COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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Stellar Abstracts

Energy Flux Determines Magnetic Field Strength of Planets and Stars

U.R. Christensen[1]**, V. Holzwarth**[1] **and A. Reiners**[2]

[1] Max-Planck-Institut für Sonnensystemforschung, Max Planck Strasse 2, 37191 Katlenburg-Lindau, Germany
[2] Institut für Astrophysik, Universität Göttingen, Friedrich Hund Platz 1, 37077 Göttingen, Germany

The magnetic fields of Earth and Jupiter, along with those of rapidly rotating, low-mass stars, are generated by convection-driven dynamos that may operate similarly (the slowly rotating Sun generates its field through a different dynamo mechanism). The field strengths of planets and stars vary over three orders of magnitude, but the critical factor causing that variation has hitherto been unclear. Here we report an extension of a scaling law derived from geodynamo models to rapidly rotating stars that have strong density stratification. The unifying principle in the scaling law is that the energy flux available for generating the magnetic field sets the field strength. Our scaling law fits the observed field strengths of Earth, Jupiter, young contracting stars and rapidly rotating low-mass stars, despite vast differences in the physical conditions of the objects. We predict that the field strengths of rapidly rotating brown dwarfs and massive extrasolar planets are high enough to make them observable.

Atomic Diffusion and Mixing in Old Stars II: Observations of Stars in the Globular Cluster NGC 6397 with VLT/FLAMES-GIRAFFE

K. Lind [1,2], A. J. Korn[1], P. S. Barklem[1] and F. Grundahl[3]

[1] Department of Physics & Astronomy, Uppsala University, Box 515, 751 20 Uppsala, Sweden
[2] European Southern Observatory (ESO), Karl-Schwarzschild-Strasse 2, 857 48 Garching bei München, Germany
[3] Department of Physics & Astronomy, University of Aarhus, Ny Munkegade, 8000 Aarhus C, Denmark

Evolutionary trends in the surface abundances of heavier elements have recently been identified in the globular cluster NGC 6397 ([Fe/H]$= -2$), indicating the operation of atomic diffusion in these stars. Such trends constitute important constraints for the extent to which diffusion modifies the internal structure and surface abundances of solar-type, metal-poor stars. We perform an independent check of the reality and size of abundance variations within this metal-poor globular cluster. Observational data covering a large stellar sample, located between the cluster turn-off point and the base of the red giant branch, are homogeneously analysed. The spectroscopic data were obtained with the medium-high resolution spectrograph FLAMES/GIRAFFE on VLT-UT2 ($R \sim 27\,000$). We derive independent effective-temperature scales from profile fitting of Balmer lines and by applying colour-$T_{\rm eff}$ calibrations to Strömgren $uvby$ and broad-band BVI photometry. An automated spectral analysis code is used together with a grid of MARCS model atmospheres to derive stellar surface abundances of Mg, Ca, Ti, and Fe. We identify systematically higher iron abundances for more evolved stars. The turn-off point stars are found to have 0.13 dex lower surface abundances of iron compared to the coolest, most evolved stars in our sample. There is a strong indication of a similar trend in magnesium, whereas calcium and titanium abundances are more homogeneous. Within reasonable error limits, the obtained abundance trends are in agreement with the predictions of stellar structure models including diffusive processes (sedimentation, levitation), if additional turbulent mixing below the outer convection zone is included.

Long-term Chromospheric Activity of Non-Eclipsing RS CVn-type Stars

Andrea P. Buccino[1] and Pablo J. D. Mauas[1]

[1] Instituto de Astronomía y Física del Espacio (CONICET), C.C. 67 Sucursal 28, 1428-Buenos Aires Argentina

The IUE database provides a large number of UV high and low-resolution spectra of RS CVn-type stars from 1978 to 1996. In particular, many of these stars were monitored continuously during several seasons by IUE. Our main purpose is to study the short and long-term chromospheric activity of the RS CVn systems most observed by IUE: HD 22468 (V711 Tau, HR 1099, K1IV+G5V), HD 21242 (UX Ari, K0IV+G5V) and HD 224085 (II Peg, K2IV).We first obtain the Mount Wilson index S from the IUE high and low-resolution spectra. Secondly, we analyse with the Lomb-Scargle periodogram the mean annual index $\langle S \rangle$ and the amplitude of the rotational modulation of the index S.For HD 22468 (V711 Tau, HR 1099), we found a possible chromospheric cycle with a period of $\sim$18 years and a shorter cycle with a period of $\sim$3 years, which could be associated to a chromospheric "flip-flop" cycle. The data of HD 224085 (II Peg) also suggest a chromospheric cycle of $\sim$21 years and a flip-flop cycle of $\sim$9 years. Finally, we obtained a possible chromospheric cycle of $\sim$7 years for HD 21242 (UX Ari). Accepted by A&A

