COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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TABLE OF CONTENTS

Coolnews on the Web

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Stellar Abstracts

Accretion of Planetary Matter and the Lithium Problem in the 16 Cygni Stellar System

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The 16 Cygni system is composed of two solar analogs with similar masses and ages. A red dwarf is in orbit around 16 Cygni A whereas 16 Cygni B hosts a giant planet. The abundances of heavy elements are similar in the two stars but lithium is much more depleted in 16 Cygni B that in 16 Cygni A, by a factor of at least 4.7. The interest of studying the 16 Cygni system is that the two star have the same age and the same initial composition. The presently observed differences must be due to their different evolution, related to the fact that one of them hosts a planet contrary to the other one. We computed models of the two stars which precisely fit the observed seismic frequencies. We used the Toulouse Geneva Evolution Code (TGEC) that includes complete atomic diffusion (including radiative accelerations). We compared the predicted surface abundances with the spectroscopic observations and confirmed that another mixing process is needed. We then included the effect of accretion-induced fingering convection. The accretion of planetary matter does not change the metal abundances but leads to lithium destruction which depends on the accreted mass. A fraction of earth mass is enough to explain the lithium surface abundances of 16 Cygni B. We also checked the beryllium abundances. In the case of accretion of heavy matter onto stellar surfaces, the accreted heavy elements do not remain in the outer convective zones but they are mixed downwards by fingering convection induced by the unstable μ-gradient. Depending on the accreted mass, this mixing process may transport lithium down to its nuclear destruction layers and lead to an extra lithium depletion at the surface. A fraction of earth mass is enough to explain

a lithium ratio of 4.7 in the 16 Cygni system. In this case beryllium is not destroyed. Such a process may be frequent in planet host stars and should be studied in other cases in the future.

Submitted to A&A

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Chemical Evolution of the Inner 2 degrees of the Milky Way Bulge: [α/Fe] Trends and Metallicity Gradients

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The structure, formation, and evolution of the Milky Way bulge is a matter of debate. Important diagnostics for discriminating between models of bulge formation and evolution include α-abundance trends with metallicity, and spatial abundance and metallicity gradients. Due to the severe optical extinction in the inner Bulge region, only a few detailed investigations have been performed of this region. Here we aim at investigating the inner 2 degrees of the Bulge (projected galactocentric distance of approximately 300 pc), rarely investigated before, by observing the [α/Fe] element trends versus metallicity, and by trying to derive the metallicity gradient in the $b < 2°$ region. [α/Fe] and metallicities have been determined by spectral synthesis of 2 μm spectra of 28 M-giants in the Bulge, lying along the Southern minor axis at $(l, b) = (0, 0)$, $(0, -1°)$, and $(0, -2°)$. These were observed with the CRIRES spectrometer at the *Very Large Telescope, VLT* at high spectral resolution. Low-resolution K-band spectra, observed with the ISAAC spectrometer at the *VLT*, are used to determine the effective temperature of the stars. We present the first connection between the Galactic Center and the Bulge using similar stars, high spectral resolution, and analysis techniques. The [α/Fe] trends in all our three fields show a large similarity among each other and with trends further out in the Bulge. All point to a rapid star-formation episode in the Bulge. We find that there is a lack of an [α/Fe] gradient in the Bulge all the way into the centre, suggesting a homogeneous Bulge when it comes to the enrichment process and star-formation history. We find a large range of metallicities from $-1.2 <$ [Fe/H] $< +0.3$, with a lower dispersion in the Galactic center: $-0.2 <$ [Fe/H] $< +0.3$. The derived metallicities of the stars in the three fields get, in the mean, progressively higher the closer to the Galactic plane they lie. We could interpret this as a continuation of the metallicity gradient established further out in the Bulge, but due to the low number of stars and possible selection effects, more data of the same sort as presented here is necessary to conclude on the inner metallicity gradient from our data alone. Our results firmly argue for the center being in the context of the Bulge rather than very distinct.

