



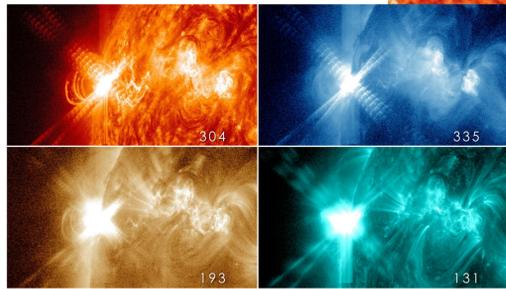
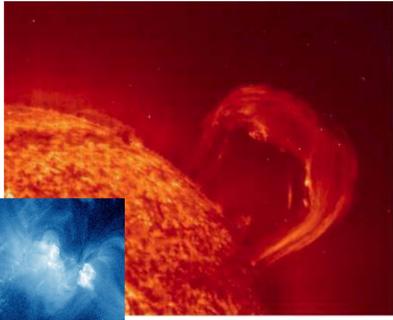
Cosmic Rays



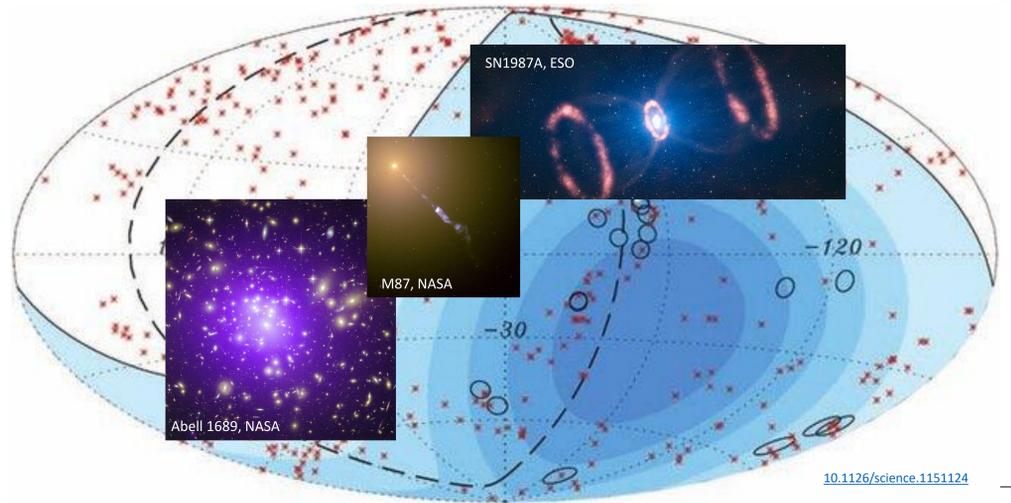
1. What are the Cosmic Rays?

Cosmic rays are microscopic particles from outer space. They are produced by the **Sun** and the **stars**, by exploding stars, black holes within the Milky Way and the **distant galaxies**. They may travel millions and millions of years across their mother galaxies, confined by the magnetic fields.

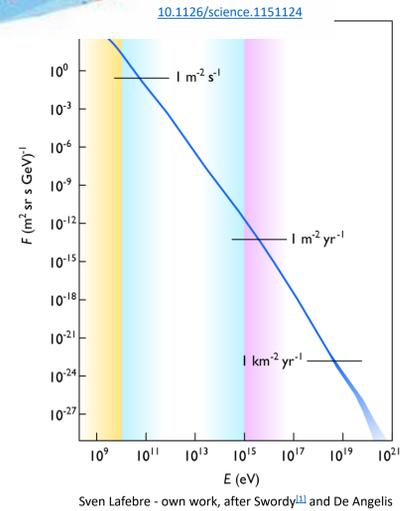
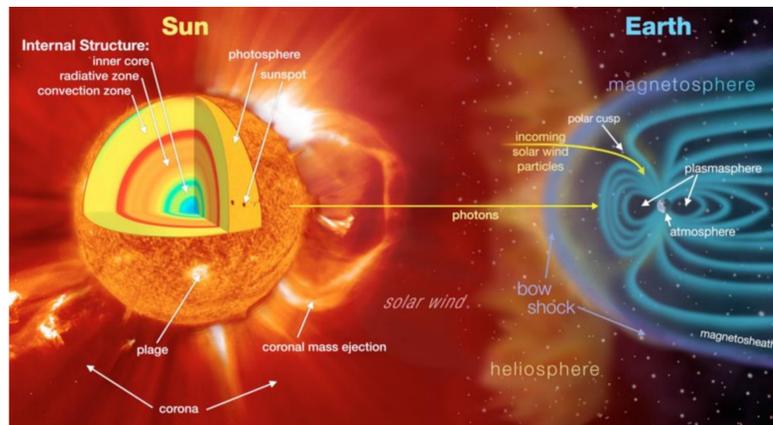
Coronal Mass Ejection:
Expulsion of solar matter and magnetic fields into space