Multiwavelength Optical Observations of Two Chromospherically Active Binary Systems: V789 Mon and GZ Leo

M.C. Gálvez[1,2], D. Montes[1], M.J. Fernández-Figueroa[1], E. De Castro[1] and M. Cornide[1]

[1] Centre for Astrophysics Research, Science and Technology Research Institute, University of Hertfordshire, Hatfield AL10 9AB, UK
[2] Departamento de Astrofísica y Ciencias de la Atmósfera, Facultad de Físicas, Universidad Complutense de Madrid, E-28040 Madrid, Spain
This paper describes a multiwavelengh optical study of chromospheres in two X-ray/EUV selected active binary stars with strong Hα emission, V789 Mon (2RE J0725-002) and GZ Leo (2RE J1101+223). The

goal of the study is to determine radial velocities and fundamental stellar parameters in chromospherically active binary systems in order to include them in the activity-rotation and activity-age relations. We carried out high resolution echelle spectroscopic observations and applied spectral subtraction technique in order to measure emission excesses due to chromosphere. The detailed study of activity indicators allowed us to characterize the presence of different chromospheric features in these systems and enabled to include them in a larger activity-rotation survey. We computed radial velocities of the systems using cross correlation with the radial velocity standards. The double-line spectral binarity was confirmed and the orbital solutions improved for both systems. In addition, other stellar parameters such as: spectral types, projected rotational velocities ($v \sin i$), and the equivalent width of the lithium Li I $\lambda6707.8$ Å absorption line were determined. *Accepted by AJ* *For preprints contact*: mcz@astrax.fis.ucm.es *For preprints via ftp or WWW*: http://www.ucm.es/info/Astrof/invest/actividad/actividad_pub.html

Accuracy of Effective Temperatures of Stars Through Intercomparison of Catalogues

V. Malyuto[1], T. Shvelidze[2]

[1] Tartu Observatory, 61062, Tartumaa, Toravere, Estonia
[2] Abastumani Astrophysical Observatory, Kazbegi av. 2a, 0160, Tbilisi, Georgia

A technique of estimating the accuracy of catalogs of stellar physical parameters developed earlier at the Tartu Observatory is described in detail. The technique is applied to a set of selected stellar catalogs of effective temperatures. The external errors of the sets are estimated with the aim to use them in future in producing a homogenized catalog of merged data.

For preprints contact: valeri@aai.ee

Spectroscopic Binaries Among Hipparcos M giants
I. Data, Orbits, and Intrinsic Variations

B. Famaey[1], D. Pourbaix[1], A. Frankowski[1,2], S. Van Eck[1], M. Mayor[3], S. Udry[3] and A. Jorissen[1]

[1] Institut d'Astronomie et d'Astrophysique, Université libre de Bruxelles, Faculté des Sciences, CP. 226, Boulevard du Triomphe, B-1050 Bruxelles, Belgium
[2] Department of Physics, Technion-Israel Institute of Technology, Haifa 32000, Israel
[3] Observatoire de Genève, Université de Genève, CH-1290 Sauverny, Switzerland

This paper is a follow-up of the vast effort to collect radial velocity data for stars belonging to the Hipparcos survey. We aim at extending the orbital data available for binaries with M giant primaries. The data will be used in the companion papers of this series to (i) derive the binary frequency among M giants and compare it to that of K giants (Paper II), and (ii) analyse the eccentricity-period diagram and the mass-function distribution (Paper III). Keplerian solutions are fitted to radial-velocity data. However, for several stars, no satisfactory solution could be found, despite the fact that the radial-velocity standard deviation is larger than the instrumental error, because M giants suffer from intrinsic radial-velocity variations due to pulsations. We show that these intrinsic radial-velocity variations can be linked with both the average spectral-line width and the photometric variability. We present an extensive collection of spectroscopic orbits for M giants, with 12 new orbits, plus 17 from the literature. Moreover, to illustrate the fact that the large radial-velocity jitter present in Mira and semi-regular variables may easily be confused with orbital variations, we also present examples of pseudo-orbital variations (in S UMa, X Cnc and possibly in HD 115521, a former IAU radial-velocity standard). Because of this difficulty, M giants involving Mira variables were excluded from our monitored sample. We finally show that the majority of M giants detected as X-ray sources are actually binaries.

