Georgoulis, M. K. and Kontar, E. P. (2019) Preface: Solar physics advances from the interior to the heliosphere. Advances in Space Research, 63(4), pp. 1387-1388. (doi:10.1016/j.asr.2019.01.008)

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Preface: Solar Physics Advances from the Interior to the Heliosphere

Solar Physics has been experiencing a golden era of unprecedented observations and voluminous data for nearly three decades. While much of the progress in the 1990s and 2000s was spurred by flagship space missions, the latest decade has also seen the culmination of game-changing ground-based facilities, long sought after by the community. Observing the Sun from space has indisputable benefits; however, space missions have a relatively limited lifespan, mainly because of the unforgiving deep space or orbital conditions and our limited ability to maintain them after launch. This is not the case for ground-based facilities that can, in principle, serve and train entire generations of researchers.

Furthermore, the timing is exceptional as the advent of diverse, pristine data coincides with an exponential increase of our computational and storage capabilities. This allows cutting-edge modeling to go hand-in-hand with detailed, multi-wavelength data, extending our horizons of understanding in ways largely inconceivable even in the recent past.

Solar physics community meetings – many of them held regularly – take place several times a year worldwide. Among them and their ensuing discussions, it often emerges as a need to epitomize contemporary progress in special topical issues that offer both a valuable future resource and a privileged perspective of the state of the research field at the time they were published. This Special Issue in the *Advances of Space Research* serves precisely these purposes. In doing so, it does not necessarily separate, or stratify, the solar interior from the solar atmosphere, the extended corona and the heliosphere, but it rather treats the different environments as interconnected sub-domains of a continuous physical system featuring a vast dynamical range of length- and time-scales. We believe that not separating artificially between different heliophysical interfaces serves the best interests of, and embraces the latest progress in, the field. In addition, choosing the *Advances of Space Research*, COSPAR's signature Journal, for this Issue, affords this effort the gravity and importance that we intended and worked to assign.

This Special Issue, featuring ten (10) original contributions, starts with discussing three landmark, 21st-century ground-based facilities in different stages of implementation or operation: the European Solar Telescope (EST; Jurčák et al. https://doi.org/10.1016/j.asr.2018.06.034) whose first light is expected in the next decade, the Atacama Large Millimiter Array (ALMA; Loukitcheva https://doi.org/10.1016/j.asr.2018.08.030), with the review of first solar physics observations presented here and the Square Kilometer Array (SKA; Nindos et al. https://doi.org/10.1016/j.asr.2018.10.023), the largest radio telescope ever built, that is expected to revolutionize solar ratio observations at the same time complementing them with petaflops of supercomputing processing power. A meaningful connection between the solar dynamo and observed, but still mysterious, hemispheric asymmetry patterns of the solar magnetic cycle, is presented by Nagy et al.????? A detailed juxtaposition of existing chromospheric observations and models that pushes the limits of both, exposing gaps of knowledge and setting the stage for future groundbreaking contributions, is offered by Pereira

https://doi.org/10.1016/j.asr.2018.09.030. The long-pursued connection between the solar and laboratory plasmas, viewed from a totally new prism of connecting magnetic reconnection – arguably the most important physical process in magnetohydrodynamical (MHD) environments – and particle acceleration, is discussed by McClements https://doi.org/10.1016/j.asr.2018.08.045 . A new complementary effort, bridging the numerical and modeling domains of the macroscopic MHD approach and the microscopic kinetic approach applied directly to the problem of solar flares, is presented by Gordovskyy et al https://doi.org/10.1016/j.asr.2018.09.024. A new theoretical study of solar flares, interpreting the spectral properties of accelerated electrons by means of a dual approach, featuring both dimensional calculations and maximum-entropy arguments, is offered by Litvinenko https://doi.org/10.1016/j.asr.2018.10.044. Moving into the domain of plasma waves, another MHD chapter of capital interest, Ballai et al. https://doi.org/10.1016/j.asr.2018.10.024 discuss dispersion in weakly ionized plasmas that can generate shock waves whose fronts are affected by neutrals and can even generate short-lived oscillations in the shocked plasma. Finally, the ramifications of the solar magnetic activity to geospace, in view of – sometimes extreme – Forbush decreases detected by ground-based neutron monitors, is examined in the intriguing study of Savić et al. https://doi.org/10.1016/j.asr.2018.09.034

This Special Issue has tremendously benefited from the help and advice of Dr. Peggy Ann Shea, ASR Co-Editor for Special Issues, and Journal Manager, Mrs. Rosie Stewart. The Guest Editors are grateful to all the authors for their valuable time and efforts, without which the publication of this Issue would have been impossible, and we congratulate them for the acceptance of their manuscripts. We also thank all the referees for their hard work and invaluable advices, which improved the Issue. The names of all reviewers who agreed to be identified are listed at the end of the Issue. Last but certainly not least, we thank in advance the diverse readers of this Issue, who can contribute decisively to its success. To these perpetual intellectual wanderers, students and thinkers alike, we wish an enjoyable and rewarding reading.

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