

Science Objectives and Mission Plan of "FACTORS" with Multiple Compact Satellites for the Space-Earth Coupling Mechanisms

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After the successful launch and the recent observational progresses of the ERG(Arase) satellite mission, we have been leading the next community exploration mission in the Japanese space physics research. In the ERG mission, we are focusing on the unique space plasma mechanisms and conditions causing the terrestrial radiation belt through the wave-particle interaction analyses and the triangle-type research system consisting the satellite and ground-based observations and the data analyses/modelings/simulations. Our next exploration target is the space-Earth connection processes/mechanisms responsible for the formation and coupling of the terrestrial magnetosphere/ionosphere/thermosphere and the acceleration and transportation of the space plasma and neutral atmospheric particles, which could be unveiled only based on the demonstrative in-situ observations using the cutting-edge measurement techniques for plasma particle/waves and electric/magnetic fields and also the remote-sensing observations of the atmospheric emissions like auroras by monochromatic imaging cameras.

We have already initiated this new type of space exploration mission and are now calling this future space exploration mission FACTORS, standing for Exploration Mission for Frontiers of Formation, Accerelation, Coupling, and Transport Mechanisms Observed by Outer Space Research System. The mission definition team and the experimental development team of FACTORS are composed of the representative researchers who have been conducting the previous/on-going space plasma missions represented by Geotail, Nozomi, Reimei, Arase, SCOPE, and MMS. While the Nozomi and SCOPE missions have not fully been completed as noticed, their instrumental heritages are essential also in this future mission.

The FACTORS mission is now been planning to consist of two or three similar compact satellites and keep a peculiar type of sun-synchronous orbit in the noon-midnight meridian with altitudes from 300km as a targeteded perigee to 4000km in apogee while the initial perigee altitude would be around 400km because we should avoid significant air drag effects in the initial critical operation phase and the close observation phase by close formation flight during just after the launch by a single Epsilon rocket of JAXA. What is the crucially different from the previous/ongoing Japanese space plasma missions is that the FACTORS mission has comprehensive and intergrated science subjects over all the elliptic orbit due to the optimized instrumental package and satellite attitude control. The main three science goals could be summarized as follows:

1. Energy coupling processes between the magnetsphere and the upper ionosphere due to various transport/propagation/mapping mechanisms in the space plasma particles/waves, the electric/magnetic fields, and the field-aligned currents
 2. Terrestrial plasma acceleration and upward transport mechanisms caused by the electric fields, plasma waves, and atmospheric heating
 3. Response and dynamics in the neutral upper atmosphere due to the energy transport from the space.
- It should also been noted that our Japanese community has not acheived multiple-satellite(formation

flight) mission yet although NASA and ESA have successfully launched and operated several types of the formation flight mission in the space physics. Also in Korea, the formation flight mission using cubesat techniques, called SNIPE, is now under development for the launch around 2021. The FACTORS mission, therefore, could contribute to the many-sided space sciences and technologies and also achieve essential discoveries as the state-of-the-art space exploration mission led by the Japanese space plasma community, which yields important insights and brings future perspectives for discussing the universal space-planet coupling mechanisms in the extra-terrestrial and exoplanetary systems. In this presentation, we address the science objectives and the current mission plan of FACTORS on the basis of the recent progress by both science discussions and engineering investigations.

Keywords: Spacecraft Exploration, Space-Earth Coupling, Future Mission, Instrumental Development, Space Plasma, Upper Atmosphere