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For preprints via ftp or WWW: http://www.astro.ulb.ac.be/Html/ps.html#Binaries

Spectroscopic Binaries Among Hipparcos M Giants
II. Binary Frequency

A. Frankowski[1,2], B. Famaey[1], S. Van Eck[1],M. Mayor[3], S. Udry[3] and A. Jorissen[1]

[1] Institut d'Astronomie et d'Astrophysique, Université libre de Bruxelles, Faculté des Sciences, CP. 226, Boulevard du Triomphe, B-1050 Bruxelles, Belgium
[2] Department of Physics, Technion-Israel Institute of Technology, Haifa 32000, Israel
[3] Observatoire de Genève, Université de Genève, CH-1290 Sauverny, Switzerland

This paper is the second one in a series devoted to the study of properties of binaries involving M giants. The binary frequency of field M giants is derived and compared with the binary fraction of K giants. Diagrams of the CORAVEL spectroscopic parameter Sb (measuring the average line-width) vs. radial-velocity standard deviation for our samples are used to define appropriate binarity criteria. These then serve to extract the binarity fraction among the M giants. Comparison is made to earlier data on K giants binarity frequency. The Sb parameter is discussed in relation to global stellar parameters and the Sb vs. stellar radius relation is used to identify fast rotators. We find that the spectroscopic binary detection rate among field M giants, in a sample with a low number of velocity measurements (2), unbiased toward earlier known binaries, is 6.3%. This is less than half of the analogous rate for field K giants, likely resulting from a real difference. This difference originates in the greater difficulty of finding binaries among M giants because of their smaller orbital velocity amplitudes and larger intrinsic jitter and in the different distributions of K and M giants in the eccentricity-period diagram. A larger detection rate was obtained in a smaller M giant sample with more radial velocity measurements per object: 11.1% confirmed plus 2.7% possible binaries. The CORAVEL spectroscopic parameter Sb was found to correlate better with the stellar radius than with either luminosity or effective temperature separately. Two outliers of the Sb vs. stellar radius relation, HD 190658 and HD 219654, have been recognized as fast rotators. The rotation is companion-induced, as both objects turn out to be spectroscopic binaries.

Spectroscopic Binaries Among Hipparcos M Giants
III. The Eccentricity-Period Diagram and Mass-Transfer Signatures

A. Jorissen[1], A. Frankowski[1,2], B. Famaey[1] and S. Van Eck[1]

[1] Institut d'Astronomie et d'Astrophysique, Université libre de Bruxelles, Faculté des Sciences, CP. 226, Boulevard du Triomphe, B-1050 Bruxelles, Belgium
[2] Department of Physics, Technion-Israel Institute of Technology, Haifa 32000, Israel

This paper is the third one in a series devoted to studying the properties of binaries involving M giants. We use a new set of orbits to construct the first (e-logP) diagram of an extensive sample of M giant binaries, to obtain their mass-function distribution, and to derive evolutionary constraints for this class of binaries and related systems. The orbital properties of binaries involving M giants were analysed and compared with those of related families of binaries (K giants, post-AGB stars, barium stars, Tc-poor S stars). The orbital elements of post-AGB stars and M giants are not different, which may very indicate that, for the considered sample of post-AGB binaries, the post-AGB star left the AGB at quite an early stage (M4 or so). Neither are the orbital elements of post-mass-transfer binaries like barium stars very different from those of M giants, suggesting that the mass transfer did not alter the orbital elements much, contrary to current belief. Finally, we show that binary systems with $e < 0.4 \log P - 1$ (with periods expressed in days) are predominantly post-mass-transfer systems, because (i) the vast majority of barium and S systems match this condition, and (ii) these systems have companion masses peaking around 0.6 solar mass, as expected for white dwarfs. The latter property has been shown to hold as well for open-cluster binaries involving K giants, for which a lower bound on the companion mass may easily be set.

