RECENT RESEARCH ACTIVITIES

Simulations and modeling of geospace environment

(Laboratory of Computer Space Science, RISH, Kyoto University)

Yoshiharu Omura and Yusuke Ebihara

We have investigated the properties of whistler mode wave-particle interactions at oblique wave normal angles to the background magnetic field. We find that electromagnetic energy of waves at frequencies below half the electron cyclotron frequency can flow nearly parallel to the ambient magnetic field. We thereby confirm that the gyroaveraging method, which averages the cyclotron motion to the gyrocenter and reduces the simulation from two-dimensional to one-dimensional, is valid for oblique wave-particle interaction [1]. We have conducted a self-consistent hybrid simulation, successfully reproducing electromagnetic ion cyclotron (EMIC) emissions with falling tone frequencies. The hybrid simulation is implemented with a parabolic ambient magnetic field [2]. We have also carried out a series of self-consistent electron hybrid code simulations for the dependence of chorus generation process on the temperature anisotropy and density of energetic electrons in the Earth's inner magnetosphere. We find that the chorus generation processes reproduced in the simulation results are consistently explained by the nonlinear wave growth theory [3].

When a substorm occurs, a bright aurora travels westward quickly. This is called a westward traveling surge. Using computer simulation, we found the reason why the bright aurora travels westward. A key parameter is the ionospheric conductivity depending on the upward field-aligned current. When we increased the ionospheric conductivity in the downward field-aligned current (although this situation is unrealistic), the bright aurora travels eastward [4]. We also show the pathway of energy from the solar wind to the ionosphere during the substorm expansion. The conversion of energy among electromagnetic energy, kinetic energy, and thermal energy is also shown [5]. In 1770, very bright aurora dominated by red color was witnessed in Japan and China. Using computer simulation, we investigated possible cause of the bright red aurora. Electrons with energy less than 100 eV should selectively precipitate into the ionosphere from 32 to 42 invariant latitudes to explain contemporary documents and paintings. The low energy electrons may originate in the plasmasphere, which could be accelerated to several tens of eV [6].

References

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