



Prof. S.S. Moiseev (23.11.1929 - 05.06.2002)

Preface

These proceedings includes a most of papers presented at the International Conference MSS-14 ("Mode Conversion, Coherent Structures and Turbulence") which was held in the Space Research Institute of RAS, Moscow, Russia from 24-d till 27-th of November 2014 and was devoted to the 85-th anniversary of Professor S.S.Moiseev. This volume contains 70 papers organized in the following Sections: Section 1 "The interaction of waves and charged particle with homogeneous and inhomogeneous media" – 28; Section 2 "Large-scale instabilities in hydrodynamics and plasmas" – 23 and Section 3 "The turbulence in plasmas and in the atmosphere and MHD-turbulence" – 19. Some short memoirs about professor S.S. Moiseev additional to published in MSS-09 proceedings are presented at the book end.

At MSS-14 Conference with the participation of leading Russian specialists and foreign ones it was discussed the modern state of investigations in the fields of helical media and chiral one dynamics including the following problems: the small-scale structures and large-scale ones interaction, the chirality influence on the electromagnetic waves propagation and the interaction of charged particle beams with plasmas, the mode conversion in inhomogeneous media; the analysis of medium inhomogeneity, in particular, nanoscale layers and the turbulence role in waves dynamics, the studying of large-scale structures

generation (including the powerful spiral vortices forming), the resonance tunneling of waves in plasmas, dielectrics, ocean and atmosphere with small-scale structures of large amplitude, the development of new approaches to these problems in analytical investigations and numerical simulations of processes considered, the development of techniques of experimental data collection, methods of these data processing and results obtained correct interpretations, the forecasting of nonlinear dynamics of large-scale structures and their applications in natural disasters analysis, the study of nonequilibrium medium states forming under powerful sources pumping.

Main Sections of Conference Scientific Programme are as the following.

1. The interaction of waves and charged particle with homogeneous and inhomogeneous media (the mode conversion, the resonance tunneling of waves in stratified media, the charged particles acceleration including **surfatron acceleration of charges in space plasmas by electromagnetic waves**, the wave barrier transillumination, the radiation of slow waves from the inhomogeneous plasma, the instability beam-plasma system, the influence of chirality, helicity and nonlinearity on these processes, possible applications in hydrodynamics, plasmas, astrophysics and nanophysics).

2. Large-scale instabilities in hydrodynamics and plasmas (nonlinear stabilization; the influence of helicity, rotation and small-scale structures, the precursors of crisis processes development, the modeling of coherent structures evolution, applications in the natural disasters forecasting, for the helical structures generation in plasmas and astrophysics during nonlinear dynamics).

3. The turbulence in plasmas and in the atmosphere and MHD-turbulence (methods of analytical description and computer simulations, the direct and inverse cascades for an energy and helicity, the analysis and modeling of multifractal characteristics of turbulent fields, the influence of intermittency and coherent structures presence, the studying of role of small-scale components interaction with large-scale ones, the influence of turbulence on energy and mass transport, rebuilding processes, methods of the turbulent fields data processing and results obtained correct interpretations, the generation of fast charged particle fluxes (including cosmic rays) by turbulent electromagnetic fields in the laboratory plasma and space one).

The conference program included plenary lectures, invited and oral talks and posters. It demonstrated the high scientific level of researches performed and their promising further developments.

The MSS-14 meeting has showed that the problems of mode conversion, coherent structures and turbulence dynamics are among the most actual tasks in the modern science and require further development both theoretical and experimental investigations. These problems have important applications in various fields of science and technology. We hope this book will be interesting to all researchers working in these fields and allied scientific areas also.

The mentioned above problems were in the scope of Professor S.S.Moiseev's interest, which was the world-known scientist and made substantial contribution to the following areas of scientific researches :

- a) the problem of plasma stability;
- b) the linear and nonlinear mode conversion in inhomogeneous and nonstationary plasmas;
- c) structural properties of turbulence in plasma and hydrodynamics and large-scale coherent structures generation;
- d) the influence of helicity on the nonlinear media dynamics;
- e) nonequilibrium medium states forming under powerful source pumping and new type of radioisotope sources of current;
- f) wave processes in the chiral materials and the problem of chiral media stability including the charge particles-wave interaction influence.

Scientific results of principal importance obtained by him gave the impulse to further development of these areas of science.

