COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

No. 218 — Dec. 2018-Jan 2019 Editor: Steve Skinner (coolnews@jila.colorado.edu)

TABLE OF CONTENTS

Coolnews on the Web

The current and previous issues of *Coolnews* are available on the following web page in pdf, postscript, and Latex format: **http://casa.colorado.edu/∼skinners/coolnews.html**

Stellar Abstracts

S-Type and *P*-Type Habitability in Stellar Binary Systems: A Comprehensive Approach. III. Results for Mars, Earth, and super-Earth Planets

Zhaopeng Wang[1] and Manfred Cuntz[1]

[1] Department of Physics, University of Texas at Arlington, Arlington, TX 76019, USA

In Paper I and II, a comprehensive approach was utilized for the calculation of *S*-type and *P*-type habitable regions in stellar binary systems for both circular and elliptical orbits of the binary components. It considered a joint constraint including orbital stability and a habitable region for a possible system planet through the stellar radiative energy fluxes ("radiative habitable zone"; RHZ). Specifically, the stellar *S*-type and *P*-type RHZs are calculated based on the solution of a fourth order polynomial. However, in concurrent developments, mostly during 2013 and 2014, important improvements have been made in the computation of stellar habitable zones for single stars based on updated climate models given by R. K. Kopparapu and collaborators. These models entail considerable changes for the inner and outer limits of the stellar habitable zones. Moreover, regarding the habitability limit given by the runaway greenhouse effect, notable disparities were identified between Earth, Mars, and super-Earth planets due to differences in their atmospheric models, thus affecting their potential for habitability. It is the aim of this study to compute *S*-type and *P*-type habitable regions of binaries in response to the updated planetary models. Moreover, our study will also consider improved relationships between effective temperatures, radii, and masses for low-luminosity stars.

Accepted by ApJ

For preprints contact: cuntz@uta.edu

For preprints via WWW: https://arxiv.org/abs/1901.11171

Time-resolved Image Polarimetry of Trappist-1 During Planetary Transits

P. A. Miles-Páez[1,2], M. R. Zapatero Osorio[3], E. Pallé[4,5], and S. A. Metchev[1,6]

[1] Department of Physics & Astronomy and Centre for Planetary Science and Exploration, The University of Western Ontario, London, ON N6A 3K7, Canada
[2]Steward Observatory and Department of Astronomy, University of Arizona, 933 N. Cherry Avenue, Tucson, AZ 85721, USA
[3]Centro de Astrobiología (CSIC-INTA), Carretera de Ajalvir km 4, 28850 Torrejón de Ardoz, Madrid, Spain
[4]Instituto de Astrofísica de Canarias, Calle Vía Láctea s/n, 38205 La Laguna, Tenerife, Spain
[5]Dpt. de Astrofísica, Univ. de La Laguna, Avda. Astrofísico Francisco Sánchez s/n, 38206 La Laguna, Tenerife, Spain
[6]Department of Physics & Astronomy, Stony Brook University, Stony Brook, NY 11794–3800, USA

We obtained linear polarization photometry (J-band) and low-resolution spectroscopy (ZJ-bands) of Trappist-1, which is a planetary system formed by an M8-type low-mass star and seven temperate, Earth-sized planets. The photopolarimetric monitoring campaign covered 6.5 h of continuous observations including one full transit of planet Trappist-1d and partial transits of Trappist-1b and e. The spectrophotometric data and the photometric light curve obtained over epochs with no planetary transits indicate that the low-mass star has very low level of linear polarization compatible with a null value. However, the "in transit" observations reveal an enhanced linear polarization signal with peak values of $p^* = 0.1\,\%$ with a confidence level of 3 σ, particularly for the full transit of Trappist-1d, thus confirming that the atmosphere of the M8-type star is very likely dusty. Additional observations probing different atmospheric states of Trappist-1 are needed to confirm our findings, as the polarimetric signals involved are low. If confirmed, polarization observations of transiting planetary systems with central ultra-cool dwarfs can become a powerful tool for the characterization of the atmospheres of the host dwarfs and the validation of transiting planet candidates that cannot be corroborated by any other method.

