Extreme Solar Particle Storms

The hostile Sun

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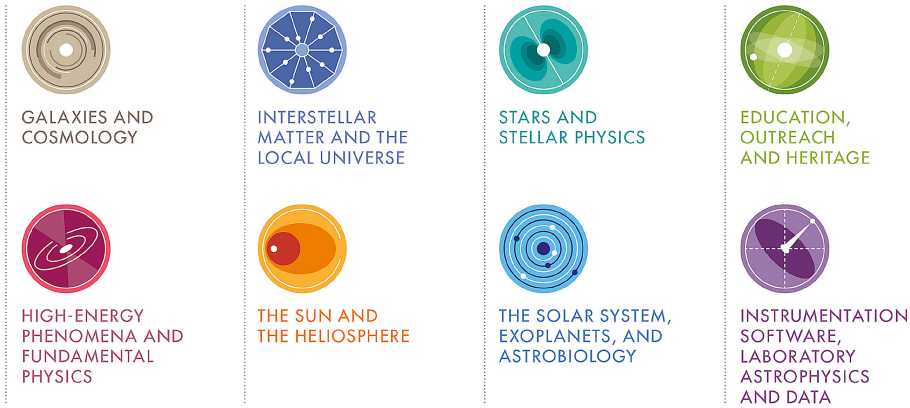

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Preface

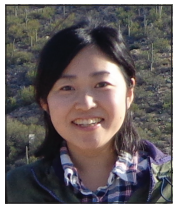
The idea for this book was set at the ISEE International Workshop *"*Extreme solar events: How hostile can the Sun be?*"* held at ISEE (Institute of Space–Earth Environmental Research) in Nagoya University, during 2018 October 02–06. An international team of 16 experts from eight different countries gathered in a quiet room to discuss knowns and unknowns in our knowledge of extreme solar events, define the most important problems, and coordinate efforts in this field. These experts form the core of the author team for this book. During the workshop, we realized that the topic is very acute and important, with different aspects, from purely academic to technological and societal ones. Conversely, the available information and knowledge were not systematized and spread among various publications and minds. Therefore, we proposed writing a jointly edited book where the present state of the art is reviewed and prospects are given. This is the book that is now on your desk.

Acknowledgments

We would like to acknowledge ISEE of Nagoya University for support provided to the stimulating international workshop, where the idea for this book was born and developed. The authors thank Charles H. Jackman (NASA/GSFC), David W. J. Thompson (Dept. of Atmospheric Science, CSU), Brian Thomas (Washburn University), Steven Hardiman, Adam Scaife, and Neal Butchart (Met Office Hadley Centre) for providing help with the visual material. The work of E.C. in Chapters 3 and 6 has benefited from his participation on the ISSI International Team led by Athanasios Papaioannou, which is investigating high-energy solar particle events. D.S. is grateful to David Moss (Manchester University) for a critical reading of his section and acknowledges financial support of RFBR under grant 18-02-00085 and BASIS Foundation under grant 18-1-1-77-1. The work of E.R. and T.S. in Chapter 4 was supported by the Swiss National Science Foundation under grant 200020_182239 (POLE). The work of E.R. and T.S. in Chapter 8 was supported by the Russian Science Foundation (grant 17-17-01060). S.P. and I.U. are thankful to the Academy of Finland for support in the framework of the ReSoLVE Centre of Excellence (Project 307411) and ESPERA Project (321882). K.K. thanks Grants-in-Aid from the MEXT/JSPS, JP15H05814. H.H. thanks Grants-in-Aid from the JSPS, JP17J06954, JP15H05816, JP15H05812 and JP1801254, as well as the ISEE of the Nagoya University for their financial supports. H.H. also thanks Yoshihiro Izumi, Delio V. Proverbio, Corpus Christi College (the University of Oxford), the National Diet Library, Rainer Arlt, and Les Cowley for providing the historical materials and permissions for their use: the auroral drawings in 1872, 771/772, and 773, the sunspot drawing in 1128, the auroral drawing in 1770, Staudacher's sunspot drawing in 1770, as well as the HaloSim program. H.H. wishes to acknowledge the essential achievements of Sam M. Silverman in the studies of historical auroral records and to thank him for valuable discussions during H.H.'s visit to Massachusetts, USA, and to thank F. Richard Stephenson for valuable scientific discussions and advice, especially during H.H.'s visit to Newcastle and Durham.

