COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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Stellar Abstracts

Stellar Granulation as the Source of High-Frequency Flicker in Kepler Light Curves

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A large fraction of cool, low-mass stars exhibit brightness fluctuations that arise from a combination of convective granulation, acoustic oscillations, magnetic activity, and stellar rotation. Much of the short-timescale variability takes the form of stochastic noise, whose presence may limit the progress of extrasolar planet detection and characterization. In order to lay the groundwork for extracting useful information from these quasi-random signals, we focus on the origin of the granulation-driven component of the variability. We apply existing theoretical scaling relations to predict the star-integrated variability amplitudes for 508 stars with photometric light curves measured by the Kepler mission. We also derive an empirical correction factor that aims to account for the suppression of convection in F-dwarf stars with magnetic activity and shallow convection zones. So that we can make predictions of specific observational quantities, we performed Monte Carlo simulations of granulation light curves using a Lorentzian power spectrum. These simulations allowed us to reproduce the so-called "flicker floor" (i.e., a lower bound in the relationship between the full light-curve range and power in short-timescale fluctuations) that was found in the Kepler data. The Monte Carlo model also enabled us to convert the modeled fluctuation variance into a flicker amplitude directly comparable with observations. When the magnetic suppression factor described above is applied, the model reproduces the observed correlation between stellar surface gravity and flicker amplitude. Observationally validated models like these provide new and complementary evidence for a possible impact of magnetic activity on the properties of near-surface convection.

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For preprints via ftp or WWW: http://arxiv.org/abs/1312.5928

M-dwarf Stellar Winds: The Effects of Realistic Magnetic Geometry on Rotational Evolution and Planets

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We perform three-dimensional numerical simulations of stellar winds of early-M dwarf stars. Our simulations incorporate observationally reconstructed large-scale surface magnetic maps, suggesting that the complexity of the magnetic field can play an important role in the angular momentum evolution of the star, possibly explaining the large distribution of periods in field dM stars, as reported in recent works. In spite of the diversity of the magnetic field topologies among the stars in our sample, we find that stellar wind flowing near the (rotational) equatorial plane carries most of the stellar angular momentum, but there is no preferred colatitude contributing to mass loss, as the mass flux is maximum at different colatitudes for different stars. We find that more non-axisymmetric magnetic fields result in more asymmetric mass fluxes and wind total pressures $p_{\rm tot}$ (defined as the sum of thermal, magnetic and ram pressures). Because planetary magnetospheric sizes are set by pressure equilibrium between the planet's magnetic field and $p_{\rm tot}$, variations of up to a factor of 3 in $p_{\rm tot}$ (as found in the case of a planet orbiting at several stellar radii away from the star) lead to variations in magnetospheric radii of about 20 percent along the planetary orbital path. In analogy to the flux of cosmic rays that impact the Earth, which is inversely modulated with the non-axisymmetric component of the total open solar magnetic flux, we conclude that planets orbiting M dwarf stars like DT Vir, DS Leo and GJ 182, which have significant non-axisymmetric field components, should be the more efficiently shielded from galactic cosmic rays, even if the planets lack a protective thick atmosphere/large magnetosphere of their own.

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PolarBase: A Data Base of High Resolution Spectropolarimetric Stellar Observations

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PolarBase is an evolving data base that contains all stellar data collected with the ESPaDOnS and NARVAL high-resolution spectropolarimeters, in their reduced form, as soon as they become public. As of early 2014, observations of 2,000 stellar objects throughout the Hertzsprung-Russell diagram are available. Intensity spectra are available for all targets, and the majority of the observations also include simultaneous spectra in circular or linear polarization, with the majority of the polarimetric measurements being performed only in circularly polarized light (Stokes V). Observations are associated with a cross-correlation pseudo-line profile in all available Stokes parameters, greatly increasing the detectability of weak polarized signatures. Stokes V signatures are detected for more than 300 stars of all masses and evolutionary stages, and linear polarization is detected in 35 targets. The detection rate in Stokes V is found to be anti-correlated with the stellar effective temperature. This unique set of Zeeman detections offers the first opportunity to run homogeneous magnetometry studies throughout the H-R diagram. The web interface of PolarBase is available at http://polarbase.irap.omp.eu.

