Maria A. Weber

NSF Astronomy and Astrophysics
Postdoctoral Fellow
University of Chicago
Department of Astronomy and Astrophysics

Address 5640 S. Ellis Ave, ERC 505
Chicago, IL 60637
Email maweber@uchicago.edu
Website www.solarismaria.com

Education

2010-2014 Ph.D. in Physics - Colorado State University, Fort Collins

Area of Concentration - Solar Physics

Thesis successfully defended on May 8, 2014.

2008-2010 M.S. in Physics - Colorado State University, Fort Collins

2004-2008 Dual B.S. in Physics and Philosophy - University of Evansville, Evansville, IN

Minor - Mathematics
Honors - Magna Cum Laude, Honors Program

Research Focus

My research is largely computational in nature, and focuses on fluid dynamics, magnetohydrodynamics (MHD), and magnetic flux emergence in solar-like and low mass stars. I am particularly interested in exploring the processes at work in stellar interiors that eventually give rise to observed trends in differential rotation, magnetism, and surface patterns of flux emergence. My early work focused on the Sun. Recently, I have been inspired to study M dwarf magnetism and investigate how the presence (or lack) of a tacholine imprints on the dynamo process and subsequent appearance of surface magnetism. One of my long term goals is to work toward coupling 3D convective dynamo models, some of which may self-consistently develop buoyantly rising loops of magnetism, with MHD simulations of the near-surface layer.

Research Experience

Oct. 2017 - Current University of Chicago, Department of Astronomy and Astrophysics & Adler Planetarium
NSF Astronomy and Astrophysics Postdoctoral Fellow (AAPF)

Performing 3D convective dynamo simulations of M dwarfs, some of which will incorporate imposed tachoclines of shear.

Modeling flux emergence in lower-mass, solar-like stars and both partially and fully convective M dwarfs.

Developing astrophysical visualizations in partnership with Adler Planetarium and the Space Visualization Lab.

Sept. 2014 - Sept. 2017 University of Exeter, Department of Physics and Astronomy, Exeter, UK
Post-doctoral Research Fellow

Studied flux emergence in solar-like stars and M dwarfs by carrying out thin flux tube simulations embedded in global-scale convection.

Analyzed simulations of convection and dynamo action in fully convective stars computed using the Anelastic Spherical Harmonic (ASH) code.

Explored the possibility of solar-like near-surface shear layers in low mass stars both analytically and numerically. The Compressible Spherical Segment (CSS) code is used to model the upper convection zone in a curved, spherical domain with higher resolution than is possible in global convection simulations.

Gained experience writing proposals for supercomputing allocations and working with the visualization software package VAPOR.

June 2010 - July 2014 High Altitude Observatory/National Center for Atmospheric Research, Boulder, CO
Graduate Research Fellow

Investigated the interaction of rising, active-region-scale magnetic flux tubes with turbulent flows in the bulk of the solar convection zone. Methods to perform research involved utilizing a thin flux tube model subject to an external, global velocity field exhibiting differential rotation and giant cell convection computed using the ASH code.

Gained experience developing and working with numerical simulations.

Summer 2009 Colorado State University, Fort Collins, CO
CSU LIDAR Group

Assisted in data collection using the CSU LIDAR system in Fort Collins, CO. Performed image analysis on data from an all-sky imager observing airglow in multiple wavelengths to investigate atmospheric gravity waves.

Summer 2008 National Solar Observatory, Sunspot, NM
Student Research Assistant

Numerically modeled the influence of atmospheric turbulence, the adaptive optics system of the Dunn Solar Telescope, and a spectropolarimeter on a three-dimensional data cube of a simulation of solar plage. An extension of the research performed the previous summer at NSO, Sac Peak, with a particular focus on the distortion of the Stokes I, Q, U, and V profiles due to seeing conditions and observational methods.

Summer 2007 National Solar Observatory, Sunspot, NM
Summer REU

Numerically modeled the influence of atmospheric turbulence, the adaptive optics system of the Dunn Solar Telescope, and a Fabry-Perot spectrometer on a three-dimensional data cube of a simulation of solar plage.