Accepted by MNRAS Letters

For preprints contact: ppaez@uwo.ca

For preprints via WWW: https://arxiv.org/abs/1901.02041

Solar Abstracts

The Solar Wind in Time II: 3D Stellar Wind Structure and Radio Emission

D. Ó Fionnagáin[1], A. A. Vidotto[1], P. Petit[2,3], C. P. Folsom[2,3], S. V. Jeffers[4] , S. C. Marsden[5], J. Morin[6], J.-D. do Nascimento Jr.[7,8] & the BCool Collaboration

[1]School of Physics, Trinity College Dublin, College Green, Dublin 2, Ireland
[2]Université de Toulouse, UPS-OMP, Institut de Recherche en Astrophysique et Planétologie, Toulouse, France
[3]IRAP, Université de Toulouse, CNRS, UPS, CNES, 31400, Toulouse, France
[4]Universität Göttingen, Institut für Astrophysik, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany
[5]University of Southern Queensland, Centre for Astrophysics, Toowoomba, QLD, 4350, Australia
[6]Laboratoire Univers et Particules de Montpellier, Université de Montpellier, CNRS, F-34095, France
[7]Dep. de Física, Universidade Federal do Rio Grande do Norte, CEP: 59072-970 Natal, RN, Brazil
[8]Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138, USA

We simulate the evolution of the solar wind along its main sequence lifetime and compute its thermal radio emission. To study the evolution of the solar wind, we use a sample of solar mass stars at different ages. All these stars have observationally-reconstructed magnetic maps, which are incorporated in our 3D magnetohydrodynamic simulations of their winds. We show that angular-momentum loss and mass-loss rates decrease steadily on evolutionary timescales, although they can vary in a magnetic cycle timescale. Stellar winds are known to emit radiation in the form of thermal bremsstrahlung in the radio spectrum. To calculate the expected radio fluxes from these winds, we solve the radiative transfer equation numerically from first principles. We compute continuum spectra across the frequency range 100 MHz - 100 GHz and find maximum radio flux densities ranging from 0.05 - 2.2 μJy. At a frequency of 1 GHz and a normalised distance of d = 10 pc, the radio flux density follows 0.24 $(\Omega/\Omega_\odot)^{0.9}$ (d/[10pc]$)^2$ μJy, where Ω is the rotation rate. This means that the best candidates for stellar wind observations in the radio regime are faster rotators within distances of 10 pc, such as κ^1 Ceti (0.73 μJy) and χ^1 Ori (2.2 μJy). These flux predictions provide a guide to

observing solar-type stars across the frequency range 0.1 - 100 GHz in the future using the next generation of radio telescopes, such as ngVLA and SKA.

Published in MNRAS

For preprints contact: ofionnad@tcd.ie

For preprints via WWW: https://arxiv.org/abs/1811.05356

Cross-Listed Abstracts (Pre-Main Sequence Stars)

Editor's Note: The abstracts below are being cross-listed with the *Star Formation Newsletter.*

The Gaia-ESO Survey: Age Spread in the Star Forming Region NGC 6530 from the HR Diagram and Gravity Indicators

L. Prisinzano[1], F. Damiani[1], V. Kalari[2,3], R. Jeffries[4], R. Bonito[1], G. Micela[1], N. J. Wright[4], R. J. Jackson[4], E. Tognelli[5], M. G. Guarcello[1], J. S. Vink[3], A. Klutsch[6], F. M. Jiménez-Esteban[7], V. Roccatagliata[5,8,9], G. Tautvaišienė[10], G. Gilmore[11], S. Randich[8], E. J. Alfaro[12], E. Flaccomio[1], S. Koposov[11], A. Lanzafame[13], E. Pancino[8], M. Bergemann[14], G. Carraro[15], E. Franciosini[8], A. Frasca[6], A. Gonneau[11], A. Hourihane[11], P. Jofré[16], J. Lewis[11], L. Magrini[8], L. Monaco[16], L. Morbidelli[8], G. G. Sacco[8], C.C. Worley[11], S. Zaggia[17]

