COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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Infrared Spectroscopy of Symbiotic Stars. V. First Orbits for Three S-Type Systems: Hen 2-173, CL Scorpii, and AS 270

Francis C. Fekel[1], Kenneth H. Hinkle[2], Richard R. Joyce[2], Peter R. Wood[3] and Thomas Lebzelter[4]

[1] Tennessee State University, Center of Excellence in Information Systems, 3500 John A. Merritt Blvd., Box 9501, Nashville, TN 37209 USA
[2] National Optical Astronomy Observatory, P. O. Box 26732, Tucson, AZ USA
[3] Research School of Astronomy and Astrophysics, Mt. Stromlo Observatory, Australian National University, Private Bag, Weston Creek, ACT 2611, Australia
[4] Institut für Astronomie, Türkenschanzstrasse 17, A-1180, Wien, Austria

Infrared radial velocities have been used to compute first orbits of the M giants in three southern S-type symbiotic systems. Of the three, Hen 2-173 has the longest orbital period, 911 days, and also has a non-circular orbit with an eccentricity of 0.21. The large value of its mass function suggests that Hen 2-173 may be an eclipsing system. For CL Sco our spectroscopic orbital period of 626 days is essentially identical to the previously determined light variability period of 625 days, and we have adopted the latter. AS 270 has an orbital period of similar length, 671 days, and both CL Sco and AS 270 have circular orbits. Only CL Sco has been extensively investigated previously, and we compare our results with the conclusions of Kenyon & Webbink. We also have examined the period–eccentricity relation for 30 S-type symbiotics. Circular orbits are found for 81% of the systems with orbital periods up to 800 days, while they occur for only 22% with periods greater than 800 days. This distribution is quite unlike that for G and K giants, but rather, is similar to that for barium stars, another type of mass-transfer binary, which also consists of a late-type giant and a white dwarf companion.

Accepted by AJ

For preprints contact: fekel@evans.tsuniv.edu

A Possible Activity Cycle in Proxima Centauri

C. Cincunegui[1,2,⋆], R. F. Díaz[1,2,⋆] and P. J. D. Mauas[1,3,⋆]

[1] Instituto de Astronomía y Física del Espacio, C.C. 67 Suc. 28 (1428) Buenos Aires
[2] Fellow of the CONICET
[3] Member of the Carrera del Investigador Científico, CONICET
⋆Visiting Astronomers, Complejo Astronómico El Leoncito, operated under agreement between the Consejo Nacional de Investigaciones Científicas y Técnicas de la República Argentina and the National Universities of La Plata, Córdoba and San Juan.

Context. Several late-type stars present activity cycles resembling the Solar one. This fact has been observed mostly in stars ranging from F to K, i. e., in stars with a radiative core and an outer convective layer.
Aims. This work aims at studying whether an activity cycle can be detected in the dM5.5e star Proxima Centauri, which is supposed to be completely convective.
Methods. We present periodical medium-resolution echelle observations covering the complete visual range, which were taken at the CASLEO Argentinean Observatory. These observations are distributed along 7 years. We discarded the spectra which present flare activity, and analize the remaining activity levels using four different statistical techniques, to look for a period of activity.
Results. We find strong evidence of a cyclic activity, with a period of ∼442 days. We also estimated that the Ca II S index varies around 130% due to activity variations outside of flares.