Service, Outreach, & Teaching Experience

- **Service**

  Referee, *Astrophysical Journal* (2013-present)

  NSF External Proposal Reviewer (2015-present)

  Delivered a sample lecture for the University of Exeter (UoE) summer Open Day (2017)

  Member of the Local Organizing Committee for IAUS 335: Space Weather of the Heliosphere at UoE (2017)

  Mentor and co-organizer of the UoE Physics and Astronomy Department Women in Physics Group (2017)

  UoE College of Engineering, Mathematics, and Physical Sciences Early Career Researcher Network (ECRN) Manager (2016-2017)

  UoE Physics and Astronomy Department Athena SWAN/Inclusivity Working Group Member (2016-2017)

  Judge for UoE's Three Minute Thesis contest (2016)

  Created content for both the UoE Physics ECRN and UoE Astrophysics websites (2015-2017)

  Assistant convener for a 2012 Fall AGU session

  Mentor to female undergraduate students at the 2013 Rocky Mountain Conference for Undergraduate Women in Physics

  Mentor to graduate students at the 2013 and 2014 SHINE Conferences

  Judged students posters at the 2013, 2014 summer AAS meetings, 2017 IAUS 335 meeting, and the 2017 AAS SPD meeting

- **Outreach**

  Volunteer for the AAS SPD 2017 solar eclipse event at Willamette University

  Developed and delivered a workshop on stellar magnetism and habitability for students aged 11-14 as part of the IAUS 335 EPO program (2017)

  Selected as a 2017 Exeter Soapbox Science Speaker

  Organizer, participant, and developer of numerous outreach events on behalf of the UoE Astrophysics group (2014-2017)

  Assisted with the March 2015 Solar Eclipse Viewing Party at UoE

  Volunteer for NCAR's Super Science Saturday (2013)

  Contributing scientist during the research period of the Discovery Channel television show *Sun Storm* that aired on December 30, 2012

  Volunteer judge for middle school and high school science fairs in Colorado at both the local and state level (2012-2014)

  Provided an astronomy workshop for the Larimer County, CO 4-H organization (2009)

- **Teaching**

  Guest lecturer on Solar/Stellar Physics at Harlaxton College (2016) and the University of Exeter (2017)

  Co-superviser (with Dr. M. Browning) to four MPhys (Masters of Physics) students at UoE (2015-2017): Suzie Boardman, Joshua Clarke, Sam Pugsley, Ed Townsend

  2014-2016, Module demonstrator for the UoE Physics Department

  2010 - 2014, 500+ hours of private tutoring for WyzAnt Tutoring Service

  2008 - 2010, Graduate Teaching Assistant for Astronomy 101 and Physics 121/141 at Colorado State University, Fort Collins

  2006 - 2008, Supplemental Instruction Leader and Lab Assistant at the University of Evansville, Evansville, IN

Awards & Fellowships

- 2017 - NSF Astronomy and Astrophysics Postdoctoral Fellowship (AAPF)
- 2015 - Thomas Metcalf SPD Travel Award and Lecturer
- 2013 - High Altitude Observatory John W. Firor Publication Award
- 2012 - Outstanding Student Paper, 4 Corners APS Conference
- 2011 - Outstanding Student Paper, Fall AGU Conference
- 2010 - Outstanding Student Paper, 4 Corners APS conference

Experience Acquiring Allocated Resources

- PI funded NSF AAPF Award No. 1701265 (Oct. 2017-Sept. 2020, $100,000 yearly)
- Co-I funded UoE Researcher Led Initiatives Award for a Women in Physics Group (2017, £500)
- Co-I awarded PRACE supercomputing allocation (2015-2016, collaboration total 28M cpu-hours)
- PI funded UoE Early Career Engagement Award for creation of astrophysics outreach videos (2016, £1000)
- Co-I funded resources for UoE College-wide ECRN (£4000 yearly beginning 2016)
- Co-I funded UoE Researcher Led Initiatives Award for Physics ECRN (2015-2016, £1500)

Supercomputing Experience

- *Zen* and *Isca* resources at UoE
- *DiRAC Complexity* resource at the University of Leicester
- European PRACE resource *MareNostrum* at Barcelona Supercomputing Center
- NASA resource *Pleiades* at Ames

Publications

- **Ph.D. Thesis**

  The Dynamic Evolution of Active-Region-Scale Magnetic Flux Tubes in the Turbulent Solar Convective Envelope, 2014
  Advisors: Yuhong Fan (High Altitude Observatory), David Krueger (Colorado State University)
  Link: http://hdl.handle.net/10217/83825

- **Journal Articles**

  Modeling the Rise of Fibril Magnetic Fields in Fully Convective Stars
  Weber, M.A., & Browning, M.K., 2016, *ApJ*, 827, 95
  ADS: http://adsabs.harvard.edu/abs/2016ApJ...827...95W
  DOI: 10.3847/0004-637X/827/2/95

