and asteroseismology - will continue to be high on the agenda for CSW14. We will also place enhanced emphasis on a few topics such as mid-IR observations (debris disk evolution; protostar formation) and high-angular resolution observations (PMS disk imaging, PMS binary orbits, future space astrometry missions). The Scientific Organizing Committee will be working to fashion the final agenda for CSW14 during the next year.

We are still in the initial organizational stage for the meeting. We have a mailing list to which you can subscribe to get announcements about the workshop, and to be notified when registration opens, etc. Visit our website to find the mailing list and to find more information about the meeting as it becomes available.

We expect to send out an official first announcement for the meeting in the Fall of this year, and expect to open our website for registration in early 2006.

If you have any questions about the conference, please email them to us at cs14@ipac.caltech.edu.

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` .

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