// COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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Stellar Abstracts

The Low-mass Initial Mass Function in the Young Cluster NGC 6611

J.M. Oliveira[11], R.D. Jeffries[1] and J.Th. van Loon[1]

[1] Astrophysics Group, Lennard-Jones Laboratories, School of Physical & Geographical Sciences, Keele University, Staffordshire ST5 5BG, UK

NGC 6611 is the massive young cluster (2−3 Myr) that ionises the Eagle Nebula. We present very deep photometric observations of the central region of NGC 6611 obtained with the Hubble Space Telescope and the following filters: ACS/WFC F775W and F850LP and NIC2 F110W and F160W, loosely equivalent to ground-based $IZJH$ filters. This survey reaches down to $I \sim 26$ mag. We construct the Initial Mass Function (IMF) from $\sim$1.5 $M_\odot$ well into the brown dwarf regime (down to $\sim$0.02 $M_\odot$). We have detected $30 - 35$ brown dwarf candidates in this sample. The low-mass IMF is combined with a higher-mass IMF constructed from the groundbased catalogue from Oliveira et al. (2005). We compare the final IMF with those of well studied star forming regions: we find that the IMF of NGC 6611 more closely resembles that of the low-mass star forming region in Taurus than that of the more massive Orion Nebula Cluster (ONC). We conclude that there seems to be no severe environmental effect in the IMF due to the proximity of the massive stars in NGC 6611.

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For preprints via ftp or WWW: http://arxiv.org/abs/0810.4444

Evidence for Magnetic Flux Saturation in Rapidly Rotating M Stars

Ansgar Reiners[1], Gibor Basri[2] and Matthew Browning[2,3]

[1] Institut für Astrophysik, Georg-August-Universität, D-37077 Göttingen, Germany
[2] Astronomy Department, University of California, Berkeley, CA 94720, USA
[3] Dept of Astronomy and Astrophysics, University of Chicago, Chicago, IL 60637, USA

We present magnetic flux measurements in seven rapidly rotating M dwarfs. Our sample stars have X-ray and H-alpha emission indicative of saturated emission, i.e., emission at a high level independent of rotation rate. Our measurements are made using near-infrared FeH molecular spectra observed with HIRES at Keck. Because of their large convective overturn times, the rotation velocity of M stars with small Rossby numbers is relatively slow and does not hamper the measurement of Zeeman splitting. The Rossby numbers of our sample stars are as small as 0.01. All our sample stars exhibit magnetic flux of kilo-Gauss strength. We find that the magnetic flux saturates in the same regime as saturation of coronal and chromospheric emission, at a critical Rossby number of around 0.1. The filling factors of both field and emission are near unity by then. We conclude that the strength of surface magnetic fields remains independent of rotation rate below that; making the Rossby number yet smaller by a factor of ten has little effect. These saturated M-star dynamos generate an integrated magnetic flux of roughly 3 kG, with a scatter of about 1 kG. The relation between emission and flux also has substantial scatter.

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For preprints via ftp or WWW: http://arxiv.org/abs/0810.5139

Solar Abstracts

The Structure and Dynamics of a Bright Point as Seen with Hinode, SoHO and TRACE

D. Pérez-Suárez[1], R.C. Maclean[1,3], J.G. Doyle[1] and M.S. Madjarska[2]

[1] Armagh Observatory, College Hill, Armagh BT61 9DG, N. Ireland
[2] Max-Planck-Institut für Sonnensystemforschung, Max-Planck-Str. 2, 37191 Katlenburg-Lindau, Germany
[3] School of Mathematics and Statistics, University of St Andrews, North Haugh, St Andrews, Fife, KY16 9SS, UK

Our aim is to determine the plasma properties of a coronal bright point and compare its magnetic topology extrapolated from magnetogram data with its appearance in X-ray images. We analyse spectroscopic data obtained with EIS/Hinode, Ca ii H and G-band images from SOT/Hinode, UV images from TRACE, X-ray images from XRT/Hinode and high-resolution/high-cadence magnetogram data from MDI/SoHO. The BP comprises several coronal loops as seen in the X-ray images, while the chromospheric structure consists of tens of small bright points as seen in Ca ii H. An excellent correlation exists between the Ca II BPs and increases in the magnetic field, implying that the Ca ii H passband is a good indicator for the concentration of magnetic flux. Doppler velocities between 6 and 15 km/s are derived from the Fe xii and Fe xiii lines for the BP region, while for Fe xiv and Si vii they are in the range from -15 to +15 km/s. The coronal electron density is $3.7{\times}10^{9}$ cm^{-3}. An excellent correlation is found between the positive magnetic flux and the X-ray light-curves. The remarkable agreement between the extrapolated magnetic field configuration and some of the loops composing the BP as seen in the X-ray images suggests that a large fraction of the magnetic field in the bright point is close to potential. The close correlation between the positive magnetic flux and the X-ray emission suggests that energy released by magnetic reconnection is stimulated by flux emergence or cancellation.

