During the first 40 years of space research, the Earth's magnetic and plasma environment has been largely explored and a number of fundamental plasma processes has been identified and elucidated. Yet deeper and quantitative understanding of the known processes is still needed. On the other hand, the complexity of their interactions in forming phenomena like auroral arcs or large-scale events like magnetospheric substorms has only just begun to be addressed, with the availability of multipoint measurements in space and on the ground.

Fundamental plasma processes identified in the magnetopshere include collisionless shocks, magnetic reconnection, energization of particles trapped in the magnetic field, particle precipitation by wave excitations, auroral particle acceleration, generation of Auroral Kilometric Radiation, boundary layer formation, Kelvin-Helmholtz instabilities at the magnetopause

Examples of complex interactions are substorms, magnetic storms, formation of small- and meso-scale auroral structures, magnetospheric convection, ionospheric evacuation, in general, the coupling between the hot and dilute plasma in magnetosphere and tail to the dense and cool plasma of the ionosphere, and the feedback from there.

Many of the processes realized in the magnetosphere and its wider environment have counterparts in other magnetized objects, planets, magnetic stars, accretion disks, etc. However, the basic parameters are often grossly different from those in the low-density and collisionless magnetosphere. All the same, insights gained in the latter region can provide useful guidance or stimulate ideas for research in plasma astrophysics.