Accepted by AJ

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Measuring the Vertical Age Structure of the Galactic Disc Using Asteroseismology and SAGA

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The existence of a vertical age gradient in the Milky Way disc has been indirectly known for long. Here, we measure it directly for the first time with seismic ages, using red giants observed by *Kepler*. We use Strömgren photometry to gauge the selection function of asteroseismic targets, and derive colour and magnitude limits where giants with measured oscillations are representative of the underlying population in the field. Limits in the 2MASS system are also derived. We lay out a method to assess and correct for target selection effects independent of Galaxy models. We find that low mass, i.e. old red giants dominate at increasing Galactic heights, whereas closer to the Galactic plane they exhibit a wide range of ages and metallicities. Parametrizing this as a vertical gradient returns approximately $4\,\mathrm{Gyr\ kpc}^{-1}$ for the disc we probe, although with a large dispersion of ages at all heights. The ages of stars show a smooth distribution over the last $\simeq 10\,\mathrm{Gyr}$, consistent with a mostly quiescent evolution for the Milky Way disc since a redshift of about 2. We also find a flat age-metallicity relation for disc stars. Finally, we show how to use secondary clump stars to estimate the present-day intrinsic metallicity spread, and suggest using their number count as a new proxy for tracing the aging of the disc. This work highlights the power of asteroseismology for Galactic studies; however, we also emphasize the need for better constraints on stellar mass-loss, which is a major source of systematic age uncertainties in red giant stars.

Accepted by MNRAS

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For preprints via WWW: http://arxiv.org/abs/1510.01376
SAGA website: http://www.mso.anu.edu.au/saga

The Visual Binary AG Tri in β Pictoris Association: Can a Debris Disc Cause Very Different Rotation Periods of its Components?

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We measure the photometric rotation periods of the components of multiple systems in young stellar associations to investigate the causes of the observed rotation period dispersion. We present the case of the wide binary AG Tri in the 23-Myr young β Pictoris Association consisting of K4 + M1 dwarfs. Our multi-band, multi-season photometric monitoring allowed us to measure the rotation periods of both components $\mathrm{P_A} = 12.4\,\mathrm{d}$ and $\mathrm{P_B} = 4.66\,\mathrm{d}$, to detect a prominent magnetic activity in the photosphere, likely responsible for the measured radial velocity variations, and for the first time, a flare event on the M1 component AG Tri B. We investigate either the possibility that the faster rotating component may have suffered an enhanced primordial disc dispersal, starting its PMS spin-up earlier than the slower rotating component, or the possibility that the formation of a debris disc may have prevented AG Tri A from gaining part of the angular momentum from the accreting disc.

Accepted by Astrophysics and Space Science

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Gaia FGK Benchmark Stars: Effective Temperatures and Surface Gravities

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In the era of large Galactic stellar surveys, carefully calibrating and validating the data sets has become an important and integral part of the data analysis. We focus on cool stars and aim at establishing a sample of 34 Gaia FGK Benchmark Stars with a range of different metallicities. The goal was to determine the effective temperature and the surface gravity independently from spectroscopy and atmospheric models as far as possible. Fundamental determinations of $T_{\rm eff}$ and $\log g$ were obtained in a systematic way from a compilation of angular diameter measurements and bolometric fluxes, and from a homogeneous mass determination based on stellar evolution models. The derived parameters were compared to recent spectroscopic and photometric determinations and to gravity estimates based on seismic data. Most of the adopted diameter measurements have formal uncertainties around 1%, which translate into uncertainties in effective temperature of 0.5%. The measurements of bolometric flux seem to be accurate to 5% or better, which contributes about 1% or less to the uncertainties in effective temperature. The comparisons of parameter determinations with the literature in general show good agreements with a few exceptions, most notably for the coolest stars and for metal-poor stars. The sample consists of 29 FGK-type stars and 5 M giants. Among the FGK stars, 21 have reliable parameters suitable for testing, validation, or calibration purposes. For four stars, future adjustments of the fundamental $T_{\rm eff}$ are required, and for five stars the $\log g$ determination needs to be improved. Future extensions of the sample of Gaia FGK Benchmark Stars are required to fill gaps in parameter space, and we include a list of suggested candidates.

