COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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Stellar Abstracts

Planetary Tidal Interactions and the Rotational Evolution of Low-mass stars: The Pleiades' Anomaly

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The surface angular velocity evolution of low-mass stars is now globally understood and the main physical mechanisms involved in it are observationally quite constrained. However, while the general behaviour of these mechanisms is grasped, their theoretical description is still under ongoing work. This is the case for instance about the description of the physical process that extracts angular momentum from the radiative core, which could be described by several theoretical candidates. Additionally, recent observations showed anomalies in the rotation period distribution of open cluster, main sequence, early K-type stars that cannot be reproduced by current angular momentum evolution models. In this work, we study the parameter space of star-planet system's configurations to investigate if including the tidal star -planet interaction in angular momentum evolution models could reproduce the anomalies of this rotation period distribution. To study this effect, we use a parametric angular momentum evolution model that allows for core-envelope decoupling and angular momentum extraction by magnetized stellar wind that we coupled to an orbital evolution code where we take into account the torque due to the tides raised on the star by the planet. We explore different stellar and planetary configurations (stellar mass from 0.5 to 1.0 $M_\odot$ and planetary mass from 10 $M_\oplus$ to 13 M_{jup}) to study their effect on the planetary orbital and stellar rotational evolution. The stellar angular momentum is

the most impacted by the star-planet interaction when the planet is engulfed during the early main sequence phase. Thus, if a close-in Jupiter-mass planet is initially located at around 50% of the stellar corotation radius, a kink in the rotational period distribution opens around late and early K-type stars during the early main sequence phase. Tidal star-planet interactions can create a kink in the rotation period distribution of low-mass stars, which could possibly account for unexpected scatter seen in the rotational period distribution of young stellar clusters.

Accepted by A&A

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For preprints via WWW: https://arxiv.org/abs/1808.08728

A Closer Look at the Transition Between Fully Convective and Partly Radiative Low-Mass Stars

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Recently, an analysis of Gaia Data Release 2 revealed a gap in the mid-M dwarf main sequence. The authors suggested the feature is linked to the onset of full convection in M dwarfs. Following the announcement of this discovery, an explanation has been proposed based on standard stellar evolution models. In this paper we re-examine this explanation. We confirm that nuclear burning and mixing processes of ^{3}He provide the best explanation for the observed feature. We also find that a change in the energy transport from convection to radiation does not induce structural changes that could be visible. Regarding the very details of the process, however, we disagree with the details of the published explanation and propose an alternative.

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For preprints via WWW: http://arxiv.org/abs/1809.07274

From Solar to Stellar Brightness Variations: The Effect of Metallicity

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Context. Comparison studies of Sun-like stars with the Sun suggest an anomalously low photometric variability of the Sun compared to Sun-like stars with similar magnetic activity. Comprehensive understanding of stellar variability is needed, to find a physical reasoning for this observation.
Aims. We investigate the effect of metallicity and effective temperature on the photometric brightness change of Sun-like stars seen at different inclinations. The considered range of fundamental stellar parameters is sufficiently small so the stars, investigated here, still count as Sun-like or even as solar twins.
Methods. To model the brightness change of stars with solar magnetic activity, we extend a well established model of solar brightness variations, SATIRE (which stands for Spectral And Total Irradiance Reconstruction), which is based on solar spectra, to stars with different fundamental parameters. For that we calculate stellar spectra for different metallicities and effective temperature using the radiative transfer code ATLAS9.
Results. We show that even a small change (e.g. within the observational error range) of metallicity or effective temperature significantly affects the photometric brightness change compared to the Sun. We find that for Sun-like stars, the amplitude of the brightness variations obtained for Strmgren (b + y)/2 reaches a local minimum for fundamental stellar parameters close to the solar metallicity and effective temperature. Moreover, our results show that the effect of inclination decreases for metallicity values greater than the solar metallicity. Overall, we find that an exact determination of fundamental stellar parameters is crucially important for understanding stellar brightness changes.

