



## **Perspectives of the studies of wave-particle interactions in the inner magnetosphere: RESONANCE project**

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### **Problem Statement**

A new space project RESONANCE is aimed to study wave-particle interactions and plasma dynamics in the inner magnetosphere. The main goals of the RESONANCE project are as follows:

1. Long-term observations of the natural phenomena:
  - (a) Dynamics of magnetospheric cyclotron maser,
  - (b) Ring current formation,
  - (c) Refilling of plasmosphere after magnetic storms,
  - (d) Study of the role of the small-scale phenomena in the global plasma dynamics.
2. An artificial influence on the operation of magnetospheric maser. Basic options following are:
  - (a) Artificial excitation and/or stimulation of wave modes;
  - (b) Modification of the flux of particles precipitation;
  - (c) Variation of maser Q-factor by modifications of the reflection index at the ionospheric footprint of the selected magnetic flux tube.

## Orbit selection

A satellite with a specially selected orbit must be able to provide measurements along a single magnetic flux tube during sufficiently long time intervals and allows us to investigate a given region to study in details long-term evolution of plasma phenomena. The optimum orbit would provide position the spacecraft inside the specified flux tube for the maximum time length. This choice places conditions on the inclination angle of the orbit. However, we will consider that the magnetic flux tube co-rotates with the Earth and the position of flux tube can be predicted. So, a long time rendez-vous between the two satellites has been calculated and constrains the magnetic latitude of the operating orbit, which must be in the inner magnetosphere near from the plasmopause.

## Mission Scenario

Two satellites will be launched in the magneto-synchronous orbit, conjugated to the ground based heating facility HAARP. Satellites will be located up to forty minutes in the flux tube, with footprint in the ionosphere over the heater: while one of them will be in the northern hemisphere, another one will be in the southern.

## “Active” pars of the scientific programme

The “Active” part of the measurements will focus on joint experiments of the RESONANCE satellite(s) and ground-based HF heating facility. This experiment is based on the possibility that parameters of the natural oscillatory systems of the magnetosphere can be changed under the effects of artificial ionospheric modification. Powerful HF electromagnetic emissions will heat the ionosphere, and will modulate the ionospheric mirrors for the cyclotron waves. This will permit an evaluation of important underlying principles in the cyclotron maser theory and to clarify the role of ionospheric mirrors in wave generation. In the case of in-phase modification, the amplitude of the natural oscillations should be increasing and while anti-phase modification should be decreasing the oscillations. Natural magnetospheric oscillations will be measured on-board the RESONANCE satellites. These measurements results will be transmitted to the receiving station close to the heating facility, and will be used to feed back the modulation of the HF radiation.

In this experiment, the telemetry line (with a controlled phase shifter), connecting the satellite and the heating facility, will regulate the feedback adjusted with the phase of the magnetospheric oscillatory system.

## Planning

Phase A of the project was finished in 2003. Phase B (realization) starts in 2004 and launch planned in 2009. Operation in flight planned during 5 years - up to 2014.

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