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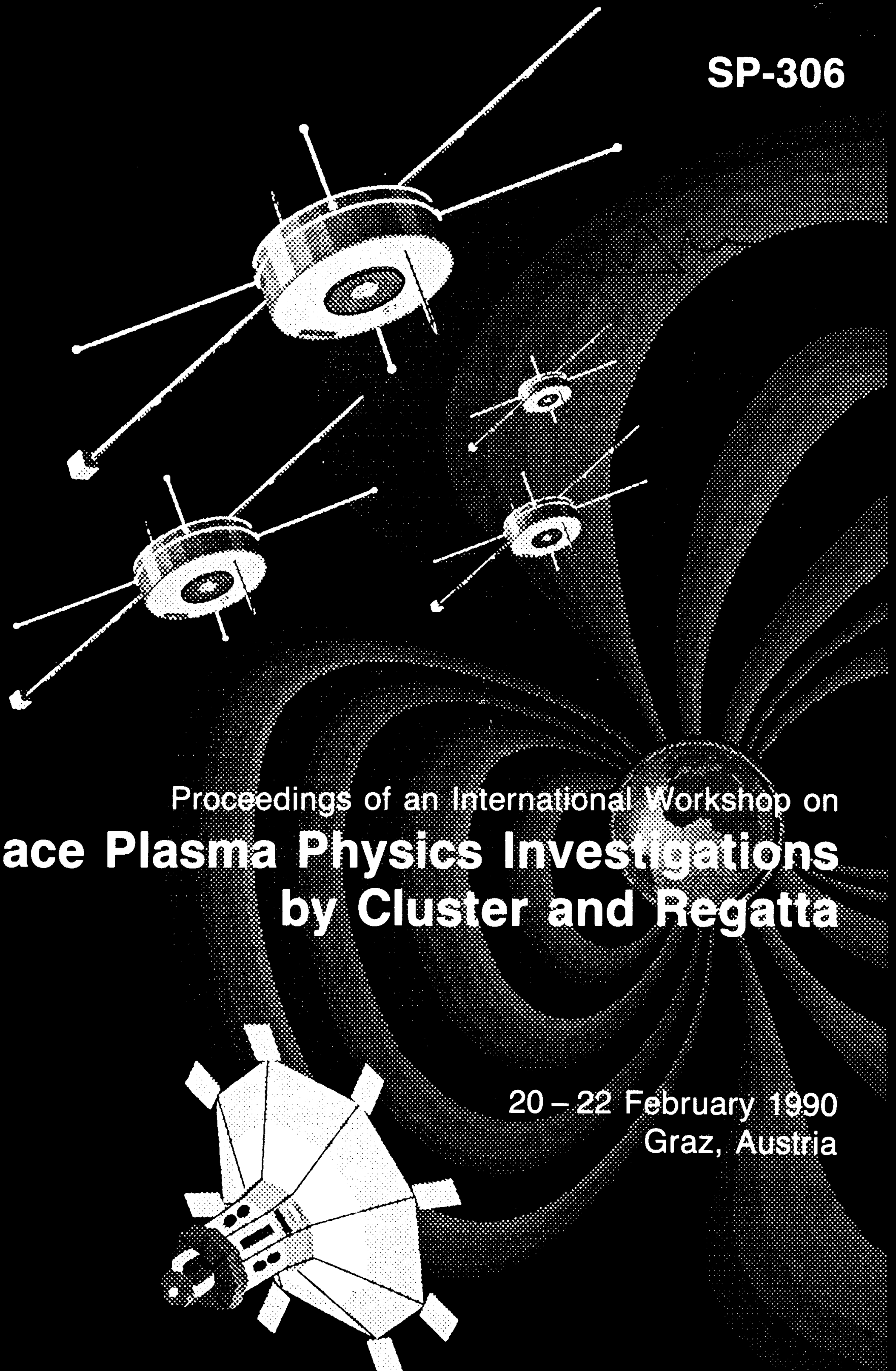

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SPECIFIC TASKS OF REGATTA-E MEASUREMENTS CORRELATED WITH CLUSTER/REGATTA-A IN THE ISTP AND REGATTA PROGRAMMES

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ABSTRACT

Perspectives of the magnetosphere studies aboard REGATTA-E s/c are discussed including the scientific objectives and payload proposals. This new Soviet near-equatorial SC is to be launched in the end of 1994 for 5-year period overlaping with operation of REGATTA-ASTRO, REGATTA-A and ISTP s/c, providing coordinated measurements of fields and particles.

