COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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Stellar Abstracts

The Long-term Dynamical Evolution of Disc-fragmented Multiple systems in the Solar Neighborhood

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The origin of very low-mass hydrogen-burning stars, brown dwarfs, and planetary-mass objects at the low-mass end of the initial mass function is not yet fully understood. Gravitational fragmentation of circumstellar discs provides a possible mechanism for the formation of such low-mass objects. The kinematic and binary properties of very low-mass objects formed through disc fragmentation at early times (< 10 Myr) were discussed in Li et al. (2015). In this paper we extend the analysis by following the long-term evolution of disc-fragmented systems, up to an age of 10 Gyr, covering the ages of the stellar and substellar population in the Galactic field. We find that the systems continue to decay, although the rates at which companions escape or collide with each other are substantially lower than during the first 10 Myr, and that dynamical evolution is limited beyond 1 Gyr. By $t = 10$ Gyr, about one third of the host stars is single, and more than half have only one companion left. Most of the other systems have two companions left that orbit

their host star in widely separated orbits. A small fraction of companions have formed binaries that orbit the host star in a hierarchical triple configuration. The majority of such double companion systems have internal orbits that are retrograde with respect to their orbits around their host stars. Our simulations allow a comparison between the predicted outcomes of disc-fragmentation with the observed low-mass hydrogen-burning stars, brown dwarfs, and planetary-mass objects in the Solar neighbourhood. Imaging and radial velocity surveys for faint binary companions among nearby stars are necessary for verification or rejection for the formation mechanism proposed in this paper.

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For preprints via WWW: https://arxiv.org/abs/1609.00120

The β Pictoris Association: Catalog of Photometric Rotational Periods of the Low-mass Members and Candidate Members

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We intended to compile the most complete catalog of bona fide members and candidate members of the β Pictoris association, and to measure their rotation periods and basic properties from our own observations, public archives, and exploring the literature. We carried out a multi-observatories campaign to get our own photometric time series and collected all archived public photometric data time series for the stars in our catalog. Each time series was analyzed with the Lomb-Scargle and CLEAN periodograms to search for the stellar rotation periods. We complemented the measured rotational properties with detailed information on multiplicity, membership, and projected rotational velocity available in the literature and discussed star by star. We measured the rotation periods of 112 out of 117 among bona fide members and candidate members of the β Pictoris association and, whenever possible, we also measured the luminosity, radius, and inclination of the stellar rotation axis. This represents to date the largest catalog of rotation periods of any young loose stellar association. We provided an extensive catalog of rotation periods together with other relevant basic properties useful to explore a number of open issues such as the causes of spread of rotation periods among coeval stars, evolution of angular momentum, and lithium-rotation connection.

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The Rotation - Lithium Depletion Correlation in the β Pictoris Association and the LDB Age Determination

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There is evidence in the 125-Myr Pleiades cluster, and more recently in the 5-Myr NGC 2264 cluster, that rotation plays a key role in the Lithium (Li) depletion processes among low-mass stars. Fast rotators appear to be less Li-depleted than equal-mass slow rotators. We intend to explore the existence of a Li depletion - rotation connection among the β Pictoris members at an age of about 24 Myr, and to use such correlation either to confirm or to improve the age estimate based on the Lithium Depletion Boundary (LDB) modeling. We have photometrically monitored all the known members of the β Pictoris association with at least one Lithium equivalent width (Li EW) measurement from the literature. We measured the rotation periods of 30 members for the first time and retrieved from the literature the rotation periods for other 36 members, building a catalogue of 66 members with measured rotation period and Li EW. We find that in the $0.3 < M < 0.8$ $M_\odot$ range, there is a strong correlation between rotation and Li EW. For higher mass stars, no significant correlation is found. For very low mass stars in the Li depletion onset, at about 0.1 $M_\odot$, data are too few to infer a significant correlation. The observed Li EWs are compared with those predicted by the Dartmouth stellar evolutionary models that incorporate the effects of magnetic fields. After decorrelating the Li EW from the rotation period, we find that the hot side of the LDB is fitted well by Li EW values corresponding to an age of 25±3 Myr in good agreement with independent estimates from the literature.

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A Possible Long-term Activity Cycle for ι Horologii: First Results from the HKα & SPI-HKα Projects

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To detect stellar activity cycles and study the possible star-planet interactions (SPI's), we have developed both HKα and SPI-HKα projects since 1999 and 2012 respectively.

In this work, we present preliminary results of possible SPI's studying the chromospheric activity and look for possible correlations between stellar activity and stellar/planetary parameters. We find that for stars with similar T_{eff}, stellar activity increases with the mass of the planet, similar to previous works. However, stellar ages can also play a role and a larger stellar sample is needed to verify these trends. We also note that some of these stars present a remarkably high level of chromospheric activity, even comparable with RSCvn or BY Dra active stars. In addition, we do not observe any correlation between stellar activity and semi-major axis.

We present the first long-term activity study of the star ι Horologii, a young solar-type star which hosts a non-transiting Jovian planet and presents a high activity level. We analyze our own spectra, obtained between 2002 and 2015, combined with public HARPS observations. We calculate the Ca II indexes derived from the 987 CASLEO and HARPS spectra and convert them to the Mount-Wilson scale. We found a long-term activity cycle of ~ 5 years which fits the *active* sequence of Bohm-Vitense. The amplitude of this longer cycle is irregular, as was also observed for the shorter one. This fact could be attributed to an antisymmetric distribution of active regions on the stellar surface.