For preprints via WWW: http://arxiv.org/abs/1401.1082
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The Ups and Downs of Alpha Centauri

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The following is a progress report on the long-term coronal ($T \sim 1$ MK) activity of α Centauri A (HD 128620: G2 V) and B (HD 128621: K1 V). Since 2005, *Chandra* X-ray Observatory has carried out semiannual pointings on AB, mainly with the High Resolution Camera (HRC-I), but also on two occasions with the Low-Energy Transmission Grating Spectrometer (LETGS), fully resolving the close pair in all cases. During 2008–2013, *Chandra* captured the rise, peak, and initial decline of B's coronal luminosity. Together with previous high states documented by *ROSAT* and *XMM-Newton,* the long-term X-ray record suggests a period of 8.2 ±0.2 yr, compared to 11 yr for the Sun; with a minimum-to-peak contrast of 4.5, about half the typical solar cycle amplitude. Meanwhile, the A component has been mired in a Maunder-Minimum-like low state since 2005, initially recognized by *XMM-Newton.* But now, A finally appears to be climbing out of the extended lull. If interpreted simply as an over-long cycle, the period would be 19.1±0.7 yr, with a minimum-to-peak contrast of 3.4. The short X-ray cycle of B, and possibly long cycle of A, are not unusual compared with the diverse (albeit much lower amplitude) chromospheric variations recorded, for example, by the HK Project. Further, the deep low state of A also is not unusual, but instead is similar to the $L_{\mathrm{X}}/L_{\mathrm{bol}}$ of the Sun during recent minima of the sunspot cycle.

(**Note:** The arXiv preprint includes one additional HRC-I pointing, in 2013 December, which was carried out after the final revision was submitted to the Journal. The new X-ray points are consistent with the long-term trends and do not affect any of the quantitative conclusions.)

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For preprints via arXiv: http://adsabs.harvard.edu/abs/2014arXiv1401.0847A

Observation and Modelling of Main Sequence Star Chromospheres; XX. The Rotation-activity Relationship in M0 Dwarfs

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Using two different spectrographs, HARPS (ESO) and SOPHIE (OHP), we have measured vsini for a sample of 103 dM0 stars. These are the first measurements of vsini for most of the stars studied here. For the first time we measured vsini for slow rotators at the spectral type dM0.

We measured vsini to a precision of 0.3 $km\ s^{-1}$ and a detection limit of about 0.5-1 $km\ s^{-1}$. All our targets have similar (R-I)c colour. In our sample, we detected rotation for 90 stars (88 dM0 stars, 1 dM0e star and 1 dM0(e) star) and we did not detect rotation in a further 13 stars. This result shows that there are very few dM0 fast rotators and much fewer than in the case of dM2 stars. We discovered 4 new spectroscopic binaries and 1 spectroscopic triple system.

We use 712 high-resolution spectra for 104 different dM0 stars obtained with HARPS and SOPHIE. We present 688 new measurements of the Ca II resonance lines and 709 new measurements of the H_α line equivalent widths.

We determined radii and effective temperatures for all our target stars. The effective temperatures were derived using the (R-I)c colour and empirical far-red colour-effective temperature correlations. We derived the radii from the standard formulae relating M_{bol}, BC and T_{eff}.

We find that the distribution of P/sini (the projected rotation period) is not bimodal as in dM2 stars beacause there are too few fast rotators. The distribution for slow dM0 rotators is also different to that found for dM2 stars. For dM0 stars the distribution spreads from 8 days to 28 days with two peaks at 16 days and 22 days respectively. However, we find that globally dM0 stars rotate slower than dM2 stars.

We use our measurements of P/sini and the Ca II mean equivalent width to derive an empirical correlation between log(P/sini) and log(Ca II EW). We find that the slope of this correlation is small: -0.681±0.138. We investigate the values of this gradient as a function of $(R\text{-}I)_c$ for dM0, dM2 and dM4 stars. We find that the magnitude of this

gradient rapidly increases with spectral type in M dwarfs, thus showing that the dynamo mechanisms at work in these stars are increasingly efficient with rotation as the spectral type increases. We observe no fall of the efficiency of the dynamo mechanisms for fully convective stars, neither in the dM0, dM2 or dM4 distributions.