1. SCIENTIFIC PROBLEMS OF MEASUREMENTS AND PHYSICAL QUANTITIES TO BE STUDIED

REGATTA-E orbit parameters should be optimized so as to solve principal scientific problems that need experimental studies. The planned orbit for the near-equatorial REGATTA-E satellite with the apogee 10-12 Re and perigee 3-4 Re permits investigating the following large scale plasma formations in the Earth's magnetosphere: outer plasmasphere region, ring current, outermost radiation belt, plasma sheet as well as near-equatorial magnetopause regions. Since the ring current dominates in the development of global geomagnetic disturbances and essentially contributes to the dynamics of many magnetospheric phenomena its study is of especial importance.

The region of ring current location coinsides with near-equatorial portion of outer radiation belt and the outer zone of the plasmosphere. The outer boundary of plasmasphere - the plasmapause - locates in the equatorial plane within 3 Re to 7 Re depending on the geomagnetic disturbance level (see Fig.1, Ref.1).

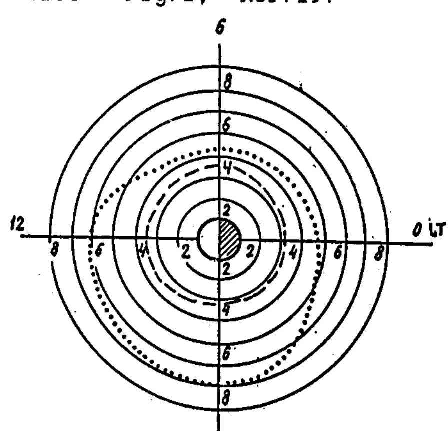

Fig.1 Schematic shape of equatorial plasmapause from measurements of PROGNOZ s/c sery depending on geomagnetic activity
... quite conditions
--- disturbance

The global magnetospheric convection of the cold plasma affects much the plasmosphere size. Thus the convection rate is one of the factors which have an effect on physical processes in that magnetospheric region which is a goal for the REGATTA-E satellite. The interaction of the fluxes of energetic charged particles generating a ring current with the plasmasphere cold

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plasma leads to forming instabilities and waves and, finally, to heating the plasmosphere. This interaction is one of the basic mechanisms which give rise to decaying the ring current and damping the geomagnetic storm. These intricate processes are important part of the magnetosphere physics and still studied poorly.

Only in 1985 the AMPTE/CCE satellite measured for the first time the chemical composition and the extent of ionization of ring current ions. Since ionospheric ions are mainly single-charged their presence in the ring current evidences convincingly that together with ions fell into the magnetosphere from the solar wind during geomagnetic storms the most part of the ring current is formed by ions of atmospheric origin. However, AMPTE measurements were not made concurrently with measurements at other magnetospheric tail regions far distant from the Earth as well as at other points of the magnetosphere and in the interplanetary space; therefore, these first measurement, regardless of their significance, could not reveal sequences of events in different regions of the magnetosphere which lead to forming the ring current and to changing in the composition of its ions (Ref.2).

These measurements allowed evaluating the energy contribution of different ions as follows: 90% of energy contribution are given by:

protons (H^+) with E = 15-200 keV	> 50 %
oxygen (O^+) with E $\geqslant$ 50 keV	> 27 %
helium (He^+, He^{++}) as well as small components $(C + N + O)^{+5}$	< 10 %

The Soviet geostationary satellite GORIZONT performed in 1985 measurements of the composition and charges of ring current ions. They were conducted at a fixed distance between the Earth and the satellite and they could not yeild the exhaustive explanation to physics of the whole events associated with the ring current and geomagnetic storms (Fig.2, Ref.3).