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For preprints contact: carolina@iafe.uba.ar

On the Time Dependence of Differential Rotation in Young Late-type Stars

A. F. Lanza[1]

[1]INAF–Osservatorio Astrofisico di Catania, Via S. Sofia, 78, 95123 Catania, Italy

A model for the angular momentum transfer within the convection zone of a rapidly rotating star is introduced and applied to the analysis of the recent observations of the temporal fluctuations of the differential rotation on the young late-type stars AB Dor and LQ Hya. Under the hypothesis that the mean magnetic field produced by the stellar dynamo rules the angular momentum exchanges and that the angular velocity depends only on the distance s from the rotation axis and the time, the minimum azimuthal Maxwell stress $|B_s B_\varphi|$, averaged over the convection zone, is found to range from ~ 0.04 to ~ 0.14 T^2. If the poloidal mean magnetic field B_s is of the order of 0.01 T, as indicated by the Zeeman Doppler Imaging maps of those stars, then the azimuthal mean field B_φ can reach an intensity of several Teslas, which significantly exceeds equipartition with the turbulent kinetic energy. Such strong fields can account also for the orbital period modulation observed in Cataclysmic Variables and RS Canum Venaticorum systems with a main-sequence secondary component. Moreover, the model allows us to compute the kinetic energy dissipation rate during the maintenance of the differential rotation. Only in the case of the largest surface shear observed on LQ Hya, the dissipated power may exceed the stellar luminosity, but the lack of a sufficient statistics on the occurrence of such episodes of large shear does not allow us to estimate their impact on the energy budget of the convection zone.

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For preprints contact: nlanza@oact.inaf.it

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O I Line Emission in Cool Stars: Calculations using Partial Redistribution

Rachel Koncewicz[1], and Carole Jordan[1]

[1]Rudolf Peierls Centre for Theoretical Physics, 1, Keble Road, Oxford, OX1 3NP, UK

Radiative transfer calculations have been performed for five cool stars: α Tau, β Gem, Procyon, ϵ Eri and the Sun, for the purpose of investigating the behaviour of the O I emission over a wide range of stellar types, and its dependence on coherent photon scattering. These stars span a range of spectral types from F5 IV - V to K5 III and surface gravities

$1.25 < \log g_* < 4.75$. Particular attention has been paid to the calculation of the flux in the resonance triplet around 1305 Å which is pumped by H Lyβ, including the effects of partial redistribution (PRD) and cross-redistribution (XRD) of photons. These are the first calculations for the resonance triplet in giant stars using a full PRD treatment. Calculations of the predominantly collisionally excited intersystem doublet at 1355, 1358 Å are included, and it is found that the ratio of these fluxes shows the effects of opacity. The flux in the forbidden line at 1641 Å is calculated for the giant stars and the effects of coherent scattering on this line are investigated. The discrepancy between the calculated and observed fluxes in the O I lines is used to infer the inadequacy of single-component chromospheric models..

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For preprints contact: konce@thphys.ox.ac.uk

Multi-site Campaign on the Open Cluster M67. I. Observations and Photometric Reductions

D. Stello[1,2,5], T. Arentoft[1,2,8], T. R. Bedding[2], M. Y. Bouzid[4], H. Bruntt[1,2,5], Z. Csubry[6], T. H. Dall[9] Z. E. Dind[2], S. Frandsen[1,8], R. L. Gilliland[3], A. P. Jacob[2], H. R. Jensen[1], Y. B. Kang[7], S.-L. Kim[7], L. L. Kiss[2], H. Kjeldsen[1,8], J.-R. Koo[7], J.-A. Lee[7], C.-U. Lee[7], J. Nuspl[6], C. Sterken[4] and R. Szabó[6]

[1]Institut for Fysik og Astronomi (IFA), Aarhus University, 8000 Aarhus, Denmark
[2]School of Physics, University of Sydney, NSW 2006, Australia
[3]Space Telescope Sceince Institute, 3700 San Martin Dr., Baltimore, USA
[4]Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, Belgium
[5]Department of Physics, US Air Force Academy, Colorado Springs, CO 80840, USA
[6]Konkoly Observatory of the Hungarian Academy of Sciences, 1525 Budapest, PO Box 67, Hungary
[7]Korea Astronomy and Space Science Institute, Daejeon 305-348, Korea
[8]Danish AsteroSeismology Centre, Aarhus Universitet, DK-8000 Aarhus, Danmark
[9] European Southern Observatory, Casilla 19001, Santiago 19, Chile