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Consistent Metallicity Scale for Cool Dwarfs and Giants. A Benchmark Test Using the Hyades

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In several instances chemical abundances of dwarf and giant stars are used simultaneously under the assumption that they share the same abundance scale. This assumption might have implications in different astrophysical contexts. We aim to ascertain a methodology capable of producing a consistent metallicity scale for giants and dwarfs. To achieve that, we analyzed giants and dwarfs in the Hyades open cluster. All these stars have archival high-resolution spectroscopic data obtained with HARPS and UVES. In addition, the giants have interferometric measurements of the angular diameters. We analyzed the sample with two methods. The first method constrains the atmospheric parameters independently from spectroscopy. For that we present a novel calibration of microturbulence based on 3D model atmospheres. The second method is the classical spectroscopic based on Fe lines. We also tested two line lists in an attempt to minimize possible non-LTE effects and to optimize the treatment of the giants. We show that it is possible to obtain a consistent metallicity scale between dwarfs and giants. The preferred method should constrain the three parameters $T_{\rm eff}$, $\log\ g$, and ξ independent of spectroscopy. In particular, the lines should be chosen to be free of blends in the spectra of giants. When attention is paid to the line list, the classical spectroscopic method can also produce consistent results. The metallicities derived with the well-constrained set of stellar parameters are consistent independent of the line list used. Therefore, for this cluster we favor the metallicity of $+0.18 \pm 0.03$ dex obtained with this method. The classical spectroscopic analysis, using the line list optimized for the giants, provides a metallicity of $+0.14 \pm 0.03$ dex, in agreement with previous works.

Accepted by A&A

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For preprints via WWW: http://arxiv.org/abs/1509.07725

Metallicity Determination of M Dwarfs - High-Resolution IR Spectroscopy

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Several new techniques to determine the metallicity of M dwarfs with better precision and accuracy have been developed over the last decades. However, most of these studies were based on empirical methods. In order to enable detailed abundance analysis, standard methods established for warmer solar-like stars, i.e. model-dependent methods using fitting of synthetic spectra, still need to be used.

In this work we continue the reliability confirmation and development of metallicity determinations of M dwarfs using high-resolution infrared spectra. The reliability was confirmed though analysis of M dwarfs in four binary systems with FGK dwarf companions. The metallicity determination was based on spectra taken in the J band (1.1-1.4 μm) with the CRIRES spectrograph. In this part of the infrared, the density of stellar molecular lines is limited, reducing the amount of blends with atomic lines enabling an accurate continuum placement. Lines of several atomic species were used to determine the stellar metallicity.

All binaries show excellent agreement between the derived metallicity of the M dwarf and its binary companion, confirming that a reliable metallicity determination of M dwarfs can be achieved using high-resolution infrared spectroscopy. Our results are also in good agreement with values found in the literature. We note that metallicites obtained with photometric metallicity calibrations available for M dwarfs only partly agree with the results we obtain from high-resolution spectroscopy. Furthermore, we propose an alternative way to determine the effective temperature of M dwarfs of spectral types later than M2 through synthetic spectral fitting of the FeH lines in our observed spectra.

Accepted by A&A

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Solar Abstracts

Temporal Evolution of Multiple Evaporating Ribbon Sources in a Solar Flare

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We present new results from the Interface Region Imaging Spectrograph (IRIS) showing the dynamic evolution of chromospheric evaporation and condensation in a flare ribbon, with the highest temporal and spatial resolution to date. IRIS observed the entire impulsive phase of the X-class flare SOL2014-09-10T17:45 using a 9.4 s cadence "sit-and-stare" mode. As the ribbon brightened successively at new positions along the slit, a unique impulsive phase evolution was observed for many tens of individual pixels in both coronal and chromospheric lines. Each activation of a new footpoint displays the same initial coronal upflows of up to $\sim$300 km s^{-1} and chromospheric downflows up to 40 km s^{-1}. Although the coronal flows can be delayed by over 1 minute with respect to those in the chromosphere, the temporal evolution of flows is strikingly similar between all pixels and consistent with predictions from hydrodynamic flare models. Given the large sample of independent footpoints, we conclude that each flaring pixel can be considered a prototypical, "elementary" flare kernel.