Simultaneous multipoint measurements in the magnetosphere including the ring current

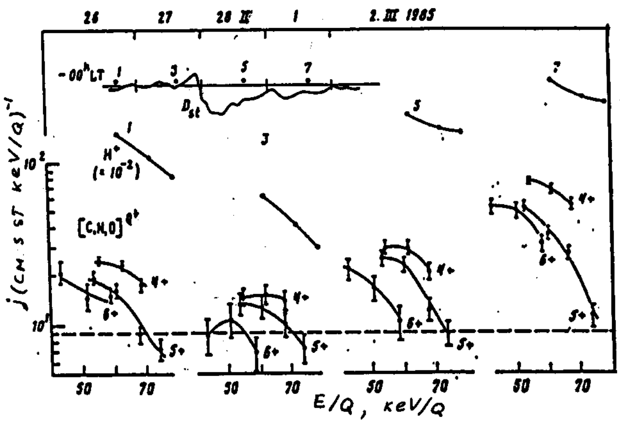

Fig.2 Energy spectra of H and (C,N,O) ions with Q-4.5 and 6 in the nightside sector of geostationary orbit according to "Gorizont" satellite observations.

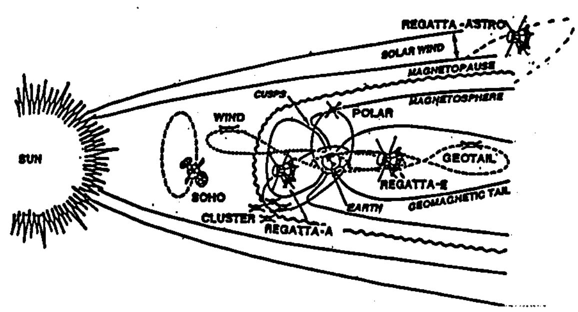

Fig.3 Schematic position of REGATTA-E relative to the other planned s/c.

zone have not been carried out to date. They are primary important as for magnetosphere physics as for general problems of the interaction between the cold and hot plasma. The REGATTA-E spacecraft allows us to study these problems and to supplement essentially measurements performed by the Global Geospace Science International Satellite System (see Fig. 3).

2. MEASUREMENTS OF THE RING CURRENT MASS AND CHARGE DISTRIBUTION

It is likely that under the mentioned orbit parameters of REGATTA-E satellite it should be launched into the magnetotail at the initial stage. This must be done to study at the beginning of the spacecraft existence the problem of forming and decay of the ring current in connection with physical events in other magnetosphere regions (that will be studied on the INTERBALL and GLOBAL GEOSPACE SCIENCE satellites).

The authors of the AMPTE/CCE measurements (Ref.2) stress the variability of the given parameters from a storm to a storm and in different cross-sections of the current global structure. The given data point to the expediency of the following plasma measurements:

1) mass composition of ion fluxes and their pitch-angular and energy distributions in the range 1-200 keV with the number density $N<1\ cm^{-3}$ and fluxes up to $10^{9}\ (cm^{2}s)^{-1}$;

2) extent of ionisation of heavy ion depending on L with the energy density up to 10^{-10} erg cm^{-3}, and fluxes up to $10^{5}\ (cm^{2}s)^{-1}$

3. RING CURRENT INTERACTION WITH OUTER PLASMOSPHERE AND THE RESPECTIVE WAVE MEASUREMENTS

In the outer plasmasphere (L>3) there is observed an increase of cold ion temperature (Ref.4). This is the loss zone in the ring current at the recovery phase of magnetic storm, that is belived to appear due to ion-cyclotron waves in the process of the interaction of cold and hot plasma components (Ref.5). Later the theoretical analysis of generation and suppression of waves in the presence of heavy ion additive in the ring current and in cold plasma has shown that the additives drastically change the resonance conditions in this region, supressing the waves at frequencies higher than the cyclotron frequencies of the i sort heavy ions i:$(f>f_i)$ and increasing them at lower frequencies (Ref.6).

Thus on the shell L = 4, where the proton-cyclotron frequency f_{H^+}= 7.5 Hz, the presence of ions O^+ with f_{δ}= 0.5 Hz will increase the waves with a frequency $f < f_{O^+}$ and suppress the proton-cyclotron waves. Ion-cyclotron wave generation near the plasmapause can be an effective mechanism of the ring current losses at a recovery phase and concurrently it may cause heating of the plasmasphere outer zone in the plasmapause vicinity. This shift of the resonance frequencies in the presence of heavy ions to the lower values can account for failures of the wave experiments, in which the ion-cyclotron waves were not successful in recording. On the other hand, there are certain successful results in recording of Pc-2 pulsations, corresponding to resonant frequency f_r = 0.1 Hz, obtained at L = 5.6-7.8 in the period of filling the outer plasmasphere at recovery phase of magnetic storm aboard ISEE-1,2 satellites, and the measurements in the plasmasphere on low-altitude satellites (discrete emissions at low-hybridresonance frequency f = 4-18 kHz (L = 2.3-4.0), as well as VLF radiation of the aurora seems extremely important to conduct the wave measurements in the plasmapause vicinity at frequencies beginning with fractions of one Herts (Ref.7-9).