Accepted by A&A

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For preprints via ftp or WWW: http://star.arm.ac.uk/preprints/ OR astro-ph (** arXiv:0810.1020 **)

Do All Flares Have White-light Emission ?

D.B. Jess[1,2], M.Mathioudakis[1], P.J.Crockett[1] and F.P Keenan[1]

[1] Physics and Astronomy, Queens University Belfast, BT7 1NN, Northern Ireland
[2] NASA Goddard Space Flight Center, Solar Physics Laboratory, Code 671, Greenbelt, MD 20771, USA

High-cadence, multiwavelength optical observations of a solar active region (NOAA 10969), obtained with the Swedish Solar Telescope, are presented. Difference imaging of white light continuum data reveals a white light brightening, 2 min in duration, linked to a co-temporal and co-spatial C2.0 flare event. The flare kernel observed in the white light images has a diameter of 300 km, thus rendering it below the resolution limit of most space-based telescopes. Continuum emission is present only during the impulsive stage of the flare, with the effects of chromospheric emission subsequently delayed by approximately 2 min. The localized flare emission peaks at 300% above the quiescent flux. This large, yet tightly confined, increase in emission is only resolvable due to the high spatial resolution of the Swedish Solar Telescope. An investigation of the line-of-sight magnetic field derived from simultaneous mdi data shows that the continuum brightening is located very close to a magnetic polarity inversion line. Additionally, an Hα flare ribbon is directed along a region of rapid magnetic energy change, with the footpoints of the ribbon remaining co-spatial with the observed white light brightening throughout the duration of the flare. The observed flare parameters are compared with current observations and theoretical models for M- and X-class events and we determine the observed white-light emission is caused by radiative back warming. We suggest that the creation of white-light emission is a common feature of all solar flares.

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For preprints via WWW: http://star.pst.qub.ac.uk/coolsun/coolpapers/jess_flare.pdf

The Energy Flux of Internal Gravity Waves in the Lower Solar Atmosphere

Thomas Straus[1], Bernhard Fleck[2], Stuart M. Jefferies[3], Gianna Cauzzi[4], Scott W. McIntosh[5], Kevin Reardon[4], Giuseppe Severino[1], Matthias Steffen[6]

[1] INAF / Osservatorio Astronomico di Capodimonte, Via Moiariello 16, 80131 Napoli, Italy
[2] ESA Science Operations Department, c/o NASA Goddard Space Flight Center, Mailcode 671.1, Greenbelt, MD 20771, USA
[3] Institute for Astronomy, University of Hawaii, 34 Ohia Ku Street, Pukalani, HI 96768, USA
[4] INAF / Osservatorio Astrofisico di Arcetri, Largo Enrico Fermi 5, 50125 Firenze, Italy
[5] High Altitude Observatory, National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307, USA
[6] Astrophysikalisches Institut Potsdam, An der Sternwarte 16, D-14482 Potsdam, Germany

Stably stratified fluids, such as stellar and planetary atmospheres, can support and propagate gravity waves. On Earth these waves, which can transport energy and momentum over large distances and can trigger convection, contribute to the formation of our weather and global climate. Gravity waves also play a pivotal role in planetary sciences and modern stellar physics. They have also been proposed as an agent for the heating of stellar atmospheres and coronae, the exact mechanism behind which is one of the outstanding puzzles in solar and stellar physics. Using a combination of high-quality observations and 3D numerical simulations we have the first unambiguous detection of propagating gravity waves in the Sun's (and hence a stellar) atmosphere. Moreover, we are able to determine the height dependence of their energy flux and find that at the base of the Sun's chromosphere it is around $5\,\mathrm{kW\,m^{-2}}$. This amount of energy is comparable to the radiative losses of the entire chromosphere and points to internal gravity waves as a key mediator of energy into the solar atmosphere.

