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直接観測で解明するエネルギー・領域間結合過程による宇宙空間プラズマにおける粒子加速とジオスペース現象
Space plasma acceleration and geospace phenomena due to the energy/sphere couplings elucidated by in-situ observations

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The terrestrial ionosphere and magnetosphere in the polar regions are directly coupled each other through the field-aligned plasma particle transport and the plasma wave propagation basically along the geomagnetic field lines. The field-aligned currents are also carried mainly by the thermal and energetic electrons originating from the ionosphere and the magnetosphere, corresponding to the downward and upward current directions, respectively. The plasma motions widely drived in the magnetized space produce the electric fields due to the magnetohydro dynamics. This global electric field distribution by the plasma convection/circulation is regarded as sources of the plasma acceleration and the other types of the space plasma activities in the vicinity of the Earth. For instance, these properties of the space plasmas in the Geospace are the direct causes of the auroral activities, which means that the space plasma dynamics significantly affect the upper neutral atmosphere and hence stimulate the heating and the disturbances. These coupling processes could sometimes influence the upper atmospheric environment in the mid-latitude regions. It has also been revealed that the ionospheric plasmas are important for the magnetospheric dynamics in the Geospace through the upflowing mechanisms and the escape processes of the accelerated ionospheric plasmas at high latitudes and their density contributions, for instance, to the plasmasphere and the ring current region in the inner magnetosphere. The ionospheric plasmas are considered to be one of the most crucial elements controlling the magnetospheric plasma activities. In addition to the projection and/or propagation of the electromagnetic effects mentioned above, it should be noted that the plasma transport processes among the various regions in the Geospace including the ionosphere and the magnetosphere are fundamental for the space plasma dynamics, and these processes are called the sphere couplings in the Geospace. On the other hand, it is the wave-particle interaction in the space plasma to dominate the energy transfer among the different types of plasma population distributing almost isolatedly in several energy ranges because these plasmas in the topside ionosphere and the magnetosphere are essentially collision-free. In order to address these plasma dynamics in terms of the wave-particle interaction and the energy coupling, in-situ observations based on spacecraft explorations are playing the most fundamental role for the space plasma physics and the solar-terrestrial physics. While a number of the satellite/spacecraft mission have been carried out by the Japanese community and the overseas research agencies, we should recognize that it is not prevailing to cover the wide energy/frequency ranges of the plasma particles and waves and quantitatively investigate the energy transfer between the particles and the waves by using direct measurement techniques realizing high time resolution.

In this presentation, we introduce the previous and current space exploration missions performed mainly by our Japanese community, and also discuss the significance and the future perspectives of the in-situ observations which would bring us with more direct physical clues for the space plasma dynamics and the Geospace environment.

キーワード: 宇宙空間プラズマ, 粒子加速, ジオスペース, 直接観測, 探査計画, 結合過程
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