  Theoretical limits on magnetic field strengths in low-mass stars
  Browning, M.K., **Weber, M.A.**, Chabrier, G., & Massey, A.P., 2016, *ApJ*, 818, 189
  ADS: http://adsabs.harvard.edu/abs/2016ApJ...818..189B
  DOI: 10.3847/0004-637X/818/2/189

  Effects of Radiative Diffusion on Thin Flux Tubes in Turbulent Solar-like Convection
  Weber, M.A., & Fan, Y., 2015, *Sol. Phys.*, 290, 1295
  ADS: http://adsabs.harvard.edu/abs/2015SoPh..290.1295W
  DOI: 10.1007/s11207-015-0674-3

  Comparing Simulations of Rising Flux Tubes Through the Solar Convection Zone with Observations of Solar Active Regions: Constraining the Dynamo Field Strength
  Weber, M.A., Fan, Y., & Miesch, M.S., 2013, *Sol. Phys.*, 287, 239
  ADS: http://adsabs.harvard.edu/abs/2013SoPh..287..239W
  DOI: 10.1007/s11207-012-0093-7

  A Theory on the Convective Origins of Active Longitudes on Solar-like Stars
  Weber, M.A., Fan, Y., & Miesch, M.S., 2013, *ApJ*, 770, 149
  ADS: http://adsabs.harvard.edu/abs/2013ApJ...770..149W
  DOI: 10.1088/0004-637X/770/2/149

  The Rise of Active Region Flux Tubes in the Turbulent Solar Convective Envelope
  Weber, M. A., Fan, Y., & Miesch, M.S., 2011, *ApJ*, 741, 11
  John W. Firor Publication Award
  ADS: http://adsabs.harvard.edu/abs/2011ApJ...741...11W
  DOI: 10.1088/0004-637X/741/1/11

  Seasonal and local time variability of ripples from airglow imager observations in US and Japan
  Yue, J., Nakamura, T., She, C.Y., **Weber, M.**, Lyons, W., & Li, T., 2010, *Ann. Geophys.*, 28, 1401
  Link: http://www.ann-geophys.net/28/1401/2010/angeo-28-1401-2010.html

- **Conference Proceedings**

  On the Suppression of Magnetic Flux Emergence by Convective Motions in Fully Convective Stars
  Weber, M.A., Browning, M.K., Boardman, S., Clarke, J., Pugsley, S., & Townsend, E., 2017, Proceedings of the IAUS 328: *Living Around Active Stars*
  ADS: http://adsabs.harvard.edu/abs/2017arXiv170304982W

  Magnetic Cycles and Hints of Flux Emergence in Solar and Stellar Dynamos
  Miesch, M.S., Nelson, N.J., Brown, B.P., Augustson, K.C., Brun, A.S., Toomre, J., Dikpati, M., **Weber, M.A.**, & Fan, Y., 2014, *JPS Conf. Proc.*, 015099
  Link: http://journals.jps.jp/doi/pdf/10.7566/JPSCP.1.015099

Oral Research Presentations: 2010 - present

Invited Review (Future): *Dynamo processes constrained by solar and stellar observations*
Feb. 2018 IAUS 340 'Long Term Datasets for the Understanding of Solar and Stellar Magnetic Cycles', Jaipur, India

Toward Linking Magnetic Flux Emergence, Convection, and Dynamo Action in Cool, Low-Mass Stars
Sept. 2017 Coffee Time Colloquium, University of Exeter, Exeter, UK

Exploring the Flux Tube Paradigm in Solar-like Convection Zones
Aug. 2017 SPD Meeting, Portland, OR

Simulations of Flux Emergence in Stellar Interiors: Toward Linking Dynamo Action with Starspots
July 2017 National Astronomy Meeting, University of Hull, Hull, UK

Exploring the Flux Tube Paradigm Beyond the Sun: Solar-like Rapid Rotators and Fully Convective M Dwarfs
June 2017 Flux Emergence Workshop, Budapest, Hungary

Invited Colloquium: *Simulations of Flux Emergence in Stellar Interiors: Toward Linking Dynamo Action with Starspots*
May 2017 Bristol University, Bristol, UK

Simulations of Magnetic Flux Emergence in Cool Star Interiors
Oct. 2016 IAUS 328 'Living Around Active Stars', Maresias, Brazil

Modeling the Rise of Fibril Magnetic Fields in Fully Convective Stars
July 2016 Coffee Time Colloquium, University of Exeter, Exeter, UK