The most important scientific results obtained by S.S.Moiseev and his collaborators may be formulated briefly as the following.

- 1) The studying (together with R.Z. Sagdeev, G.M. Zaslavsky, V.N. Oraevsky, A.A. Galeev, E.Ya. Kogan, A.M. Friedman) of new types of plasma instabilities including dissipative, secondary and low-frequency thermal ones which influence substantially on the magnetized plasma confinement. In particular, the universal drift-dissipative instability was founded (together with R.Z.Sagdeev) which may exists both in the fully ionized plasma and partially ionized one and results to the very dangerous (for a plasma confinement in magnetic mirrors, for example, in tokamaks) turbulent Bohm diffusion.

2) Investigation of linear and nonlinear mode conversions in inhomogeneous plasma and discovery of new principally important effects including the following:

- the possibility of 100 % linear mode conversion in inhomogeneous media and nonstationary ones;

- the higher harmonics generation under the electromagnetic wave interactions with the inhomogeneous plasma in the plasma resonance layers (together with V.E. Zakharov, N.S. Erokhin); this effect was confirmed experimentally and it is important, in particular, for a plasma parameters diagnostics and the interpretation of solar radiation spectra;

- the analysis of electromagnetic wave beams self-focusing in the inhomogeneous plasma and their passage into the overdense plasma region (together with R.Z. Sagdeev, V.V. Mukhin, N.S. Erokhin, V.E. Novikov); this phenomenon is important for the overdense plasma heating by powerful electromagnetic radiation and for nonlinear transillumination of the thick opaque plasma layers, for example, electromagnetic signals transmission from antenna covered by the dense plasma;

- the study of nonlocal kinetic effects arising at the electromagnetic wave interactions with inhomogeneous plasma and the discovery of thick wave barrier effective transillumination, conditioned by the phase focusing of charged particle microbeams, which was confirmed experimentally (together with A.A. Vodyanitsky, N.S. Erokhin, V.N. Oravsky, V.I. Muratov et.al) in Kharkov physico-technical institute.

3) The investigations of coherent structures and structural properties of turbulence are as the following:

- the search of new frozen integrals and lagrangian invariants in the medium hydrodynamical models (together with R.Z. Sagdeev, A.V. Tour, V.V. Yanovsky);

- the investigations of non-kolmogorov regimes of strong turbulence both in the usual- and magneto hydrodynamics related to the cases of finite correlation times of fluctuations, the analysis of their characteristics dependence on the external random force strength (together with S.N. Gordienko);

- the analysis of transport processes features conditioned by excitation of nonkolmogorov-type of turbulence (together with S.N.Gordienko, O.G. Chkhetiani);

- the search of possibilities for hydrodynamical drag reduction due to the coherent structures generation in shear flows.

4) Investigations on nonlinear media helical dynamics include the following:

- theoretical study of the new important instability in geophysical hydrodynamics related to large-scale helical structures generation by intense small-scale turbulence due to the energy inverse cascade (together with R.Z. Sagdeev, A.V. Tour, G.A. Khomenko et al.); this effect was confirmed experimentally during course of two ship expeditions to Pacific ocean; on the basis of this instability the new helical mechanism of tropical cyclones generation was suggested;

- the helical mechanism of vortical structures excitation in geophysical hydrodynamics was generalized to the cases of plasmas and magnetics (together with E. Golbraikh, V.G. Pungin);

- the new physical system of precursors of large-scale natural hazards development was formulated and substantiated (together with A.F. Nerushev, A.A. Lazarev, S.N. Netreba);

- it was shown the possibility of transport processes weakening in turbulent media (for example, the turbulent viscosity reduction) if the helical structures generation occurs (together with A.V. Belyan).

5) Results on nonequilibrium distributions of charged particles and radioisotope sources of current are as the following:

- the new power-law distribution of charged particles in nonequilibrium media, for example, in the thin metallic films, under powerful energy source pumping was obtained (together with V.I. Karas, V.M. Kontorovich, V.E. Novikov);

- on the basis of power-law distribution of charged particles in solid state plasmas the new type of atomic battery (so called secondary emission radioisotope source of current) using the ion-electron emissions from thin metallic films was elaborated (together with V.I. Karas, V.I. Muratov, S.I. Kononenko, V.M. Balebanov); such battery will have enhanced efficiency (about 10 % and more) and it allows the direct conversion of the nuclear energy to the electric one;

- the new mechanism of ultrarelativistic acceleration of charged particles by intense electromagnetic waves in the weakly inhomogeneous plasma and power-law distribution of accelerated particles were studied; its applications to the problem of cosmic rays generation was con-

sidered (together with R.Z. Sagdeev, N.S. Erokhin, V.L. Krasovsky et.al.).

