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New Challenges in Space Science – An overview

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It may be fair to say that “space” became a subject of scientific research at the launch of the Sputnik in 1957, so that this year marks the 60th anniversary of the birth of space science. In these years we have found plenty of fascinating features in the space and clarified the physics behind them, but new questions keep challenging us. They can be grouped in three categories.

(1) Space that is filled by hot collisionless plasma represents an ideal laboratory for understanding basic processes in such plasma by means of in-situ observations. These processes include reconnection, turbulence and wave-particle interactions. Thermodynamic character of these “collisionless” gas can be very different from that of the ordinary gas addressed by classical thermodynamics.

(2) The range covered by in-situ observations is no longer limited to the near-Earth space but extends over a variety of planets (with their satellite), comets, and even outside of the heliopause. The data obtained there often reveal structure and dynamics which are quite different from those observed in near-Earth space and pose fascinating new questions.

(3) As spacecraft has become one of the essential infra structures of the society, forecasting of the space weather has gained increasing importance. In order to improve the forecast, relationships among the solar events, their effect on solar wind and IMF (Interplanetary Magnetic Field), and ensuing perturbation in the magnetosphere/ionosphere need be better understood.

This paper will present notable cases in each category, including the entropy of the radiation belt, the origin of “Planetary Period Oscillations” in the Saturnian magnetosphere, and the magnetic structure of ICME (Interplanetary Coronal Mass Ejection).