Published in ApJ

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For preprints via WWW: http://adsabs.harvard.edu/abs/2015ApJ...807L..22G

The IAG Solar Flux Atlas: Accurate Wavelengths and Absolute Convective Blueshift in Standard Solar Spectra

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We present a new solar flux atlas with the aim to understand wavelength precision and accuracy in solar benchmark data. The atlas covers the wavelength range 405–2300 nm and was observed at the Institut für Astrophysik, Göttingen (IAG) with a Fourier Transform Spectrograph. In contrast to other FTS atlases, the entire visible wavelength range was observed simultaneously using only one spectrograph setting. We compare the wavelength solution of the new atlas to the Kitt Peak solar flux atlases and to the HARPS frequency-comb calibrated solar atlas. Comparison reveals systematics in the two Kitt Peak FTS atlases resulting from their wavelength scale construction, and shows consistency between the IAG and the HARPS atlas. We conclude that the IAG atlas is precise and accurate on the order of $\pm 10\,\mathrm{m\,s^{-1}}$ in the wavelength range 405–1065 nm while the Kitt Peak atlases show deviations as large as several ten to $100\,\mathrm{m\,s^{-1}}$. We determine absolute convective blueshift across the spectrum from the IAG atlas and report slight differences relative to results from the Kitt Peak atlas that we attribute to the differences between wavelength scales. We conclude that benchmark solar data with accurate wavelength solution are crucial to better understand the effect of convection on stellar RV measurements, which is one of the main limitations of Doppler spectroscopy at $\mathrm{m\,s^{-1}}$ precision.

Accepted by A&A

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For preprints via WWW: http://adsabs.harvard.edu/abs/2015arXiv151103014R

Upcoming Meeting

Space Climate School and Space Climate 6 Symposium

30 Mar. - 3 Apr. 2016 (School); 4 - 7 Apr. 2016 (Symposium)

Levi, Finland

FIRST ANNOUNCEMENT

Dear Colleagues and Friends!

We have the great pleasure to invite you to the *Space Climate School and Space Climate 6 Symposium* to be held in Levi, Finnish Lapland. The School will take place from 30 March to 3 April, 2016, and the Symposium in 4 - 7 April, 2016.

Space Climate is an active and topical field of research of space physics, which studies the long-term variations of solar activity and its effects in the heliosphere and near-Earth environment, including atmosphere and climate. Space Climate 6 Symposium brings together leading experts on the field with the objective, e.g., to better understand sunspots and the other forms of solar activity (flares, coronal mass ejections, coronal holes, high-speed solar wind streams etc.) during the last few centuries. One important aspect is to better understand the various datasets used for space climate studies. Space Climate School is concentrated on different long-term datasets available for space climate studies and their analysis using, e.g., pattern recognition, statistical and other methods relevant to large data bases. These topics are important for space climate research, which utilizes long, often inhomogeneous measurement series of, e.g., solar, solar wind, geomagnetic and climate observations. School lecturers are internationally recognized scientists with broad teaching experience. Space Climate School offers, to students and young scientists, a unique opportunity to learn important aspects of Space Climate science.

