

# IAUGA 2022 FM 5 Beyond the Goldilocks Zone: the Effect of Stellar Magnetic Activity on Exoplanet Habitability

## (i) Final scientific programme

### Tuesday August 2, FM5-1

Chair: Heidi Korhonen

- 10:30 – 11:00 Recent Developments in the Babcock-Leighton Dynamo Theory for the Solar Cycle, Bidya Binay Karak **(invited)**
- 11:00 – 11:15 Modelling the occurrence of grand minima in sun-like stars using a dynamo model, Vindya Vashishth
- 11:15 – 11:45 Effect of planetary magnetic fields in the planetary habitability, Rakesh Yadav **(Invited)**

### Tuesday August 2, FM5-2

Chair: Aline Vidotto

- 13:30 – 14:00 Stellar magnetic fields and the solar-stellar connection, Stephen Marsden **(Invited)**
- 14:00 – 14:15 Near-infrared Zeeman-Doppler Imaging of AD Leo with SPIRou: towards a magnetic polarity reversal?, Stefano Bellotti
- 14:15 – 14:30 What makes a stellar surface preferentially facular or spot dominated?, Eliana Maritza Amazo-Gomez
- 14:30 – 15:00 Solar Flares – an observational overview, Lucia Kleint **(Invited)**

### Tuesday August 2, FM5-3

Chair: Antoaneta Antonova

- 15:15 – 15:45 On the Formation of Solar Superstorms, Ying Liu **(Invited)**
- 15:45 – 16:00 Coronal mass ejections associated with DH type II radio bursts: near-Sun characteristics and interplanetary propagation, Binal Patel
- 16:00 – 16:15 Coronal Mass Ejections and Exoplanets: A Numerical Perspective, Julián Alvarado-Gómez
- 16:15 – 16:45 Discussion

### Wednesday August 3, FM5-4

Chair: Stephen Marsden

- 10:30 – 11:00 Recent studies of stellar flares across the electromagnetic spectrum, Antoaneta Antonova **(Invited)**
- 11:00 – 11:15 Characteristic time of stellar flares on Proxima Centauri, He Han

- 11:15 – 11:30 The effects of stellar flares on the composition and spectra of gaseous exoplanets orbiting M dwarfs, Thomas Konings
- 11:30 – 11:45 Radio Dynamic Spectroscopy of UV Cet and Prox Cen, Timothy Bastian
- 11:45 – 12:00 Pre-main Sequence Stellar Megaflares and Young Planetary Atmospheres, Eric Feigelson

### **Wednesday August 3, FM5-5**

Chair: Cristina Mandrini

- 13:30 – 14:00 Hunting for stellar coronal mass ejections, Kosuke Namekata **(Invited)**
- 14:00 – 14:15 Where are the stellar coronal mass ejections? Krisztián Vida
- 14:15 – 14:30 Trying to catch the elusive stellar coronal mass ejections, Heidi Korhonen
- 14:30 – 15:00 Space weather response to large-scale solar wind drivers, Emilia Kilpua **(Invited)**

### **Wednesday August 3, FM5-6**

Chair: Heidi Korhonen

- 15:15 – 15:45 Stellar space weather effects on potentially habitable planets, Aline Vidotto **(Invited)**
- 15:45 – 16:00 Towards a better understanding of exoplanetary environments around cool stars, Judy Chebly
- 16:00 – 16:15 Planet-enhanced activity from M dwarfs, Robert Kavanagh
- 16:15 – 16:30 Evolution and diversity of the magnetism of the Sun and Sun-like stars, Quentin Noraz
- 16:30 – 16:45 Discussion

### **Demographics:**

Original invited speakers: 5 female / 6 male

Accepted invited speakers: 4 female / 5 male

Session chairs: 4 female / 1 male

Speakers contributed talks: 4 female / 10 male

## **(ii) Summary of the scientific highlights of the meeting**

Even if the global pandemic made organising this Focus Meeting somewhat more challenging than originally anticipated, the meeting itself was very successful with many fruitful discussions. Each session was attended by some 30-50 on-site participant and some 10 virtual attendees. We could bring together the different communities working on stellar and solar activity, exoplanets and the effect of magnetic activity on (exo)planets.

The scientific highlights include the newest observations of stellar magnetic activity, theoretical advances in dynamo theory to explain the observed activity, observations of energetic events on stars, and the most recent efforts to model the effect of activity on orbiting planets and their

habitability. Especially the observations of energetic events on other stars than the Sun in the form of flares and coronal mass ejection and their potential impact on the habitability resulted in many discussions during the meeting.

## **(v) An Executive Summary of the Meeting**

The aim of this Focus Meeting was to bring together theorists, modellers and observers in the fields of solar, stellar and (exo)planetary physics to further the understanding of the impact of solar and stellar magnetic activity on their space environments and the habitability of orbiting planets.

The magnetic activity of cool stars in the form of flares, winds, and coronal mass ejections has a direct impact on planets. This activity varies with the mass, age, and rotation rate of the star and can be damaging for life, even in the case of a fairly inactive star like the Sun. During periods of intense solar activity, the solar wind is enhanced and geomagnetic storms produce auroras, disrupt radio transmissions, affect power grids, damage orbiting satellites, and can be hazardous to astronauts. By analogy, the magnetic activity of young cool stars, which exhibit much higher activity levels than the Sun, may be hazardous for the creation and development of life. Therefore, knowledge of magnetic activity of the host star is of crucial importance when determining the habitability of a planet. In close-in worlds, like in the habitable zone of an M dwarf, stellar magnetic activity could have a catastrophic impact on the actual habitability of the planet. Even the planets further away from the star are significantly affected, as is seen in the solar wind stripping of Mars' atmosphere, and in the enhanced ion escape from the Martian atmosphere in connection to CME events.

In this Focus Meeting we used the Sun and the Solar System as the starting point, as it is by far the best studied stellar system and allows us to study different processes in unprecedented detail. The knowledge obtained from these studies was connected to the state-of-the-art observations and models of stellar activity, and finally to their effects on exoplanets.

We had a two day focus meeting with six sessions (three each day). For each session we had 1-2 invited speakers with 30 min talks, and a number of contributed talks that were 15 minutes each. We also had two discussion sessions, one in the end of each day. Our nine invited speakers all work in different countries and on four different continents. From the invited speakers 44% were women and 46% men. The invitees also included scientists in different stages of their career, from young researchers that have only couple of years since their PhD to established professors.

On the whole, we had a very successful Focus Meeting with many interesting and fruitful discussions during the meeting.