Editor biographies

Fusa Miyake



Fusa Miyake was born in Japan and educated at the Division of Particle and Astrophysical Science, Nagoya University. She obtained her PhD at Nagoya University in 2013 and has worked since then for the Institute for Advanced Research and Solar–Terrestrial Environment Laboratory (now the Institute for Space–Earth Environmental Research, ISEE), Nagoya University. Her research explores occurrence features of extreme solar proton events over the past several tens of thousands of years, focusing particularly on measuring cosmogenic isotopes. She, together with a team of researchers, discovered the extreme solar events of 775 CE and 993 CE in cosmogenic isotope (initially in ^{14}C) data, which forms the field of this book.

Ilya G. Usoskin

Ilya Usoskin was born and educated in the previous century and millennium, in a city and country whose names no longer exist: Leningrad (now St. Petersburg) of USSR (now Russian Federation). He graduated (with honors) from Leningrad Polytechnic (now St. Petersburg State Technical University) with a MSc in space physics and then enrolled, as a junior researcher and a PhD student, in the A. F. Ioffe Physical-Technical Institute, where he studied energetic particles of extraterrestrial origin, cosmic rays. He obtained his Cand. Sci. degree in astrophysics in 1995 and then worked as an international postdoctoral fellow at INFN Milano, in Italy, where he was involved in the highly sophisticated spaceborne astroparticle experiment AMS (*Alpha Magnetic Spectrometer*). Since 2000, Ilya Usoskin has worked as the head of the Oulu Cosmic Ray Station at the University of Oulu in Finland. The station includes one reference neutron monitor in Oulu, two neutron monitors in Antarctica, and a muon telescope in Central Finland. Since 2012, he has been a full professor of space physics at the University of Oulu, and for 2014–2019, he served as the vice-director of the ReSoLVE (Research on SOlar Long-term Variability and Effects) Center of Excellence of the Academy of Finland. The most honorable awards he has received include knighthood (first class knight) of the Order of the Lion of Finland (2013), the Julis Bartels medal (2018) of the European Geosciences Union, and membership in the Finnish Academy of Sciences and Letters.

Prof. Usoskin is an expert in solar activity as well as in the variability of cosmic rays and their atmospheric effects. He is one of the founders of the space climate research discipline. He has authored or co-authored more than 200 peer-reviewed research publication in the fields of solar and heliospheric physics, solar–terrestrial relations, and geophysics. He is also actively involved in numerous expert's duties for the research community.

Stepan V. Poluianov

Stepan Poluianov was born in Murmansk, USSR. He received his Specialist degree (the equivalent of a MSc) with honors in optics from the ITMO (Information Technologies, Mechanics and Optics) University in St. Petersburg. After graduation, he moved back home to Murmansk and worked at the Polar Geophysical Institute, where he did experimental research in the propagation of artificial ultralow-frequency radio waves. In 2012, Stepan Poluianov became a doctoral student at the University of Oulu, Finland. He received his PhD degree in space physics in 2016, studying cosmic rays and their interaction with matter. Afterwards, he continued working at the university in the same field. He is involved in measurements of cosmic rays by neutron monitors in Finland and Antarctica. In 2019, he became a member of the AMS Collaboration, which runs the cosmic-ray experiment AMS-02 at the *International Space Station*. With colleagues, he has developed a universal and detailed model of cosmogenic nuclide production in the atmosphere, and a novel method for the estimation of solar energetic particle spectra from lunar rocks, and has participated in the formulation of updated GLE and sub-GLE definitions.

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