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For preprints via WWW: https://arxiv.org/abs/1809.04360

HD 38858: A Solar Type Star With a *sim*10.8 yr Activity Cycle. Searching for Balmer and Metallic Line Variations

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Context. The detection of chromospheric activity cycles in solar-analogue and twin stars, can be used to put in context the solar cycle. However, there is a relatively low percentage of these stars with activity cycles detected. It is well known that the cores of Ca II H&K lines are modulated by stellar activity. The behaviour of Balmer and other optical lines with stellar activity is not yet completely understood. Aims. To search for Ca II H&K, Balmer and Fe II line variations modulated by the stellar activity. In particular, we apply a novel strategy to detect possible shape variations in the Hα line. Methods. We analyse activity signatures in HD 38858 by using HARPS and CASLEO spectra obtained between 2003 and 2017. We calculate the Mount Wilson index (S_{MW}), $\log(R'_{HK})$ and the statistical moments of Ca II H&K, Balmer and other optical lines. We search for periodicities by using the generalized Lomb-Scargle periodogram. Results. We detect a long-term activity cycle of 10.8 yr in Ca II H&K and Hα, being HD 38858 one of the most similar stars to the Sun for which a cycle has been detected. In contrast, this cycle is marginally detected in the Fe II lines. Also, we detect a noticeable radial velocity variation, which seems to be produced by stellar activity. Conclusions. HD 38858 is the second solar-analogue star where we find a clear activity cycle which is replicated by Balmer lines. Spectral indexes based on the shape of Hα seems to be more realiable than the fluxes in the same line to detect activity variations. On the other hand, the cyclic modulation detected gives place to a radial velocity variation, previously associated to a super-Earth planet. Finally, due to the similarity of HD 38858 with the Sun, we recommend to continue monitoring this star.

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For preprints via WWW: https://arxiv.org/abs/1809.05581

Calibration of Differential Light Curves for Physical Analysis of Starspots

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This paper presents detailed consideration of methodologies to calibrate differential light curves for accurate physical starspot modeling. We use the Sun and starspot models as a testbed to highlight some factors in this calibration that that have not yet been treated with care. One unambiguously successful procedure for converting a differential light curve into a light deficit curve appears difficult to implement, but methodologies are presented that work in many cases. The years-long time coverage of *Kepler* provides a strong advantage, but unresolved issues concerning the competing and sometimes similar effects of surface differential rotation versus spot number and size evolution can prevent the confident recovery of correct spot covering fractions in certain cases.

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Does Nonaxisymmetric Dynamo Operate in the Sun?

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We explore effects of random non-axisymmetric perturbations of kinetic helicity (the α effect) and diffusive decay of bipolar magnetic regions on generation and evolution of large-scale non-axisymmetric magnetic fields on the Sun. Using a reduced 2D nonlinear mean-field dynamo model and assuming that bipolar regions emerge due to magnetic buoyancy in situ of the large-scale dynamo action, we show that fluctuations of the α effect can maintain the non-axisymmetric magnetic fields through a solar-type $\alpha^2\Omega$ dynamo process. It is found that diffusive decay of bipolar active regions is likely to be the primary source of non-axisymmetric magnetic fields observed on the Sun. Our results show that non-axisymmetric dynamo models with stochastic perturbations of the α effect can explain periods of extremely high activity ('super-cycle' events) as well as periods of deep decline of magnetic activity. We compare the models with synoptic observations of solar magnetic fields for the last four activity cycles, and discuss implications of our results for interpretation of observations of stellar magnetic activity.

