Solar interior, dynamo, and surface properties

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Abstract:

The key to understanding the dynamics of the solar system lies within its source -- the solar dynamo. While great strides have been made in probing the structure and variability of the solar interior in the past several decades, many questions remain regarding the ultimate drivers of solar activity emanating from flows deep within the convection zone and regulated by the Sun's vast magnetic field network. In order to realize significant progress towards understanding the fundamental drivers of the solar activity and the solar cycle that will bring about crucial advancements in our understanding of the Sun as our nearest stellar companion and its influences throughout the solar system at large by 2050, observations and investigations of the emergence and dynamics of the Sun's photospheric magnetic fields need to be broadened.

The interconnected, cross-scale solar magnetic system is a paramount input for driving atmospheric and activity cycle models, highlighting the need for expanded long-baseline, contextual synoptic campaigns. The necessity for direct polar measurements has become abundantly clear, as evidenced through revolutionary observations of the poles of both Jupiter and Saturn. Azimuthal variations and flux transport over the course of multiple solar cycles are key elements to unraveling the solar dynamo, and measurements of the polar fields, longitudinal flows, helioseismic imaging, and vector photospheric flow maps are vital components toward ensuring progress.

Understanding the local structure and evolution of photospheric magnetic fields are critical for understanding solar activity, namely, active region formation and evolution, chromospheric and coronal heating, and flare and coronal mass ejection energization. Multiple vantage points across the ecliptic plane are essential for tomographic reconstruction of the true orientation of these magnetic fields.

Other probes of diagnostic solar properties, particularly through broad-spectrum irradiance measurements and high-temperature spectroscopy, offer rewarding pathways to understanding global physical processes. Irradiance observations provide a simple, low-resolution link between variability in bulk plasma properties during quiet and active Sun in relation to the solar cycle and can be used as a straightforward comparison to other stars. Current irradiance measurements are spectrally limited and should be expanded to higher temperatures. Combining such investigations with high-temperature,

high-resolution spectroscopy, particularly in the largely unexplored soft X-ray regime could revolutionize our understanding of heating near the solar surface, which energizes the Sun's atmospheric layers.

Many questions remain regarding the source of the Sun's activity cycle and the resultant global surface properties. This talk aims to capture these questions and to set goals for making progress in the coming decades toward predicting activity as well as advancing our understanding of the fundamental physical processes driven directly by the solar dynamo.

Session: Solar Physics, heliosphere, cosmic rays

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