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Intermittent Astrophysical Radiation Sources and Terrestrial Life

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Terrestrial life is exposed to a variety of radiation sources. Astrophysical observations suggest that strong excursions in cosmic ray flux and spectral hardness are expected. Gamma-ray bursts and supernovae are expected to irradiate the atmosphere with keV to GeV photons at irregular intervals. Supernovae will produce large cosmic ray excursions, with time development varying with distance from the event. Large fluxes of keV to MeV protons from the Sun pose a strong threat to electromagnetic technology. The terrestrial record shows cosmogenic isotope excursions which are consistent with major solar proton events, and there are observations of G-stars suggesting that the rate of such events may be much higher than previously assumed. In addition there are unknown and unexplained astronomical transients which may indicate new classes of events. The Sun, supernovae, and gamma-ray bursts are all capable of producing lethal fluences, and some are expected on intervals of 10^8 years or so. The history of life on Earth is filled with mass extinctions at a variety of levels of intensity. Most are not understood. Astrophysical radiation may play a role, particularly from large increases in muon irradiation on the ground, and changes in atmospheric chemistry which deplete ozone, admitting increased solar UVB. UVB is strongly absorbed by DNA and proteins, and breaks the chemical bonds—it is a known carcinogen. High muon fluxes will also be damaging to such molecules, but experiments are needed to pin down the rate. Solar proton events which are not directly dangerous for the biota may nevertheless pose a major threat to modern electromagnetic technology through direct impact on satellites and magnetic induction of large currents in power grids, disabling transformers. We will look at the kind of events that are expected on timescales from human to geological, and their likely consequences.