There exists another mechanism of losses. It is connected with the interaction between ring current ions and neutral geocorona hydrogen, that leads to forming energetic neutral atoms. This charge-exchange interaction with geocorona can be essential mechanism of losses in the ring current and the magnetic field recovery after storm. Therefore, it is worth supplementing the plasma-wave paskage with the neutral energetic particle scanner up to 20-40 keV (Ref.2).

4. MODEL SCIENTIFIC PAYLOAD

4.1. Cold Plasma

3-D Energy-mass spectrometer

Ei/Qi	0.1 - 100 V
Ni	0.1 - 1000 cm

3-D Electron spectrometer

Ee	up to 50 eV
Ne	1 - 100 cm

HF resonance probe

Ne	0.1 - 100 cm

4.2 Magnetospheric plasma

3-D Ion Energy-mass-spectrometer

Ei/Qi	1 - 30 kV
Mi/Qi	1 - 50 a.u.

Ion Energy-mass-charge spectrometer

Ei/Qi	up to 150 kV
Mi	1 - 32 a.u.
Qi	1 - 10

3-D Ion Energy Spectrometer

Ei/Qi	up to 50 kV

3-D Electron Energy Spectrometer

Ee	up to 50 kV

4.3 Energetic particles.

Ion spectrometer

Ei	0.2 - 20 Mev/nuc

Electron spectrometer

Ee	20 KeV - 5 MeV

4.4 Fields and waves

3 components flux-gate magnetometer

H	0.1 nT
F	0 - 100 Hz

3 components measurements of electric current

F	0 - 100 kHz

3 components measurements of DC electric field

E	0.1 mV/m - 10 V/m
F	0 - 10000 Hz

6 components measurements of electromagnetic waves

F(E)	50 Hz - 800 kHz
F(H)	1 Hz - 10 kHz

Frequenqy correlator for plasma waves and dencity oscillations

F	0 - 50 Hz

4.5 Satellite potential control Ion gun emission current.

REFERENCES

1. Gringauz K.I. 1983, Plasmasphere and its interaction with the ring current, Space Sci. Rev.,.35,245

2. Williams D.J. 1988, Ring current and radiation belts, Rev. Geophys.,. 26,2, 229-248

3. Vlasova N.A., Kovtyuch A.S., Panasyuk M.I. et al. 1988, The ion ring current during geomagnetic disturbances observed on geostationary orbit, Kosmicheskie Issledovania, .26, 5, 747-752

4. Besrukich V.V., Gringauz K.I. 1976, The hot zone in the outer plasmasphere of the Earth, J.Atmos. Terr.Phys., .38, 1085-1091

5. Galeev A.A. 1975, Physics of hot plasma in the magnetosphere,. N.Y.-L., Plenum Press, 251

6. Kozura J.U., Gravens T.E., Nagy A.F., Fontheim E.C. 1984, Effect of energetic heavy ions on electromagnetic ion cyclotron wave generation in the plasmapause region, J.Geophys. Res.,. 89, 2217-2233

7. Fraser B.J., Samson J.C., McPherron R.L., Russel C.T. 1986, Ion cyclotron waves observed near the plasmapause, Adv. Space Res.,. 6, 3, 223-226

8. Hansen H.J., Scourfield M.W.J., Rash J.P. 1986, Correlated pulsations in the auroral light intensity and narrow band VLF emission, Adv. Space Res.,. 6, 3, 227-230

9. Boskova J., Jiricek F., Smilauer J., Triska P 1986, VLF emission at freqences above the LHR in the plasmasphere as observed on low-orbiting Intercosmos sattelites, Adv. Space Res.,. 6, 3, 231-234