We report on an ambitious multi-site campaign aimed at detecting stellar variability, particularly solar-like oscillations, in the red giant stars in the open cluster M67 (NGC 2682). During the six-week observing run, which comprised 164 telescope nights, we used nine 0.6-m to 2.1-m class telescopes located around the world to obtain uninterrupted time-series photometry. We outline here the data acquisition and reduction, with emphasis on the optimisation of the signal-to-noise of the low amplitude (50–500 μmag) solar-like oscillations. This includes a new and efficient method for obtaining the linearity profile of the CCD response at ultra high precision ($\sim$ 10 parts per million). The noise in the final time series is 0.50 mmag per minute integration for the best site, while the noise in the Fourier spectrum of all sites combined is 20 μmag. In addition to the red giant stars, this data set proves to be very valuable for studying high-amplitude variable stars such as eclipsing binaries, W UMa systems and δ Scuti stars.

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For preprints contact: stello@physics.usyd.edu.au

For preprints via ftp or WWW: astro-ph/0609340

The Coronal Structure of Speedy Mic - II: Prominence Masses and Off-disc Emission

Nicholas J. Dunstone[1], Andrew Collier Cameron[1], John R. Barnes[2] and Moira M. Jardine[1]

[1] School of Physics and Astronomy, University of St.Andrews, North Haugh, St.Andrews, FIFE, KY16 9SS, UK.
[2] Centre for Astrophysics Research, University of Hertfordshire, College Lane, Hatfield, Herts AL10 9AB, UK.

Observations of stellar prominences on young rapidly rotating stars provide unique probes of their magnetic fields out to many stellar radii. We compare two independently obtained datasets of the K3 dwarf Speedy Mic using the Anglo-Australian Telescope (AAT) and the ESO Very Large Telescope (VLT). Taken more than a fortnight apart they provide the first insight into the evolution of the prominence system on such a young rapidly rotating star. The largest prominences observed transiting the stellar disc are found at very similar rotational phases between the epochs. This suggests that the magnetic structures supporting the prominences retain their identity on a two to three week timescale. We identify prominences as transient absorption features in all lines of the Hydrogen Balmer series down to H_{10}. We use the ratios of the prominence EWs in these lines to determine their column densities in the first excited

state of hydrogen. We determine the optical depths, finding prominences to be rather optically thick ($\tau \approx 20$) in the H_α line. The total hydrogen column density and thus the prominence masses are determined via observations of the CaII H&K lines. We find typical masses for four of the largest prominences to be in the range $0.5 - 2.3$ x10^{14} kg, slightly larger than giant solar prominence masses. Rotationally modulated emission is seen outside of the H_α line. These loops of emission are shown to be caused by prominences seen off the stellar disc. We find that all of the large emission loops can be associated with prominences we see transiting the stellar disc. This combined with the fact that many prominences appear to eclipse the off-disc emission of others, strongly suggests that the prominence system is highly flattened and likely confined to low stellar latitudes.

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For preprints contact: njd2@st-and.ac.uk

For preprints via ftp or WWW: http://arxiv.org/abs/astro-ph/0610106

Solar Abstracts

High Time Resolution Observations of Solar Hα Flares

K. Radziszewski[1], P. Rudawy[1] and K. J. H. Phillips[2]

[1] Astronomical Institute of Wrocław University, 51-622 Wrocław, ul. Kopernika 11, Poland
[2] Mullard Space Science Laboratory, Holmbury St Mary, Dorking, Surrey RH5 6NT, United Kingdom

