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Russian-Italian Workshop on "Nonlinear Processes in Laboratory and Astrophysical Plasma"

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The Russian-Italian Workshop on "Nonlinear Processes in Laboratory and Astrophysical Plasmas" was held on February 24–27, 1998, in Zvenigorod near Moscow.

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The physics of nonlinear processes is now a wide and well-developed part of contemporary knowledge in which progress is being made at a very fast pace. Such rapid progress is made possible by the development of the theory of nonlinear systems, by its important applications in various fields of modern science and technology, and by the advantages offered by modern supercomputers. Plasma physics has traditionally been a source of numerous problems and methods in nonlinear science.

This Workshop was organized on the initiative of the Italian Consulate in Moscow and of the scientific attaché, Professor Moreno Vaselli. The Workshop provided a forum for scientists from Russia and Italy who have collaborated for many years on the theory of nonlinear processes in plasmas. The core of this collaboration is formed by the group from the General Physics Institute of the Russian Academy of Sciences in Moscow and the group from the Physics Department of Pisa University.

A number of additional groups actively participate in this collaboration: on the Russian side, the Faculty of Computational Mathematics and Cybernetics of Moscow State University, the Faculty of General and Applied Physics of the Moscow Institute for Physics and Technology, the Institute of Computational Technologies of the Siberian Division of the Russian Academy of Sciences in Novosibirsk, and the Institute of Theoretical and Experimental Physics in Moscow, and on the Italian side the Scuola Normale Superiore in Pisa, the Institute for Plasma Physics-CNR in Milan, and the Department of Physics of Milan University. This scientific collaboration also involves scientists from the Departement Spatiale, Observatoire de Paris-Meudon, France, the Instituut voor Plasmafysica in Rijnhuizen (Utrecht), the Netherlands, the Physics Department of Bologna University in Italy, the Kurchatov Institute of Atomic Energy in Moscow, from the Budker Institute of Nuclear Physics in Novosibirsk, and the Space Research Institute of the

Russian Academy of Sciences in Moscow. At the Workshop, in addition to the presentations made by scientists Russia and Italy, results of joint research programs carried out in Holland and France were also presented.

The Workshop was supported by the Russian Foundation for Basic Research, by the Embassy of the Italian Republic to the Russian Federation, by the Ministry of Sciences and Technology of the Russian Federation, and by the Consiglio Nazionale delle Ricerche of Italy.

Several subjects were discussed during the workshop related to the basic problems of the interaction of high-intensity ultra-short laser pulses with matter, magnetic field line reconnection and acceleration of charged particles in laboratory and space plasmas, the dynamics of vortex systems, nonlinear processes in gravitating plasmas (galaxies and stellar systems), nonlinear magnetohydrodynamics of high electric current discharges, and the fundamental problems of regular and chaotic behaviour of dynamic systems.

Concerning the interaction of high-intensity laser light with matter, most of the results presented addressed the nonlinear self-consistent evolution of laser pulses during their interaction with plasmas. Talks were given on relativistic plasma waves, on relativistic electromagnetic solitons, on the generation of quasi-static magnetic fields in laser plasma interaction and on the generation of high harmonics of laser radiation, presenting results of theoretical studies and of laboratory experiments. Many of the reports were devoted to discussing the results obtained with computer modelling of the laser plasma interaction on supercomputers. The groups involved in the Russian-Italian collaboration have developed unique 2D and 3D computer codes. These codes provide an opportunity to investigate complex physical processes that are virtually impossible to study within the framework of the traditional analytical approach. Similar computer codes are now available only to a small number of scientific groups in the world. For this reason, several reports were presented at this workshop on specific mathematical problems concerning the numerical simulation of strong electromagnetic fields in plasmas.

A second broad range of problems discussed at the Workshop concerned the dynamics of the vortex systems in planetary atmospheres, galaxies and laboratory plasmas. The results of laboratory studies of vortex behavior in shallow rotating fluids were presented, and their role in the dynamics of various astrophysical objects and in transport processes in laboratory plasmas was discussed. The project of an experimental device for studying vortices in electrically non-neutral plasma was also presented. A detailed discussion took place of the properties of the vortex system generated in Jupiter's atmosphere as a result of the impact of the Shoemaker-Levy comet.

The problems of the reconnection of magnetic field lines in high temperature plasmas were also addressed. These problems have long been of great importance for laboratory and astrophysical plasmas. The results of theoretical investigations of magnetic reconnection in the collisionless plasma of the Earth's magnetosphere were presented, as well as the acceleration of charged particles and reconnection in a collisionless plasma under conditions typical for laboratory devices. A detailed description of the behavior of nonlinear waves in the Earth's distant magnetosphere and in the auroral region was presented. Results of recent laboratory experiments on magnetic reconnection in straight device and in reverse field pinches were also presented. The physics of magnetic reconnection plays an important role in high electric current plasma discharges as well. At this workshop, talks devoted to the study of capillary discharges were presented. Recently capillary discharges have attracted a great deal of attention due to their importance for the production of X-ray lasers and for the guiding of ultra-short laser pulses over long distances. In addi-

tion, there were discussions of some lessons to be learned from experimental plasma focus studies for astrophysics.

Theoretical problems in the behavior of dynamic systems were discussed in several presentations devoted to the appearance of stochasticity in magnetic field lines and in the trajectories of charged particles in magnetic configurations with current sheets. In addition, the general problems of the accuracy of the conservation of adiabatic invariants and of the appearance of stochastic regimes in spatially inhomogeneous fluid flows were discussed.

The audience was very interested in the reports on general problems of plasma electronics, dusty plasmas, and of the ozone hole in the Earth's atmosphere.

Young scientists, including graduate and post-doctoral students, participated in this workshop. Among a total number of 50 participants there were 9 young scientists from Russia and Italy.

This workshop on "Nonlinear Processes in Laboratory and Astrophysical Plasmas" continued a series of previous "SNS-Pisa Easter Meetings" that were held in Pisa yearly around Easter and were organized jointly by the Scuola Normale Superiore and by the Department of Physics of Pisa University. These meetings, aimed at providing an opportunity for presenting and confronting recent results in different fields of plasma physics, were characterized by open and fruitful discussions. The participants in these meetings belonged to groups that had a long experience of collaborating together in plasma research, and they were joined by scientists from different groups from Europe and America. This formula was very successful and has proved successful again in the Russian-Italian Workshop held for the first time in Russia in Zvenigorod. It attracted several Russian scientists who, although not involved in direct collaboration with Italian groups, were nevertheless interested in sharing with them their recent scientific results and in learning about the results obtained by these groups.