General Magnetic Field of the Sun as a Star as Indicator of Massive Streams Flowing on the Sun

S. Plachinda[1], D. Baklanova[1], I. Han[2], K.-M. Kim[2], P. Reegen[3], G. Valyavin[2], W. Weiss[3]

[1] Crimean Astrophysical Observatory, Nauchny, Crimea, 98409, Ukraine
[2] Korea Astronomy and Space Science Institute, 36-1 Whaam-dong, Yuseong, Daejeon, Korea 305-348
[3] Institut fur Astronomie, Turkenschanzstrasse 17, 1180 Vienna, Austria

The behaviour of the General Magnetic Field of the Sun as a Star (GMFSS) is characterized by the change of amplitude of oscillations with the eleven-year cycle of activity. In maximum of activity, GMFSS reaches its maximal values, and in a minimum it reaches minimal values. The values of active frequencies vary from cycle to cycle of sunspot activity. Each peak of the GMFSS power spectrum is widened by the number of active frequencies. From observations of GMFSS, the velocity of solar photosphere movements deviates from the speed of the differential rotation of the Sun more than 5 ms^{-1} as it follows from gelioseismology. For 40 years of direct observations (two solar magnetic cycles), the resulting magnetic field of GMFSS is not equal to zero. GMFSS demonstrates properties of a real large-scale field.

For preprints contact: plach@crao.crimea.ua

Geometrical Properties of Avalanches in a Pseudo-3D Coronal Loop Laura F. Morales[1] and Paul Charbonneau[1]

[1] Univ. of Montreal, Montreal, Canada

We investigate the geometrical properties of energy release of synthetic coronal loops constructed using a recently published self-organized critical avalanche model of solar flares. The model is based on an idealized representation of a coronal loop as a bundle of closely-packed magnetic flux strands wrapping around one another in response to photospheric fluid motions, much as in Parker's nanoflare model. Simulations were performed with a 2D-cellular automaton that satisfies the constraints $\nabla \cdot \mathbf{B} = 0$ by design. We transform the avalanching nodes produced by simulations into synthetic flare images by converting the 2D lattice into a bent cylindrical loop that is projected onto the plane of the sky. We then studied the statistical properties of avalanches peak snapshots and time-integrated avalanches occurring in these synthetic coronal loops. We found that the frequency distribution of avalanche peak areas A assumes a power-law form $f(A) \propto A^{-\alpha_A}$ with an index $\alpha_A \simeq 2.37$, in excellent agreement with observationally-inferred values and reducing error bars from previous works. We also measured the area fractal dimension D of avalanches produced by our simulations using the box counting method, which yields $1.17 \leq D \leq 1.24$, a result falling nicely within the range of observational determinations. Submitted to ApJ *For preprints contact*:laura@astro.umontreal.ca

Habitability of Super-Earth Planets Around Other Suns: Models Including Red Giant Branch Evolution

W. von Bloh[1], M. Cuntz[2], K.-P. Schröder[3], C. Bounama[1], and S. Franck[1]

[1] Potsdam Institute for Climate Impact Research, 14412 Potsdam, Germany
[2] Department of Physics, University of Texas at Arlington, Box 19059, Arlington, TX 76019, USA
[3] Department of Astronomy, University of Guanajuato, 36000 Guanajuato, GTO, Mexico

The unexpected diversity of exoplanets includes a growing number of super-Earth planets, i.e., exoplanets with masses of up to several Earth masses and a similar chemical and mineralogical composition as Earth. We present a thermal evolution model for a 10 Earth mass planet orbiting a star like the Sun. Our model is based on the integrated system approach, which describes the photosynthetic biomass production taking into account a variety of climatological, biogeochemical, and geodynamical processes. This allows us to identify a so-called photosynthesis-sustaining habitable zone (pHZ) determined by the limits of biological productivity on the planetary surface. Our model considers the solar evolution during the main-sequence stage and along the Red Giant Branch as described by the most recent solar model. We obtain a large set of solutions consistent with the principal possibility of life. The highest likelihood of habitability is found for "water worlds". Only mass-rich water worlds are able to realize pHZ-type habitability beyond the stellar main-sequence on the Red Giant Branch.