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For preprints contact: pip@iszf.irk.ru

For preprints via WWW: https://arxiv.org/abs/1808.05332

Low-Mass and Substellar Abstracts

Chemical Tracers in Proto-Brown Dwarfs: CN, HCN, and HNC Observations

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We present results from a study of nitrogen chemistry in Class 0/I proto-brown dwarfs (proto-BDs). We have used the IRAM 30 m telescope to observe the CN (2-1), HCN (3-2), and HNC (3-2) lines in 7 proto-BDs. All proto-BDs show a large CN/HCN abundance ratio of >20, and a HNC/HCN abundance ratio close to or larger than unity. The enhanced CN/HCN ratios can be explained by high UV flux originating from an active accretion zone in the proto-BDs. The larger than unity HNC/HCN ratio for the proto-BDs is likely caused by a combination of low temperature and high density. Both CN and HNC show a flat distribution with CO, indicating that these species can survive in regions where CO is depleted. We have investigated the correlations in the molecular abundances of these species for the proto-BDs with Class 0/I protostars. We find tentative trends of CN (HCN) abundances being about an order of magnitude higher (lower) in the proto-BDs compared to protostars. HNC for the proto-BDs shows a nearly constant abundance unlike the large spread of $\sim$2 orders of magnitude seen for the protostars. Also notable is a rise in the HNC/HCN abundance ratio for the lowest luminosity objects, suggesting that this ratio is higher under low-temperature environments. None of the relatively evolved Class Flat/Class II brown dwarfs in our sample show emission in HNC. The HNC molecule can be considered as an efficient tracer to search and identify early stage sub-stellar mass objects.

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For preprints via WWW: https://arxiv.org/abs/1809.10164

Job Opening

Ph.D. Student Positions

Solar System Science
Univ. of Göttingen (Germany)
Deadline: 15 November 2018

Dear Colleagues:

The International Max Planck Research School for Solar System Science (IMPRS) at the University of Göttingen (http://www.solar-system-school.de) invites applications for several PhD positions to start in 2019.

https://www.mps.mpg.de/phd/applynow

The International Max Planck Research School for Solar System Science at the University of Gttingen in Germany (Solar System School) offers a research-oriented doctoral programme covering the physical aspects of Solar system science. It is jointly run by the Max Planck Institute for Solar System Research (MPS) and the University of Gttingen. Research at the MPS covers three main research areas: Sun and Heliosphere (director S. Solanki), Solar and Stellar Interiors (director L. Gizon) and Planets and Comets (director U. Christensen). Solar System School students collaborate with leading scientists in these fields and graduates are awarded a doctoral degree from the renowned University of Gttingen or, if they choose, another university.

The Solar System School is open to students from all countries and offers an international three-year PhD programme in an exceptional research environment with state-of-the-art facilities on the Gttingen Campus. Successful applicants will be offered a three-year doctoral support contract as well as post-doc wrap-up funding.

The language of the structured graduate programme is English, with German language courses offered (optional). The programme includes an inspiring curriculum of scientific lectures and seminars as well as advanced training workshops and provides a relocation cost subsidy and travel funds to attend international conferences.

Applicants to the Solar System School should have a keen interest in Solar system science and a record of academic excellence. They must have, or must be about to obtain, an M.Sc. degree or equivalent in physics, earth sciences or a related field, including a written Masters thesis, and must document a good command of the English language.

* Applicants can register immediately at the online application portal. * Applications should be submitted between October 1 and November 15. * The School will contact the referees named by the candidate upon submission of the application and will ask referees to submit their letters through the online portal no later than November 20.

To start your application, please see the following pages:

Solar System School http://www.solar-system-school.de

Call for Applications 2018 https://www.mps.mpg.de/phd/applynow

Frequently Asked Questions https://www.mps.mpg.de/phd/faq

List of Open PhD Projects https://www.mps.mpg.de/phd/open-projects

Online Application Portal https://www.application.mps.mpg.de/

Dr. Sonja Schuh ¡info@solar-system-school.de¿ IMPRS Scientific Coordinator

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 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

`http://casa.colorado.edu/~skinners/coolnews.html .`

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