Published by ApJ

For preprints contact: straus@oacn.inaf.it

The Solar Chromosphere at High Resolution with IBIS. II. Acoustic Shocks in the Quiet Internetwork and the Role of Magnetic fields

A. Vecchio[1,2], G. Cauzzi[1,3] and K. P. Reardon[1,3]

[1] INAF - Osservatorio Astrofisico di Arcetri, 50125 Firenze, Italy

[2] Dipartimento di Fisica, Università della Calabria, 87036 Rende (CS), Italy

[3] National Solar Observatory, P.O. Box 62, Sunspot NM, USA

Aims: We characterize the dynamics of the quiet inter-network chromosphere by studying the occurrence of acoustic shocks and their relation with the concomitant photospheric structure and dynamics, including small scale magnetic structures.

Methods: We analyze a comprehensive data set that includes high resolution chromospheric (CaII 854.2 nm) and photospheric (FeI 709.0 nm) spectra obtained with the IBIS imaging spectrometer in two quiet-Sun regions. This is complemented by high-resolution sequences of MDI magnetograms of the same targets. From the chromospheric spectra we identify the spatio-temporal occurrence of the acoustic shocks. We compare it with the photospheric dynamics by means of both Fourier and wavelet analysis, and study the influence of magnetic structures on the phenomenon.

Results: Mid-chromospheric shocks occur within the general chromospheric dynamics pattern of acoustic waves propagating from the photosphere. In particular, they appear as a response to underlying powerful photospheric motions at periodicities nearing the acoustic cut-off, consistent with 1-D hydrodynamical modeling. However, their spatial distribution within the supergranular cells is highly dependent on the local magnetic topology, both at the network and internetwork scale. We find that large portions of the internetwork regions undergo very few shocks, as "shadowed" by the horizontal component of the magnetic field. The latter is betrayed by the presence of chromospheric fibrils, observed in the core of the CaII line as slanted structures with distinct dynamical properties. The shadow mechanism appears to operate also on the very small scales of inter-network magnetic elements, and provides for a very pervasive influence of the magnetic field even in the quietest region analyzed.

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For preprints contact: gcauzzi@arcetri.astro.it

For preprints via ftp or WWW: http://arXiv.org/abs/0807.4966

Cross-Listed Abstracts (Pre-Main Sequence Stars)

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

Further X-ray detections of Herbig stars

Beate Stelzer[1], Jan Robrade[2], Jürgen H. M. M. Schmitt[2] and Jerome Bouvier[3]

[1] INAF - Osservatorio Astronomico di Palermo, Piazza del Parlamento 1, I-90134 Palermo, Italy

[2] Hamburger Sternwarte, Gojenbergsweg 112, D-21029 Hamburg, Germany

[3] Laboratoire d'Astrophysique, Observatoire de Grenoble, Université Joseph Fourier, B.P. 53, F-38041 Grenoble Cedex 9, France

The interpretation of X-ray detections from Herbig Ae/Be stars is disputed as it is not clear if these intermediate-mass pre-main sequence stars are able to drive a dynamo and ensuing phenomena of magnetic activity. Alternative X-ray production mechanisms, related to stellar winds, star-disk magnetospheres, or unresolved late-type T Tauri star companions have been proposed. The companion hypothesis can be tested by resolving Herbig stars in X-rays from their known visual secondaries. Furthermore, their global X-ray properties (such as detection rate, luminosity, temperature, variability), may give clues to the emission mechanism by comparison to other types of stars, e.g. similar-age but lower-mass T Tauri stars, similar-mass but more evolved main-sequence A- and B-type stars, and with respect to model predictions. In a series of papers we have been investigating high-resolution X-ray Chandra images of Herbig Ae/Be and main-sequence B-type stars where known close visual companions are spatially separated from the primaries. Here we report on six as yet unpublished Chandra exposures from our X-ray survey of Herbig stars. The target list comprises six Herbig stars with known cool companions, and three further A/B-type stars that are serendipitously in the Chandra field-of-view. In this sample we record a detection rate of 100 %, i.e. all A/B-type stars display X-ray emission at levels of $\log(L_{\rm x}/L_{\rm bol}) \sim -5... -7$. The analysis of hardness ratios confirms that HAeBe's have hotter and/or more absorbed X-ray emitting plasma than more evolved B-type stars. Radiative winds are ruled out as exclusive emission mechanism on basis of the high X-ray temperatures. Confirming earlier results, the X-ray properties of Herbig Ae/Be stars are not vastly different from those of their late-type companion stars (if such are known). The diagnostics provided by the presently available data leave open if the hard X-ray emission of Herbig stars is due to young age or indicative of further coronally active low-mass companion stars. In the latter case, our detection statistics imply a high fraction of higher-order multiple systems among Herbig stars.

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For preprints contact: stelzer@astropa.unipa.it

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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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