Effects on Technology

Eino Valtonen
Space Research Laboratory, Department of Physics
University of Turku
FIN-20014 Turku University

Space weather effects on technology are manifold. They extend from space to the surface of the Earth, and in space beyond the Earth's orbit. The topic of this lecture is limited to the effects on technologies employed in implementing scientific payloads, including instruments used for observing space weather. Space weather, as experienced by scientific instruments, can be primarily described in terms of time and energy variable fluxes of particles. The main effects, on the other hand, are characterised by various types of radiation damage and upsets, surface and internal charging, and direct sensor interference. To the extent that the same or equivalent technologies are used in other space systems, the problems encountered are of course the same as for scientific instruments.

While the physics behind the causes of particle flux enhancements is of primary importance in space weather studies, here we will ignore it and concentrate on the physics that can be used for describing and evaluating the effects, and on methods available for avoiding and protecting instruments against hazardous effects. A short overview is given of the dynamic space radiation environment and of the standard models used for engineering purposes. Shortcomings of the models in assessing environmental effects are briefly discussed. Various types of space weather effects on typical technologies used in scientific payloads are presented in some detail. The physical mechanisms responsible for the effects, and models and simulation methods used for studying the consequences are reviewed. Examples of space weather effects on instruments on past and present space flights are given. Finally, design methods at component and instrument level and operational techniques that can mitigate the hazards are considered.