Solar flare (X-ray emissions) observed at different wavelengths



The Sun-Earth connection



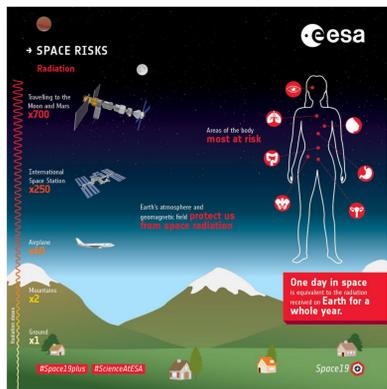
2. Composition

- 90 % Hydrogen nuclei (protons)
- 9 % Helium nuclei (α -particles)
- 1 % electrons
- trace nuclei of all stable elements (up to Uranium) at quantities varying with the energy
- Very small fraction stable antimatter particles (positron and antiproton)

4. Why do we study Cosmic Rays?

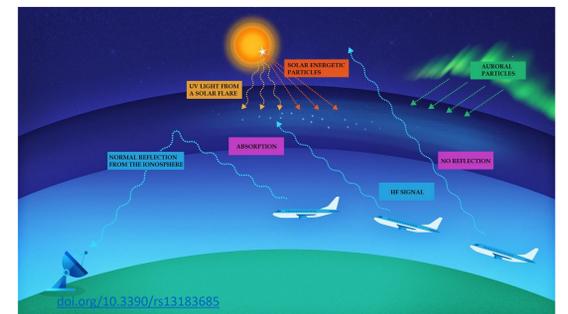
Radiation exposure

Beyond the protection of the atmosphere and the geomagnetic field – airplane crew and passengers, astronauts; Miyake events – Super Solar Flares



3. Energies

- Solar wind: 0.5-10 keV
- Solar Energetic: Particles 10 keV – 50 GeV
- Galactic Cosmic Rays: < 1E20 eV ...

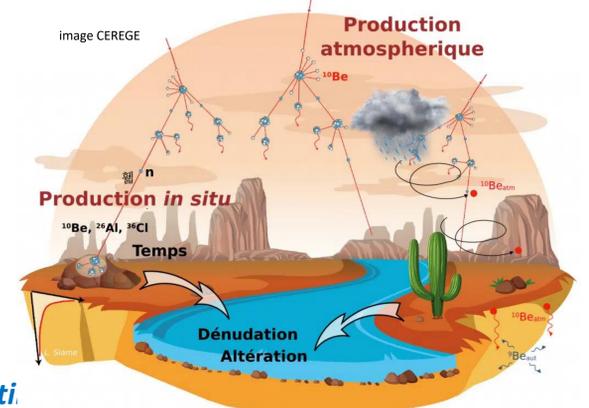
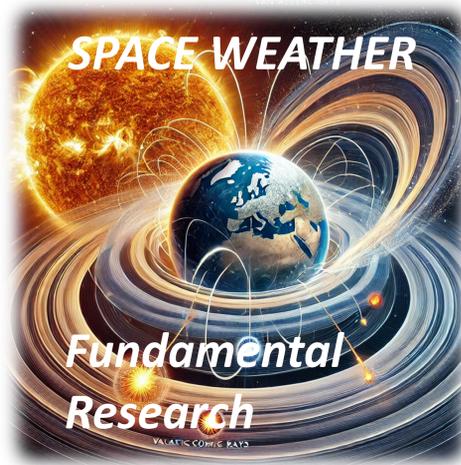


Damage to satellites and electronics

Satellite charging, Single Event Upsets, Software Poisoning dangers for critical control systems

Radio communication disturbances
Polar Caps Absorption leading to radio blackouts

Solar Energetic Particles - source of solar material; Galactic Cosmic Rays Particles composition and energies are important source of information for various astrophysical and cosmological theories

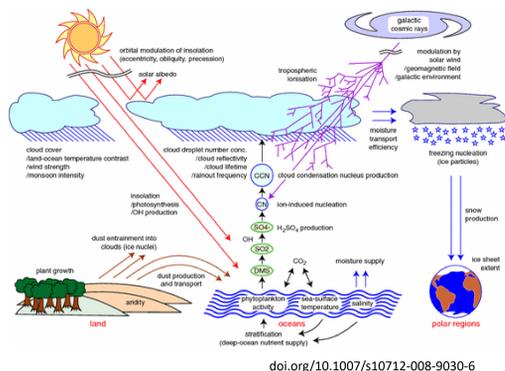


Cosmogenic nuclide data

geological dating and historical climate reconstruction (^3H , ^{14}C , ^{32}P , ^{10}Be ...); Muon Tomography

Climatological effects

There is an underlying relation between cosmic rays intensities and atmospheric climate – addressed by the CLOUD experiment at CERN



Source of High Energy Particles for fundamental research
20 million times higher energies than the LHC at CERN 14 TeV