SCIENTIFIC ORGANIZING COMMITTEE:

Axel Brandenburg, Paul Charbonneau, Ed Cliver, Marius Echim, Katya Georgieva, Sarah Gibson, Nat Gopalswamy, Maarit Kpyl, Dan Marsh, Kalevi Mursula (chair), Dibyendu Nandi, Alexei Pevtsov, Alexis Rouillard, Alexander Ruzmaikin, Eija Tanskanen, Andrei Tlatov, Ilya Usoskin (vice-chair), Mirela Voiculescu, Bertalan Zieger

LOCAL ORGANIZING COMMITTEE Timo Asikainen (chair), Lauri Holappa, Jennimari Koskela, Kalevi Mursula, Timo Qvick, Ilya Usoskin, Ilpo Virtanen (vice-chair), Iiro Virtanen, Pauli Visnen, Liyun Zhang.

Further details on abstract submission, registration, and accommodation will be available soon at the meeting website http://www.spaceclimate.fi/

For questions, contact: spaceclimate@spaceclimate.fi

Welcome to Space Climate School and Space Climate Symposium in Levi!

Sincerely Yours,

Kalevi Mursula (SOC chair), Timo Asikainen (LOC chair), Ilya Usoskin (SOC vice-chair), Ilpo Virtanen (LOC vice-chair)

Ph.D. Student Position

High-resolution Infrared Stellar Spectroscopy

Lund University (Sweden)

Research in stellar spectroscopy has a long tradition in Sweden and has recently been fueled by and benefitted from a rapid development of telescopes and in instrumentation. The research group at Lund Observatory regularly uses the largest telescopes around the world, such as the American Keck, Gemini N & S, KPNO, IRTF, and McDonald Observatory telescopes and the European VLT and NOT telescopes.

The funding of the Ph.D. position is based on a Swedish research council grant in the field of galaxy formation and evolution: *The Origin of the Milky Way and its Bulge: Spectroscopic Investigations of Stellar Populations in the Galactic Centre Region*. The Ph.D. student will preferably work within this project, which already has been very successful in acquiring a wealth of data, under tough competition.

Job assignment:

The Ph.D. student will work on projects including the development of methodology in the field of high-resolution optical/infrared spectroscopy of stars. The research activity will consist of the collection, analysis and interpretation of observational data, and the modeling of these. Furthermore, theoretical investigations needed for the interpretations will be encouraged. The suggested main research project deals with analyzing the chemical content of red giant stars in order to investigate the origin and evolution of the huge, central structure of the Milky Way, the Bulge. Usage of world-leading observatories and collaboration in an international network is anticipated. Knowledge of stellar atmospheres, radiation transport, and stellar spectroscopy is a merit.

Eligibility/Entry requirements:

The grant is open to students of all nationalities who, at the time of starting the Ph.D. studies, have obtained a Masters degree in astronomy, physics, or engineering physics, or in other ways obtained the equivalent qualifications. In case of uncertainty concerning the applicant's eligibility, it is advisable to contact the department for clarification. The discipline curriculum for postgraduate studies in Astronomy and astrophysics is found at:
http://www.science.lu.se/sites/science.lu.se/files/syllabi_astronomy.pdf. Goodknowledge in spoken and written English is required. For more information on our Ph.D. programme, see http://www.astro.lu.se/Education/FU/.

Contact: Nils Ryde, Senior university lecturer, +4646-2221574; email: ryde@astro.lu.se

Reference number PA2015/2770

Closing date: December 2, 2015

Starting date: Summer 2016

Apply Online: https://lu.mynetworkglobal.com/en/what:job/jobID:74381/

Job Opening

Ph.D. Student Positions

International Max Planck Research School for Solar System Science

University of Göttingen (Germany)

Dear Colleagues:

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, Solar and Stellar Interiors and Planets and Comets. 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 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 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 (or a scientific publication), and must document a good command of the English language.

*** Applications may be submitted via our online application portal.***

*** Review of applications will begin on **15 November 2015**. ***

To start your application, please see the following pages:

Solar System School http://www.solar-system-school.de
Call for Applications https://www.mps.mpg.de/phd/applynow
Open PhD Projects https://www.mps.mpg.de/phd/openprojects
Online Application 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.***