We present the first results of a search for fast changes of solar flare Hα emission correlated in time with variations of hard X-ray fluxes recorded with the Reuven Ramaty High Energy Solar Spectroscopic Imager (*RHESSI*). Using the Large Coronagraph (*LC*), Multi-Channel Subtractive Double Pass (*MSDP*) spectrograph and the Solar Eclipse Coronal Imaging System (*SECIS*) at the Białkow Observatory, we collected a total of 23 sets of high time resolution (0.04–0.075 sec) observations of Hα bright flare kernels during two observational seasons (2003 and 2004). For the first time, several-minute-long high-resolution observations of the H-alpha line profiles as well as simultaneous two-dimensional images have been obtained with time resolution much better than 1 s. Detailed observations of four flares recorded on 2003 July 16 and 2004 April 23 are described. We found examples of good time correlations between X-ray flux variations and variations of the Hα emission of the selected bright flaring kernels. In some events particularly, small but impulsive variations of the hard X-ray (20–50 keV) flux and of the Hα emission are well correlated. The Hα emission follows the 20–50 keV X-ray emission by ~ 2 s and ~ 3 s for two of the flares, longer for a third. The 3–10 keV and 10–20 keV X-ray emission, generally characterizing the thermal emission, follow these impulsive changes. There are, however, several examples of impulsive increases in 10–20 keV emission which appear to be of nonthermal origin. These results are consistent with previous observations and with theoretical studies in which the chromospheric response to energetic beamed electrons is calculated, provided that the chromospheric hydrogen densities are relatively high ($\sim 10^{14} - 10^{15}$ cm^{-3}).

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For preprints contact: radziszewski@astro.uni.wroc.pl

Do Quasi-regular Structures Exist in the Photosphere? I. Observational Evidence

A.V. Getling[1]

[1]Institute of Nuclear Physics, Lomonosov Moscow State University, 119992 Moscow, Russia

Two series of solar-granulation images — the La Palma series of 5 June 1993 and the SOHO MDI series of 17–18 January 1997 — are analysed both qualitatively and quantitatively. New evidence is presented for the existence of long-lived, quasi-regular structures (first reported by Getling and Brandt (2002)), which no longer appear unusual in images averaged over 1–2-h time intervals. Such structures appear as families of light and dark concentric rings or families of light and dark parallel strips (“ridges” and “trenches” in the brightness distributions). In some cases, rings are combined with radial “spokes” and can thus form “web” patterns. The characteristic width of a ridge or trench is somewhat larger than the typical size of granules. Running-average movies constructed from the series of images are used to seek such structures. An algorithm is developed to obtain, for automatically selected centres, the radial distributions of the azimuthally averaged intensity, which highlight the concentric-ring patterns. We also present a time-averaged granulation image processed with a software package intended for the detection of geological structures in aerospace images. A technique of running-average-based correlations between the brightness variations at various points of the granular field is developed and indications are found for a dynamical link between the emergence and sinking of hot and cool parcels of the solar plasma. In particular, such a correlation analysis confirms our suggestion that granules — overheated blobs — may repeatedly emerge on the solar surface. Based on our study, the critical remarks by Rast (2002) on the original paper by Getling and Brandt (2002) can be dismissed.

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For preprints contact: A.Getling@ru.net

For preprints via ftp or WWW: `http://www.magnetosphere.ru/~avg/sol_phys_06_I.pdf`

Centennial Increase in Geomagnetic Activity: Latitudinal Differences and Global Estimates

Kalevi Mursula[1], and Daniel Martini[1,2]

[1] Dept. of Physics, University of Oulu, Oulu, Finland
[2] permanent address: GGKI, Sopron, Hungary

