# EP 1: Sun and Heliosphere I

Time: Monday 11:00–12:30 Location: H7

**Invited Talk** EP 1.1 Mon 11:00 H7

**The onset mechanism and a physics-based prediction of large solar flares** — •Kanya Kusano — Institute for Space-Earth Environmental Research, Nagoya University, Nagoya, Japan

What determines the onset of large solar flares is not yet well understood, although various models have been proposed. Therefore, their prediction mostly relies on empirical methods, and the accurate prediction of large flares is still difficult. Here, we report a new physics-based method, $\kappa$-scheme, that can predict imminent large solar flares (Kusano et al. 2020, Science). The $\kappa$-scheme is based on the theoretical model that a small magnetic reconnection between two sheared magnetic loops triggers the new ideal MHD instability, named the double-arc instability (Ishiguro & Kusano 2017, ApJ), driving a solar flare. We applied the $\kappa$-scheme to 198 active regions (ARs) with the largest sunspots recorded from 2010 to 2017 using the SDO SHARP dataset. While only 7 ARs in them produced solar flares larger than class X2, we demonstrated that the $\kappa$-scheme could clearly discriminate the 6 ARs in them out of the ARs not producing the large flare. It is also shown that the $\kappa$-scheme can predict even the precise position where a large flare begins. Based on the results, we conclude that magnetic twist flux density close to a magnetic polarity inversion line determines when and where solar flares may occur and how large they can be. Finally, we also discuss an attempt to extend the $\kappa$-scheme to predict eruptive flares and coronal mass ejections (Lin et al. 2020 & 2021, ApJ).

EP 1.2 Mon 11:30 H7

**Helicity Shedding by Flux Rope Ejection** — •Bernhard Kliem and Norbert Seehafer — Universität Potsdam, Institut für Physik und Astronomie

It has been suggested that magnetic helicity must be shed from the Sun by coronal mass ejections to limit its accumulation in each hemisphere. However, the efficiency of such helicity shedding and its dependence on source region parameters are not yet known. We perform a parametric simulation study of flux rope ejection from marginally stable force-free equilibria to address these questions. By varying the ratio of guide and strapping field and the flux rope twist, different ratios of self and mutual helicity are set and the onset of the torus or helical kink instability is obtained. The helicity shed is found to vary in a broad range from a minor to a major part of the initial helicity, with self helicity being largely or completely shed and mutual helicity, which makes up the larger part of the initial helicity, being shed only partly, up to a configuration-dependent base level. The torus-unstable configuration without a guide field and with only a relatively weak twist sheds nearly 2/3 of the initial helicity, while the highly twisted, kink-unstable configuration sheds only 1/4. The initial flux-normalized helicity of the former configuration is 0.21, a value presumably not far from the maximum helicity that a stable force-free flux rope equilibrium can contain. These results numerically demonstrate the conjecture of helicity shedding by coronal mass ejections and provide a first account of its parametric dependence.

EP 1.3 Mon 11:45 H7

**Flux rope reformation as a model for homologous solar flares and coronal mass ejections** — •Alshaimaa Hassanin[1,2], Bernhard Kliem[2], Tibor Toeroek[3], and Norbert Seehafer[2] — [1]Faculty of Science,Cairo University, Cairo, Egypt — [2]Institute of Physics and Astronomy, University of Potsdam, 14476 Potsdam, Germany — [3]3Predictive Science Inc., 9990 Mesa Rim Road, Suite 170, San Diego, CA 92121, USA

In this study we model for the first time a sequence of a confined and a full eruption, employing the flux rope reformed in the confined eruption as the initial condition for the ejective one. The full eruption develops as a result of imposed converging motions in the photospheric boundary which drive flux cancellation. In this process, a part of the positive and negative sunspot flux converge toward the polarity inversion line, reconnect, and cancel each other. Flux of the same amount as the canceled flux transfers to the flux rope, building up free magnetic energy. With sustained flux cancellation and the associated progressive weakening of the magnetic tension of the overlying flux, we find that a flux reduction of $\approx 8.9\%$ leads to the ejective eruption. These results demonstrate that homologous eruptions, eventually leading to a coronal mass ejection (CME), can be driven by flux cancellation.

**Invited Talk** EP 1.4 Mon 12:00 H7

**Coronal bright points (small-scale loops) in the solar atmosphere** — •Maria S. Madjarska — Max-Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany

When observed in extreme-ultraviolet (EUV) and X-rays, the million degree solar atmosphere, the solar corona, is predominantly populated by loops with a wide range of sizes. During the maximum of the solar activity cycle, bright active-region loops connect the opposite polarity strong magnetic fields of sunspots. Back in 1969 the first X-ray observations astonished the solar scientists by revealing that the solar corona that has been known as quiet and homogenous, is occupied by many bright point-like X-ray emission sources. They were named X-ray Bright Points (XBPs, now called Coronal Bright points, CBPs). Later, the Skylab observations showed that the XBPs actually represent dynamically evolving small-scale loops that confine plasma heated to up to 3 million degrees. It is now known that these small-scale loops are the main building blocks of the solar atmosphere outside active regions uniformly populating the solar atmosphere including active-region latitudes and coronal holes. I will present this essential class of solar phenomena, giving an overview of the current knowledge about their general, plasma, and magnetic properties as well as transient dynamic phenomena associated with them. The observationally derived energetics and the theoretical modelling that aims at explaining the CBP formation and eruptive behaviour, and their role in coronal heating and their contribution to the solar wind, will also be reviewed.