For preprints contact: cuntz@uta.edu

An Analysis of Reconnection Dynamics in an Eruptive Flare Model

Daniel B. Seaton

Thesis work conducted at: Institude for the Study of Earth, Oceans & Space, University of New Hampshire, USA

Current address: Royal Observatory of Belgium, Avenue Circulaire 3, 1180 Brussels, Belgium

E-mail: dseaton@oma.be

Ph.D dissertation directed by: Terry G. Forbes

Ph.D degree awarded: September 2008

This dissertation develops a one-dimensional, analytic model for current sheets that form during solar flares. The model uses a method developed by B. V. Somov & V. S. Titov for Petschek-type reconnection. The first part of this dissertation provides a detailed analysis of the Somov-Titov model, its assumptions, strengths and weaknesses. We consider the role of both the diffusion region and nonuniform resistivity in the generation of Petschek-type solutions.

The second part of this dissertation extends the averaging method to the dynamics of an asymmetric current sheet during a solar flare. We determine the location of the x-line and the distribution of incoming Poynting flux into upward and downward directed reconnection jets. We find that, except at the very beginning of a flare when the current sheet is most symmetric, the x-line is generally located near the lower tip of the sheet. We predict that it should be low enough in the corona to be observed by X-ray and EUV telescopes. We find that in most cases the majority of incoming flux exits the current sheet through the upward jet, in contrast to previous studies that assumed as much as 50% of the incoming flux is directed into the downward jet and flare ribbons.

In the third part, we integrate thermal conduction into the Somov-Titov framework using a slow-shock model that includes conduction, and allows us to describe the thermal halo that surrounds the current sheet because of heat flow across the current sheet boundary. We find that thermal conduction has a significant effect on the fast-mode mach number of the reconnection outflow, producing mach numbers as high as 7 for solar-flare conditions, three times greater than previously calculated. We conclude that these termination shocks are considerably more efficient at producing particle acceleration than previously thought since the efficiency of particle acceleration at shocks increases dramatically with Mach number. We compare this model with numerical simulations by T. Yokoyama & K. Shibata and find good agreement.

Announcement

Proceedings of the conference **Structure Formation in Astrophysics**, edited by Gilles Chabrier (École normale supérieure de Lyon, France) are now available on-line at:
http://assets.cambridge.org/97805218/87793/frontmatter/9780521887793_frontmatter.pdf.

The proceedings are published by Cambridge University Press (2009).

Submitted by: Gilles Chabrier (chabrier@ens-lyon.fr)

Upcoming Meeting

IAGA 11th Scientific Assembly:
New Solar and Interplanetary Results

23 - 30 August 2009

Sopron, Hungary

FIRST ANNOUNCEMENT

Dear Colleagues:

This is the First Announcement and Call for Papers for the IAGA 11th Scientific Assembly, Session IV.01: *New Solar and Interplanetary Results*, Sopron, Hungary, August 23-30, 2009. Continuous observations from solar and heliospheric missions have been advancing our knowledge of the physical and dynamical properties of the Sun and the solar wind. These observations, along with theory and models, continue to advance and pose challenges on our understanding of the responsible physical processes. This session invites contributions covering new results from observations from space and ground-based observatories, theory and modeling of different aspects of the Sun and the heliosphere, including its interior, extended atmospheres and the solar wind. This session is aimed at stimulating exchange and promoting discussion on the recent developments derived from observations and latest research in the field.

Abstract submission deadline: April 15, 2009 (online) or March 31, 2009 (post)

Deadline for application for grant: March 31, 2009 Meeting website: http://www.iaga2009sopron.hu

Convener: Yuan-Kuen Ko Naval Research laboratory Code 7674, 4555 Overlook Ave., SW, Washington DC, 20375, USA tel: +1 202 767-6199, fax: +1 202 404-7997, yko@ssd5.nrl.navy.mil

Co-convener: Michael L. Kaiser NASA Goddard Space Flight Center, Code 674, Greenbelt, MD 20771, USA Michael.Kaiser@nasa.gov

Co-convener: Takashi Sekii National Astronomical Observatory of Japan, Mitaka, Tokyo 181-8588, Japan sekii@solar.mtk.nao.ac.jp

Co-convener: Robert F. Wimmer-Schweingruber Institut fuer Experimentelle und Angewandte Physik University of Kiel, Leibnizstrasse 11, D-24118 Kiel, Germany wimmer@physik.uni-kiel.de

Recent Directions in Astrophysical Quantitative Spectroscopy and Radiation Hydrodynamics - Dimitri-Fest!