We study here the centennial change in geomagnetic activity using the newly proposed IHV (Inter-Hour Variability) index. We correct the earlier estimates of the centennial increase by taking into account the effect of the change of the sampling of the magnetic field from one sample per hour to hourly means in the first years of the previous century. Since the IHV index is a variability index, the larger variability in the case of hourly sampling leads, without due correction, to excessively large values in the beginning of the century and an underestimated centennial increase. We discuss two ways to extract the necessary sampling calibration factors and show that they agree very well with each other. The effect of calibration is especially large at the mid-latitude CLH/FRD station where the centennial increase changes from only 6 % to 24 % due to calibration. Sampling calibration also leads to a larger centennial increase of global geomagnetic activity based on the IHV index. The results verify a significant centennial increase in global geomagnetic activity, in a qualitative agreement with the aa index, although a quantitative comparison is not warranted. We also find that the centennial increase has a rather strong and curious latitudinal dependence. It is largest at high latitudes. Quite unexpectedly, it is larger at low latitudes than at mid-latitudes. These new findings indicate interesting long-term changes in near-Earth space. We also discuss possible internal and external causes for these observed differences. The centennial change of geomagnetic activity may be partly affected by changes in external conditions, partly by the secular decrease of the Earth's magnetic moment whose effect in near-Earth space may be larger than estimated so far.

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For preprints contact: kalevi.mursula@oulu.fi

Observations Supporting the Role of Magnetoconvection in Energy Supply to the Quiescent Solar Atmosphere

**Scott W. McIntosh[1], Alisdair R. Davey[1], Donald M. Hassler [1],
James D. Armstrong[2], Werner Curdt[3], Klaus Wilhelm[3], Gang Lin [4]**

[1] Southwest Research Institute, Department of Space Studies, 1050 Walnut St, Suite 400, Boulder, CO 80302 USA
[2] Institute for Astronomy, University of Hawaii, 4761 Lower Kula Road, Kula, HI 96790 USA
[3] Max Planck Institute for Solar System Research, Max-Planck-Str. 2, 37191 Katlenburg-Lindau, Germany
[4] Department of Electrical, Computer and Systems Engineering, Rensselaer Polytechnic Institute, 110, 8th Street, Troy, NY 12180 USA

Identifying the two physical mechanisms behind the production and sustenance of the quiescent solar corona and solar wind poses two of the outstanding problems in solar physics today. We present analysis of spectroscopic observations from the *Solar and Heliospheric Observatory* that are consistent with a single physical mechanism being responsible for a significant portion of the heat supplied to the lower solar corona and the initial acceleration of the solar wind; the ubiquitous action of magnetoconvection-driven reprocessing and exchange reconnection of the Sun's magnetic field

on the supergranular scale. We deduce that while the net magnetic flux on the scale of a supergranule controls the injection rate of mass and energy into the transition region plasma it is the global magnetic topology of the plasma that dictates whether the released ejecta provides thermal input to the quiet solar corona or becomes a tributary that feeds the solar wind.

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For preprints contact: mcintosh@boulder.swri.edu

For preprints via ftp or WWW: http://lanl.arxiv.org/abs/astro- ph/0609503

Observation of a Short-lived Pattern in the Solar Chromosphere

F. Wöger, S. Wedemeyer-Böhm, W. Schmidt and O. von der Lühe

Kiepenheuer-Institut für Sonnenphysik, Schöneckstraße 6, D-79104 Freiburg, Germany

In this work we investigate the dynamic behavior of inter-network regions of the solar chromosphere. We observed the chromosphere of the quiet Sun using a narrow-band Lyot filter centered at the Ca II K_{2v} emission peak with a bandpass of 0.3 Å. We achieved a spatial resolution of on average $0\farcs7$ at a cadence of 10 s. In the inter-network we find a mesh-like pattern that features bright grains at the vertices. The pattern has a typical spatial scale of $1\farcs95$ and a mean evolution time scale of 53 s with a standard deviation of 10 s. A comparison of our results with a recent three-dimensional radiation hydrodynamical model implies that the observed pattern is of chromospheric origin. The measured time scales are not compatible with those of reversed granulation in the photosphere although the appearance is similar. A direct comparison between network and inter-network structure shows that their typical time scales differ by at least a factor of two. The existence of a rapidly evolving small-scale pattern in the inter-network regions supports the picture of the lower chromosphere as a highly dynamical and intermittent phenomenon.