Magnetic Flux Tubes in the Turbulent Solar Interior: Toward Linking Fibril Magnetic Fields with Active Regions
June 2015 **Invited Talk: SPD Metcalf Travel Award Lecturer**
Flux Emergence Workshop, Boulder, CO
June 2015 Solar Dynamo Frontiers, Boulder, CO

Exploring Near Surface Shear Layers on Low-Mass Stars
May 2015 Stellar and Planetary Dynamos, Goettingen, Germany

The Combined Influence of Convection and Radiative Heating on the Rise of Solar Magnetic Flux Tubes
Dec. 2014 MHD Days 2014, Potsdam, Germany

The Dynamic Evolution of Active-Region-Scale Magnetic Flux Tubes in the Turbulent Solar Convective Envelope
Oct. 2014 Colloquium, University of Exeter, Exeter, UK
June 2014 Dissertation presentation, Summer AAS/SPD Meeting, Boston, MA

Convective Origins of Solar-like Active Longitudes
Oct. 2013 4 Corners APS Meeting, Denver, CO

The Active Longitude Phenomenon and its Possible Convective Origin
July 2013 SPD Meeting, Bozeman, MT
July 2013 SHINE Student Day, Buford, GA

A Theory on the Possible Convective Origins of Active Longitudes on Solar-like Stars
June 2013 Summer AAS Meeting, Indianapolis, IN

Solar Active Longitudes Resulting from Thin Flux Tube Simulations in a Solar-like Convective Envelope

Oct. 2012 4 Corners APS Meeting, Socorro, NM

Outstanding Student Paper Award

Dynamic Evolution of Magnetic Flux Tubes in the Convection Zone of the Sun and Solar-like Rapid Rotators

Aug. 2012 Presentation to HAO External Advisory Committee

Emergence Properties of Magnetic Flux Tubes in the Solar Convection Zone

June 2012 SHINE Student Day, Maui, Hawaii

Our Dynamic Sun: On the Solar Cycle, Dynamo, and Magnetic Fields

June 2012 SHINE Student Day, Maui, Hawaii

Comparing Simulations of Rising Flux Tubes Through the Solar Convection Zone with Observations of Solar Active Regions

April 2012 Colloquium, University of Wisconsin, Madison, WI

Comparing Simulations of Rising Flux Tubes Through the Solar Convection Zone with Observations of Active Region Properties: Constraining the Dynamo Field Strength

Dec. 2011 Fall AGU Meeting, San Francisco, CA

Outstanding Student Paper Award

Oct. 2011 4 Corners APS Meeting, Tucson, AZ

The Rise of Active Region Flux Tubes in the Turbulent Solar Convective Envelope

June 2011 SPD Meeting, Las Cruces, NM

March 2011 Boulder Solar Day, Boulder, CO

Dec. 2010 Fall AGU Meeting, San Francisco, CA

Oct. 2010 4 Corners APS Meeting, Ogden, UT

Outstanding Student Paper Award

Invited Teaching Lectures

The Secret Life of Stars: Birth, Death, and What Lies Beneath the Surface

July 2017 Pre-University Physics Course, University of Exeter, Exeter, UK

An Introduction to the Solar Dynamo

Oct. 2016 Astronomy 101 Lecture, Harlaxton College - University of Evansville, Harlaxton, UK

Outreach Presentations

Invited: *The Solar-Stellar Connection: Applying Lessons Learned From the Sun to Study Other Stars with Habitable Worlds*

June 2017 Soapbox Science, Exeter, UK

Invited: *Habitability and the Search for Alien Worlds*

Oct. 2016 Harlaxton College - University of Evansville, Harlaxton, UK

Are We Alone in the Universe?: Estimating the number of intelligent worlds in the Milky Way

May 2016 Pint of Science, Exeter, UK

Invited: *Stellar and Planetary Dynamos*

March 2016 The King's School, Ottery St. Mary, UK

An Introduction to Plasmas

Dec. 2015 The King's School, Ottery St. Mary, UK

References

- **Dr. Matthew Browning**

  Post-doctoral Supervisor
  University of Exeter, Exeter, UK
  m.k.m.browning@exeter.ac.uk
  +44 1392 726605

- **Dr. Yuhong Fan**

  PhD Research Advisor
  High Altitude Observatory/NCAR, Boulder, CO
  yfan@ucar.edu
  303-497-1575

- **Dr. Mark Miesch**

  PhD Research Co-Advisor
  High Altitude Observatory/NCAR, Boulder, CO
  miesch@ucar.edu
  303-497-1582