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Observation and Modelling of Main Sequence Star Chromospheres; XXI. New Constraints on the Dynamo Mechanisms in M Dwarfs

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Using two different spectrographs, HARPS (ESO) and SOPHIE (OHP), we have measured vsini for a sample of 85 dM3 stars. In our sample, we detected rotation for 80 stars (72 dM3 stars, and 8 dM3e stars) and we did not detect rotation in a further 5 stars. We discovered 4 new spectroscopic binaries.

We analyse the 1379 high-resolution spectra for our dM3 stars. We present 1345 new measurements of the Ca II resonance lines and 1380 new measurements of the H_α line equivalent widths.

We find that the distribution of P/sini (the projected rotation period) for dM3 stars is quite different to those of dM2 and dM4 stars. Also, the mean rotation period for the slow rotators for dM3 stars is sensibly larger (20.1 days) than for dM2 (14.4 days) and dM4 stars (11.4 days). We also found that in general, the mean rotation period for slow rotators decreases with increasing spectral type, except at the spectral type dM3 which represents the fully convective threshold. These represent important new constraints for the dynamo mechanisms. We discovered that there is a change happening in the efficiency of dynamo mechanisms at the fully convective transition. The dynamo mechanisms seem more efficient when the stars are fully convective. These findings are supported by the fact that at the spectral type dM3, the coronal loop lengths start to increase.

We found that the gradient of the rotation-activity relationships increases with increasing spectral type in M dwarves. In other words, the dynamo mechanisms are increasingly sensitive to rotation with increasing spectral type.

We show that many of main characteristics of the mean rotation period-(R-I)c relationship can be reproduced by simply taking into account the effects of rotation and radius on the dynamo mechanisms. The observations indeed support the idea that stellar radius plays a significant role on the efficiency of the dynamo mechanisms in M dwarves.

We also compare mean rotation period-(R-I)c relationship to the mean Ca II-(R-I)c relationship. We conclude that the observations can be interpreted by a combined effect of rotation and radius on the levels of magnetic activity.

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Calculated Resonance Line Profiles of Mg II, C II, and Si IV in the Solar Atmosphere

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NASA's Interface Region Imaging Spectrograph (IRIS) space mission, launched 2013 June 27, is intended to study the structure of the solar chromosphere and transition region between the chromosphere and corona. The spectral lines to be observed include the Mg II k line at 2796.5 Å, the C II 1334.5 Å line, and the Si IV line at 1393.8 Å, which are formed in the middle chromosphere, the upper chromosphere, and the lower transition region, respectively. Here we calculate the profiles of these lines from four models of the solar atmosphere, intended to represent the faint and mean internetwork, a network lane, and bright network. We show how the profiles change from the center of the solar disk toward the limb of the Sun, and in response to outflows and inflows. These results are intended to cover the range of expected quiet-Sun observations and assist in their interpretation. We expect that the observations will lead to improvements in the models, which then can be used to estimate the required non-radiative heating in the different regions.

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Evidence for Two Separate Heliospheric Current Sheets of Cylindrical Shape During Mid-2012

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During the reversal of the Suns polar fields at sunspot maximum, outward extrapolations of magnetograph measurements often predict the presence of two or more current sheets extending into the interplanetary medium, instead of the single heliospheric current sheet (HCS) that forms the basis of the standard ballerina skirt picture. By comparing potential-field source-surface models of the coronal streamer belt with white-light coronagraph observations, we deduce that the HCS was split into two distinct structures with circular cross sections during mid-2012. These cylindrical current sheets were centered near the heliographic equator and separated in longitude by roughly 180; a corresponding four-sector polarity pattern was observed at Earth. Each cylinder enclosed a negative-polarity coronal hole that was identifiable in extreme ultraviolet images and gave rise to a high-speed stream. The two current sheet systems are shown to be a result of the dominance of the Suns nonaxisymmetric quadrupole component, as the axial dipole field was undergoing its reversal during solar cycle 24.

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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 bimonthly call for abstracts will be issued. 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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