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For preprints contact: woeger@kis.uni-freiburg.de

Low-Mass and Substellar Abstracts

The First Direct Measurements of Magnetic Fields on Very Low-Mass Stars

Ansgar Reiners[1,2,3] and Gibor Basri[4]

[1] Hamburger Sternwarte, Universität Hamburg, D-21029 Hamburg, Germany
[2] Max-Planck-Institut für Sonnensystemforschung, D-37191 Katlenburg-Lindau, Germany
[3] Marie Curie Outgoing International Fellow
[4] Astronomy Department, University of California, Berkeley, CA 94720

We present the first direct magnetic field measurements on M dwarfs cooler than spectral class M4.5. Utilizing a new method based on the effects of a field on the Wing-Ford FeH band near 1 micron, we obtain information on whether the integrated surface magnetic flux (Bf) is low (well under 1 kilogauss), intermediate (between 1 and about 2.5 kG), or strong (greater than about 3 kG) on a set of stars ranging from M2 down to M9. Along with the field, we also measure the rotational broadening ($v \sin i$) and Hα emission strength for more than 20 stars. Our goal is to advance the understanding of how dynamo field production varies with stellar parameters for very low-mass stars, how the field and emission activity are related, and whether there is a connection between the rotation and magnetic flux.

We find that fields are produced throughout the M-dwarfs. Among the early M stars we have too few targets to yield conclusive results. In the mid-M stars, there is a clear connection between slow rotation and weak fields. In the late-M stars, rotation is always measureable, and the strongest fields go with the most rapid rotators. Interestingly, these very cool rapid rotators appear to have the largest magnetic flux in the whole sample (greater than in the classical dMe stars). Hα emission is found to be a good general proxy for magnetic fields, although the relation between the fractional emission and the magnetic flux varies with effective temperature. The known drop-off in this fractional emission near the bottom of the main sequence is not accompanied by a drop-off in magnetic flux, lending credence to the hypothesis that it is due to atmospheric coupling to the field rather than changes in the field itself. It is clear that the methodology we have developed can be further applied to discover more about the behavior of magnetic dynamos

and magnetic activity in cool and fully convective objects.

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For preprints contact: areiners@hs.uni-hamburg.de

XEST Abstracts

Editor's Note: The abstracts below present first results from the *XMM-Newton Extended Survey of the Taurus Molecular Cloud (XEST)*. See the Sept. 2006 issue for additional XEST abstracts. These abstracts are being cross-listed with the *Star Formation Newsletter* and are included here since they address several topics of general interest to cool star researchers.

A U-band Survey of Brown Dwarfs in the Taurus Molecular Cloud with the XMM-Newton Optical/UV Monitor

N. Grosso[1], M. Audard[2], J. Bouvier[1], K. R. Briggs[3] and M. Güdel[3]

[1] Laboratoire d'Astrophysique de Grenoble, Université Joseph-Fourier, F-38041 Grenoble cedex 9, France
[2] Columbia Astrophysics Laboratory, Columbia University, 550 West 120th Street, New York, NY 10027, USA
[3] Paul Scherrer Institut, 5232 Villigen und Würenlingen, Switzerland

AIMS. We aim to characterize the U-band variability of young brown dwarfs in the Taurus Molecular Cloud and discuss its origin. METHODS. We used the *XMM-Newton Extended Survey of the Taurus Molecular Cloud*, where a sample of 11 young *bona fide* brown dwarfs (spectral type later than M6) were observed simultaneously in X-rays with *XMM-Newton* and in the U-band with the *XMM-Newton* Optical/UV Monitor (OM). RESULTS. We obtained upper limits to the U-band emission of 10 brown dwarfs ($U\geq$19.6–20.6 mag), whereas 2MASS J04141188+2811535 was detected in the U-band. Remarkably, the magnitude of this brown dwarf increased regularly from $U\sim$19.5 mag at the beginning of the observation, peaked 6 h later at $U\sim$18.4 mag, and then decreased to $U\sim$18.65 mag in the next 2 h. The first OM U-band measurement is consistent with the quiescent level observed about one year later thanks to ground follow-up observations. This brown dwarf was not detected in X-rays by *XMM-Newton* during the OM observation. CONCLUSIONS. We discuss the possible sources of U-band variability for this young brown dwarf, namely a magnetic flare, non-steady accretion onto the substellar surface, and rotational modulation of a hot spot. We conclude that this event is related to accretion from a circumsubstellar disk, where the mass accretion rate was about a factor of 3 higher than during the quiescent level.