30 March - 3 April 2009

High Altitude Observatory/NCAR, Boulder, Colorado

A meeting to honor Dimitri Mihalas for his lifetime contributions to the fields of astrophysical quantitative spectroscopy and radiation hydrodynamics on the occasion of his 70th birthday. Topics will cover recent developments and future prospects in general radiative transfer theory, modeling stellar atmospheres, theory and modeling of stellar winds, and basic theory and applications of the astrophysical radiation hydrodynamics.

SOC: L.H. Auer (USA), J.I. Castor (USA), I. Hubeny (USA; Co-Chair), R.I. Klein (USA), M.L. Norman (USA), R.P. Kudritzki (USA), J.M. Stone (USA; Co-Chair), K. Werner (Germany)
LOC: K. MacGregor (chair), T. Ayres, M. Dikpati, T. Metcalfe, A. Trujillo

Topics:

1. Radiation Transport and Stellar Atmospheres (Day 1)
2. Stellar Winds (Day 2)
3. Radiation Hydrodynamics Basics (Day 3)
4. Radiation Hydrodynamics Applications (Day 4)
5. Future Prospects (Day 5)

Preliminary list of invited speakers:

E. Audit, L.H. Auer (t.b.c.), J.I. Castor (t.b.c.), K. Gayley, D.J. Hillier, P. Hoeflich, I. Hubeny, R.I. Klein (t.b.c), W. Kley, J.H. Krolik, A. Nordlund, M.L. Norman, D. Proga, S.P. Owocki (t.b.c), A. Pradhan, J. Puls (t.b.c.), J.M. Stone, K. Werner

(t.b.c. = to be confirmed)

For more information: **www.hao.ucar.edu/events/dimitri-fest/**

Space Climate: The Role of Solar and Geomagnetic Variability
AGU Geomagnetism and Paleomagnetism Session

24 - 27 May 2009

Toronto, Canada

Dear Colleagues:

We would like to call your attention to the 2009 American Geophysical Union Joint Assembly, which will be held at Metro Toronto Convention Centre, Toronto, Canada from 24 to 27 May 2009. We invite you to participate in the Geomagnetism and Paleomagnetism (GP) session, GP05 Space Climate: The Role of Solar and Geomagnetic Variability. This session focuses on discussions of Space Climate. Space Climate is an extension of Space Weather to long time scales. It is driven by solar radiative and particulate output and is strongly influenced by geomagnetic variations. We particularly solicit presentations on long-term solar and geomagnetic variations relevant to the Earth's climate.

Abstract submissions are now open for the 2009 Joint Assembly at:

http://www.agu.org/meetings/ja09/program/abstract_submissions.php

The abstract submission deadline is 4 March, 2009 at 2359 UT.

We hope to see you in Toronto.

Blanca Mendoza, Principal Convener, Universidad Nacional Autonoma de Mexico, Mexico.
Co-conveners: Kalevi Mursula, University of Oulu, Finland and Alexander Ruzmaikin, JPL ,NASA, USA.

Job Openings

JOB OPENING

Several Postdoctoral Research Positions
Astrophysics of Low-Mass and Pre-Main Sequence Stars
Institute for Astrophysics, University of Göttingen (Germany)

The Institute for Astrophysics at the Georg-August-University of Göttingen, Germany, invites applications for several postdoctoral positions.

The successful candidates will participate in research activities embedded in the Emmy Noether Group on *Magnetic Activity from Stars to Planets* and the Research Training Group on *Extrasolar Planets and their Host Stars*. Applicants should have worked on a research area closely related to these fields. Expertise in spectroscopy and photometry of pre-main sequence stars, low-mass stars, or brown dwarfs is highly desired.

The appointments will be for two years, they include funds for publications and travel. The salary will be according to the German postdoctoral standards (TV-L).
The Georg-August-Universität is an equal opportunity employer. Applications from women and minorities are particularly welcome. Applications from challenged persons will be preferred at equivalent qualification.
Candidates should send a curriculum vitae, a publication list, a description of research interests and plans. They should also arrange for at least two letters of recommendation to be sent by e-mail to areiners (at) astro.physik.uni-goettingen.de,

or directly to:

Dr. Ansgar Reiners
Georg-August-Universität
Institut für Astrophysik
Friedrich-Hund-Platz 1
D-37077 Göttingen
Tel +49 551 3913825
Fax +49 551 395043
URL: http://www.astro.physik.uni-goettingen.de/
The deadline for all material is 30 January 2009.

Please send only copies of your documents (no originals). We will not be able to send back your application and all documents will be destroyed after 3 months.

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.***