·. indicates your author number, for example: [1] INAF - Osservatorio Astronomico di Palermo, Piazza del Parlamento 1, 90134, Palermo, Italy
[2] Departamento de Astronoma, Universidad de Chile, Casilla 36-D, Santiago, Chile
[3] Armagh Observatory and Planetarium, College Hill, Armagh, BT61 9DG, UK
[4] Astrophysics Group, Keele University, Keele, Staffordshire ST5 5BG, UK
[5] Department of Physics 'E. Fermi', University of Pisa, Largo Bruno Pontecorvo 3, I-56127 Pisa, Italy
[6] INAF - Osservatorio Astrofisico di Catania, via S. Sofia 78, 95123, Catania, Italy
[7] Departmento de Astrofísica, Centro de Astrobiología (INTA-CSIC), ESAC Campus, Camino Bajo del Castillo s/n, E-28692 Villanueva de la Cañada, Madrid, Spain
[8] INAF - Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, 50125, Florence, Italy
[9] INFN, Sezione di Pisa, Largo Pontecorvo 3, 56127 Pisa, Italy
[10] Astronomical Observatory, Institute of Theoretical Physics and Astronomy, Vilnius University, Saulėtekio av. 3, 10257 Vilnius, Lithuania
[11] Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 0HA, UK
[12] Instituto de Astrofísica de Andalucía-CSIC, Apdo. 3004, 18080 Granada, Spain
[13] Dipartimento di Fisica e Astronomia, Università di Catania, via S. Sofia 78, 95123, Catania, Italy
[14] Max Planck Institute for Astronomy, Koenigstuhl 17, 69117 Heidelberg, Germany
[15] Dipartimento di Fisica e Astronomia Galileo Galilei, Università di Padova, Vicolo Osservatorio 3, I-35122, Padova, Italy
[16] Departamento de Ciencias Fisicas, Universidad Andres Bello, Republica 220, Santiago, Chile
[17] INAF - Padova Observatory, Vicolo dell'Osservatorio 5, 35122 Padova, Italy

In very young clusters, the stellar age distribution is the empirical proof of the duration of star cluster formation and thus it gives indications of the physical mechanisms involved in the star formation process. Determining the amount of interstellar extinction and the correct reddening law are crucial steps to derive fundamental stellar parameters and in particular accurate ages from the HR diagram. In this context, we derived accurate stellar ages for NGC 6530, the young cluster associated with the Lagoon Nebula to infer the star formation history of this region. We use the *Gaia*-ESO survey observations of the Lagoon Nebula, together with photometric literature data and *Gaia* DR2 kinematics, to derive cluster membership and fundamental stellar parameters. Using spectroscopic effective temperatures, we analyze the reddening properties of all objects and derive accurate stellar ages for cluster members. We identified 652 confirmed and 9 probable members. The reddening inferred for members and non-members allows us to distinguish foreground objects, mainly main-sequence (MS) stars, and background objects, mainly giants. This classification is in agreement with the distances inferred from *Gaia* DR2 parallaxes for these objects. The foreground and background stars show a spatial pattern that allows us to trace the three-dimensional structure of the nebular dust component. Finally, we derive stellar ages for 382 confirmed cluster members for which we obtained the individual reddening values. In addition, we find that the gravity-sensitive γ index distribution for the M-type stars is correlated with stellar age. For all members with $T_{\rm eff} < 5500\,$K, the mean logarithmic age is 5.84 (units of years) with a dispersion of 0.36 dex. The age distribution of stars with accretion and/or disk (CTTSe) is similar to that of stars without accretion and without disk (WTTSp). We interpret this dispersion as evidence of a real age spread since the total uncertainties on age determinations, derived from Monte Carlo simulations, are significantly smaller than the observed spread. This conclusion is supported by the evidence of a decreasing of the gravity-sensitive γ index as a function of stellar ages. The presence of a small age spread is also supported by the spatial distribution and the kinematics of old and young members. In particular, members with accretion and/or disk, formed in the last 1 Myr, show evidence of subclustering around the cluster center, in the Hourglass Nebula and in the M8-E region, suggesting a possible triggering of star formation events by the O-type star ionization fronts.