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For preprints via ftp or WWW: http://hal.ccsd.cnrs.fr/ccsd-00090709

Unbinned Maximum-likelihood Estimators for Low-count Data: Applications to Faint X-ray Spectra in the Taurus Molecular Cloud

Kaspar Arzner[1], Manuel Güdel[1], Kevin R. Briggs[1], Alessandra Telleschi[1] Manfred Schmidt[2], Marc Audard[3], Luigi Scelsi[5], Elena Franciosini[4],

[1] Paul Scherrer Institut, Würenlingen and Villigen, CH-5232 Villigen PSI, Switzerland
[2] Zurich University of Applied Sciences, Jägerstrasse 2, CH-8400 Winterthur, Switzerland
[3] Columbia Astrophysics Laboratory, Mail Code 5247, 550 West 120th Street, New York, NY 10027, USA
[4] INAF - Osservatorio Astronomico di Palermo, Piazza del Parlamento 1, I-90134 Palermo, Italy
[5] Dipartimento di Scienze Fisiche ed Astronomiche, Università di Palermo, Piazza del Parlamento 1, I-90134 Palermo, Italy

Traditional binned statistics such as χ^2 suffer from information loss and arbitrariness of the binning procedure, which is especially important at low count rates as encountered in the *XMM-Newton* Extended Survey of the Taurus Molecular Cloud (XEST). We point out that the underlying statistical quantity (the log likelihood L) does not require any binning beyond the one implied by instrumental readout channels, and we propose to use it for low-count data. The performance of L in the model classification and point estimation problems is explored by Monte-Carlo simulations of *Chandra* and *XMM-Newton* X-ray spectra, and is compared to the performances of the binned Poisson statistic (C), Pearson's χ^2 and Neyman's χ^2_N, the Kolmogorov-Smirnov, and Kuiper's statistics. It is found that the unbinned log likelihood L performs best with regard to the expected chi-square distance between true and estimated spectra, the chance of a successful identification among discrete candidate models, the area under the receiver-operator curve of reduced (two-model) binary classification problems, and generally also with regard to the mean square errors of individual spectrum parameters. The χ^2 ($\chi^2_{\rm N}$) statistics should only be used if more than 10 (15) predicted counts per bin are available. From the practical point of view, the computational cost of evaluating L is smaller than for any of the alternative methods if the forward model is specified in terms of a Poisson intensity and normalization is a free parameter. The maximum-L method is applied to 14 XEST observations, and confidence regions are discussed. The unbinned results are compared to binned XSPEC results, and found to generally agree, with exceptions explained by instability under re-binning and by background fine structures. In particular, HO Tau is found by the unbinned method to be rather cool ($kT \sim 0.2$ keV), which may be a sign of shock emission. The maximum-L method has no lower limit on the available counts, and allows to treat weak sources which are beyond the means of binned methods.

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For preprints contact: arzner@astro.phys.ethz.ch

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Upcoming Meeting

IAU Symposium 243 : Star-Disk Interaction in Young Stars

21 - 25 May 2007

Grenoble, France

Web Page: http://www.iaus243.org

Submitted by: Jerome Bouvier

Electronic mail: Jerome.Bouvier@obs.ujf-grenoble.fr

This is the first announcement of the IAU Symposium 243 *Star-Disk Interaction in Young Stars* to be held in Grenoble, France, on May 21-25, 2007.