6) The investigation of features of electromagnetic waves propagation, their generation and absorption in weakly inhomogeneous chiral media were started and the following results were obtained:

- the governing equations to describe the electromagnetic waves interaction with inhomogeneous chiral plasmas were derived and the analysis of polarization characteristics conversion for propagating hybrid electromagnetic modes was performed (together with N.S. Erokhin);
- it was proven the 100 % hybrid mode conversion in the case of normal waves incidence upon inhomogeneous plasma and it was shown that in the chiral inhomogeneous plasma without the external magnetic field, the plasma resonance layer may be open for the electromagnetic wave propagating from the vacuum (together with N.S. Erokhin);
- the new instability conditioned by the medium chirality was founded (together with O.G. Chkhetiani, V.G. Pungin);
- the Ohm law was generalized to the case of chiral plasma (together with O.G. Chkhetiani, V.G. Pungin).

These studyings are very important for elaborations of new materials with unusual electromagnetic properties and for the effect of media resonance tunneling by electromagnetic waves in the presence of large amplitude sub-wavelength structures (this result was obtained on the basis of exactly solvable analytical models).

Besides, S.S.Moiseev gave much attention to other scientific problems such as the cold thermonuclear fusion, the search of ways to solution of the greenhouse effect. This characterizes the breadth of his mentality.

The results of performed studyings were published by Professor S.S.Moiseev in the numerous papers and the number of monographies, including, for example, the following.

1) N.S. Erokhin, M.V. Kuzelev, S.S. Moiseev, A.A. Rukhadze, A.B. Shvartsburg. Nonequilibrium and resonant processes in plasma radiophysics, Moscow, Nauka, 1982, - 271 p.;

2) H. Branover, S.S. Moiseev, E. Golbraikh, A. Eidelman. Turbulence and Structures: Chaos, Fluctuations, and Helical Self-Organization in Nature and Laboratory. – San Diego: Academic Press, 1999, - 270 p.;

3) S.S. Moiseev, V.N. Oraevsky, V.G. Pungin. Nonlinear instabilities in plasmas and hydrodynamics. Bristol: IOP Publishing, 1999, - 176 p.

4) N.S. Erokhin, S.S. Moiseev. Wave processes in inhomogeneous plasma. – In: Voprosy teorii plazmy, ed. By M.A. Leontovich, Atomizdat, 1973, v.7, p.146.

5) N.S. Erokhin, S.S. Moiseev. Problems of linear and nonlinear mode conversion. Uspekhi Fiz. Nauk, 1973, v.109, № 2, p.225.

The results obtained by S.S.Moiseev are world-wide recognized and had borne him the high authority in the international scientific community. He was awarded by the high prizes, in particular, the 1977 Ukrainian state award in science and technology, the 1987 USSR state award in science and technology. Besides S.S.Moiseev was conferred the title of an Honored Scientist of Russia. He was elected the honored member of the Russian Astronautics Academy. During a number of years S.S.Moiseev was a scientific sessions convener at the General Assemblies of the European Geophysical Society. He was also the Organizing Committees member for a number of large international scientific meetings.

S.S.Moiseev devoted much time to the experimental confirmation of theoretical results obtained and to the possible practical applications of them. In particular, he received more than 8 certificates on inventions and 3 patents indicating the importance of his scientific results for various practical applications.

To demonstrate his scientific achievements the part of 280 papers list of S.S.Moiseev's publications was given early in the International Conference MSS-04 Proceedings "Mode Conversion, Coherent Structures and Turbulence" (Moscow, URSS Publishing House, 2004, - 552 p.).

R.Z. Sagdeev, V.E. Zakharov, N.S. Erokhin, E.Ya. Kogan, E. Golbraikh, V.I. Karas, A. Eidelman, S.N. Arteha, O.G. Chkhetiani, A.I. Neishtadt, A.S. Petrosyan, A.V. Tour, A.M. Egorov, V.A. Buts, E.B. Kudashev, S.I. Kononenko, L.A. Nazarenko, E.A. Kornilov, G.V. Levina.