Accepted by A&A

For preprints contact: loredana.prisinzano at inaf.it

For preprints via WWW: https://arxiv.org/abs/1901.09589

Announcement

BinHab 2.0: An Advanced Interactive Tool for Habitable Regions of Binary Systems

Manfred Cuntz[1]

[1] Dept. of Physics, Univ. of Texas at Arlington (UTA), Arlington, TX 76019

In 2014, the Binary Star Habitable Zone Calculator, named BinHab, became available to the scientific community, located at The University of Texas at Arlington (UTA).

BinHab allows the calculation of S-type and P-type habitable zones (HZs) in stellar binary systems. P-type orbits occur when the planet orbits both binary components, whereas in the case of S-type orbits the planet orbits only one of the binary components, with the second component considered a perturbator. The selected approach considers a variety of aspects, which include: 1. Besides simple cases, the treatment of nonequal-mass systems and systems in elliptical orbits. 2. The consideration of a joint constraint, including orbital stability and a habita ble region for assumed system planets based on the stellar radiative energy fluxes ("radiative habitable zone"; RHZ), needs to be met. 3. The provision of a combined formalism for the assessment of both S-type and P-type HZs; in particular, through the solution of a fourth-order polynomial, mathematical criteria are employed for the kind of systems in which S-type and P-type HZs are realized. 4. The implementation of HZs with different types of limits.

BinHab 2.0 offers significant upgrades and enhancements, including:

* Consideration of Improved Planetary Climate Models
Impact of the Planetary Mass on the HZs (if applicable), based on Data for Mars, Earth, and super-Earth-type planets
Professional Figure Plotting for Binary HZs, including Orbital Stability Limits

Link: https://physbinhab.uta.edu/

Five different cases of habitable zones are identified, which are: S-type and P-type habitable zones provided by the full extent of the RHZs; habitable zones, where the RHZs are truncated by the additional constraint of planetary orbital stability (referred to as ST and PT-type, respectively, for Truncated); and cases with HZs identified as absent.

The adopted methods are based on:
Cuntz, M. 2014, ApJ, 780, 14 (arXiv: 1303.6645v2), Cuntz, M. 2015, ApJ, 798, 101 (arXiv: 1409.3796), Wang, Zh., & Cuntz, M. 2019, ApJ, in press (arXiv: 1901.11171), and references therein.

The website of BinHab 2.0 has been created by Dr. Zhaopeng Wang (UTA). We also acknowledge earlier comments by Sarah Moorman (UTA).
For comments and suggestions, please contact: Dr. Manfred Cuntz: cuntz@uta.edu

Towards Future Research on Space Weather Drivers (FReSWeD 2019)

2 - 7 July 2019

San Juan, Argentina

Dear Colleagues:

This meeting will promote the exchange of information in the area of space weather, from the point of view of the phenomena that drive it from its origin in the solar atmosphere, through its evolution in the interplanetary medium, to its arrival in geospace. The event will be accompanied by a school with a mix of introductory tutorials, demos and hands-on labs.

This meeting and associated school are being organized on the occasion of the total solar eclipse of 2019, whose totality path will cross five provinces of Argentina extending for more than 1200 km.

Early-bird registration and abstract submission are now open:

http://www.iafe.uba.ar/freswed2019/registration.html

Partial financial support can be requested at:

http://www.iafe.uba.ar/freswed2019/financial_support.html

Please note that the deadline for early-bird registration, partial financial support request, and abstract submission for those requesting support, is 18 January 2019.

Best regards,

Cristina Mandrini, Hebe Cremades, and Carlos Francile, On behalf of FReSWeD SOC and LOC

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.***