Disk accretion and jet outflows are intimately associated with the formation of stars and planets. One central issue raised by recent observational studies is the origin of the physical connection between accretion and wind/jet processes. It has become clear that the physical connection takes place within 1 AU of the central star, in a region where the interaction between the star and the inner disk is still poorly understood. The conference is intended to review the observational constraints available on the physical processes thought to be at work at the star-disk interface, to confront the predictions of the latest numerical and analytical MHD models of star-disk-jet systems with observations, and to explore the consequences of these processes for stellar angular momentum evolution and inner disk structure.

Topics: Magnetic Field in Young Stars; Signature of magnetospheric accretion and inner disk truncation; Magnetospheric ejection; Star-disk magnetospheric coupling; Varying the boundary conditions : Multiple systems, Exploring the mass and accretion range, Disk evolution and planet formation

Additional information, including the preliminary program of the Symposium, is available at : **http://www.iaus243.org**

Job Opening

Postdoctoral Research Position

Star and/or Planet Formation

University of Geneva (Switzerland)

Applications are invited for a postdoctoral research position at the University of Geneva (Geneva Observatory and its affiliated Integral Science Data Centre) to start as soon as possible.

The successful candidate will be member of a new research group led by Prof. Marc Audard in the field of star formation. The group will work on a project to study physical processes in disks around young stars through multi-wavelength observations and/or theoretical modeling. In particular, research efforts focus on understanding high-energy processes in young stars and their impact on the circumstellar disk and on planet formation.

Applicants with an observational (infrared, millimeter, or X-rays) or theoretical background in star and/or planet formation are particularly encouraged to apply. The successful candidate is expected to collaborate with the group but will also be encouraged to pursue independent research.

The appointment will be for two years, with possible extensions up to four years, contingent on funding and performance. Funds for research expenses are available as well.

Candidates should send a curriculum vitae, a publication list, a description of research interests and plans. They should also arrange for three letters of recommendation to be sent by e-mail (preferred; Marc.Audard@obs.unige.ch) or directly to Prof. Marc Audard, ISDC/Geneva Observatory, Ch. d'Ecogia 16, 1290 Versoix, Switzerland (Tel: +41 22 379 2166). Applications will be accepted until the position is filled.

Job Opening

Postdoctoral Researcher

Modeling of Solar Transient Events

Armagh Observatory (N. Ireland)

A fixed-term Postdoctoral Researcher position is available from 2006 December 1, or as soon as possible thereafter. The Observatory has full access to all UK facilities and is a member of the UK SALT Consortium. Applicants must have, or be about to obtain, a PhD in an appropriate discipline. It is desirable that candidates have expertise in the modeling of various solar transient events, e.g. explosive events, blinkers, spicules, etc.

Starting salary in the range 22,289 to 30,002 pounds (under review), depending on qualifications and experience. Fixed-term contract posts are available for the stated period in the first instance but in particular circumstances may be extended subject to availability of funding.

Enquiries and requests for further information may be made to Prof. J.G. Doyle, at the address below, or by e-mail to jgd@arm.ac.uk. Information about the Armagh Observatory may be obtained by consulting the web-site: http://star.arm.ac.uk/.

The initial closing date is 2006 October 27. Late applications will be considered until the position is filled. Applicants should obtain an application pack from the Administrator or from the Observatory web-site, and send the completed application form together with a full curriculum vitae, statement of research interests and complete bibliography to: The Administrator, Armagh Observatory, College Hill, Armagh BT61 9DG, Northern Ireland (Tel: +44-(0)28-3752-2928; FAX: +44-(0)28-3752-7174; e-mail: lfy@arm.ac.uk). References from at least two referees should be sent to the Administrator to arrive by the initial closing date or as soon as possible thereafter.

The Armagh Observatory is an equal opportunities employer.

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.***