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Solar Abstracts

Explaining Inverted Temperature Loops in the Quiet Solar Corona with Magnetohydrodynamic Wave Mode Conversion

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Coronal loops trace out bipolar, arch-like magnetic fields above the Sun's surface. Recent measurements that combine rotational tomography, extreme ultraviolet imaging, and potential-field extrapolation have shown the existence of large loops with inverted temperature profiles; i.e., loops for which the apex temperature is a local minimum, not a maximum. These "down loops" appear to exist primarily in equatorial quiet regions near solar minimum. We simulate both these and the more prevalent large-scale "up loops" by modeling coronal heating as a time-steady superposition of: (1) dissipation of incompressible Alfvén-wave turbulence, and (2) dissipation of compressive waves formed by mode conversion from the initial population of Alfvén waves. We found that when a large percentage ($> 99\%$) of the Alfvén waves undergo this conversion, heating is greatly concentrated at the footpoints and stable "down loops" are created. In some cases we found loops with three maxima that are also gravitationally stable. Models that agree with the tomographic temperature data exhibit higher gas pressures for "down loops" than for "up loops," which is consistent with observations. These models also show a narrow range of Alfvén wave amplitudes: 3 to 6 km s^{-1} at the coronal base. This is low in comparison to typical observed amplitudes of 20 to 30 km s^{-1} in bright X-ray loops. However, the large-scale loops we model are believed to comprise a weaker diffuse background that fills much of the volume of the corona. By constraining the physics of loops that underlie quiescent streamers, we hope to better understand the formation of the slow solar wind.

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Low-Mass and Substellar Abstracts

A Multi-wavelength Characterization of Proto-brown Dwarf Candidates in Serpens

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We present results from a deep sub-millimeter survey in the Serpens Main and Serpens/G3-G6 clusters, conducted with the Submillimetre Common-User Bolometer Array (SCUBA-2) at the James Clerk Maxwell Telescope. We have combined near- and mid-infrared spectroscopy, *Herschel* PACS far-infrared photometry, sub-millimeter continuum and molecular gas line observations, with the aim to conduct a detailed multi-wavelength characterization of 'proto-brown dwarf' candidates in Serpens. We have performed continuum and line radiative transfer modeling, and have considered various classification schemes to understand the structure and the evolutionary stage of the system. We have identified four proto-brown dwarf candidates, of which the lowest luminosity source has an $L_{\rm bol}$ ~0.05 $L_{\odot}$. Two of these candidates show characteristics consistent with Stage 0/I systems, while the other two are Stage I-T/Class Flat systems with tenuous envelopes. Our work has also revealed a ~20% fraction of mis-identified Class 0/I/Flat sources that show characteristics consistent with Class II edge-on disk systems. We have set constraints on the mass of the central object using the measured bolometric luminosities and numerical simulations of stellar evolution. Considering the available gas+dust mass reservoir and the current mass of the central source, three of these candidates are likely to evolve into brown dwarfs.

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Announcement

ExoMol Database Update

Submitted by: Jonathan Tennyson, University College London

The ExoMol project provides extensive molecule line lists (lists of transition frequencies and associated Einstein A coefficients) for use in studies of exoplanet and other hot atmospheres. The ExoMol database, which is hosted at www.exomol.com, has undergone a major upgrade providing both more comprehensive sets of data, ie more molecules, and a richer set of data, ie more features. The newly implemented data structure augments the provision of energy levels (and hence transition frequencies) and Einstein A coefficients with other key properties, including pressure-broadening parameters, lifetimes of individual states, temperature-dependent cooling functions, Land?? g-factors, partition functions, cross sections, k-coefficients and transition dipoles with phase relations. Particular attention has been paid to the treatment of pressure broadening parameters. The new data structure includes a definition file which provides the necessary information for utilities accessing ExoMol through its application programming interface (API). This new upgrade is fully documented in a recently published article (Tennyson et al, 2016, J. Molec. Spectrosc., 327, 73 or ArXiv/1603.05890). We welcome comments, feedback and suggestions for improvements and new molecules.

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Upcoming Meeting

The Third Workshop on Extremely Precise Radial Velocities (EPRV III)

14 - 17 August 2017

The Pennsylvania State University, University Park, PA

Dear Colleagues:

This workshop is for teams around the world to share techniques for advancing precise radial velocity work towards 10 cm/s precision in coming years. Building on the success of the first two workshops at Penn State in 2010 and Yale in 2015, the focus on this workshop will be on the performance of the next generation of precise Doppler instruments, including hardware, statistical techniques for signal extraction and interpretation, and stellar jitter modeling and mitigation.

Please send questions or inquiries to Dr. Jason Wright at: jtw13@psu.edu.

Job Opening

Ph.D. Positions

Solar System Science

Univ. of Göttingen (Germany)

Call for Applications IMPRS PhD Positions in Solar System Science in Göttingen, Germany
Deadline: November 15, 2016
Web site: https://www.mps.mpg.de/phd/applynow

Dear Colleagues:

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

The IMPRS for Solar System Science 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 Göttingen. 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 Göttingen 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 Göttingen Campus. Successful applicants will be offered a three-year doctoral support contract as well as postdoc 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, 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 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 2016 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.***