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Meetings and Conferences

THIRD INTERNATIONAL CONFERENCE ON PLASMA PHYSICS AND CONTROLLED NUCLEAR FUSION RESEARCH

(Novosibirsk, August 1–7, 1968)

B. B. KADOMTSEV

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THE Third International Conference on Plasma Physics and Controlled Nuclear Fusion was held on August 1–7, 1968 in the small academic town of the Siberian department of the USSR Academy of Sciences. No sensational reports were made at the conference, and to an outside observer it may have possibly appeared not outstanding. However, to the participants of the conference—some 700 delegates and guests from 20 countries—it was not only a propitious opportunity to form a general picture of the development of thermonuclear studies, but also a rather impressive demonstration of progress in all directions, and of the ever-growing advancement in the parameters of thermonuclear plasmas.

Indeed, only ten years ago, at the Second Geneva conference, it seemed a distant and almost unrealizable dream to produce a plasma at a temperature of 10 keV, density of 10^{14} cm^{-3} and containment time of about 1 sec. At the present time, these parameters are approached along several directions. For instance, a plasma at a temperature of several keV, density of up to 5×10^{13} cm^{-3} and lifetime of 2×10^{-4} sec was obtained in the adiabatic trap 2-X (Livermoore); in the toroidal system "Tokamak" (Atomic Energy Institute) the plasma has a density up to 10^{14} cm^{-3}, a temperature 0.3–0.5 keV and a lifetime $\sim 10^{-2}$ sec, while it is possible to create in θ pinches, for relatively short times $\sim 10^{-5}$ sec, quite hot (temperatures of up to 1–2 keV) and dense plasmas (densities up to 10^{17} cm^{-3}).

Even greater progress is observed in the understanding of plasma processes. Apparently, the portion of the conference devoted mainly to the investigation of physical properties of high-temperature discharge plasmas, rather than to applications aspects, is of particular interest to the readers of this journal.

If we begin with toroidal systems, then the data obtained by Gibson et al. (England) in the experimental investigation of the containment of separate particles in a stellarator is of general interest. The measurements have shown that β particles from the decay of tritium can make more than 10^7 revolutions in the stellarator around the trap before reaching the wall. This is proof of the existence of toroidal drift surfaces to an accuracy which is quite sufficient for problems of thermonuclear fusion. At the same time, this result is evidence of the fact that anomalous diffusion is of a collective nature—individual particles are not subjected to it.

As for the question of plasma containment in toroidal traps, even though it has not been fully solved at the conference, it was posed from a new point of view. In several toroidal traps, the non-correspondence of the measured plasma leakage and the transverse turbulent fluxes was demonstrated. This means that the plasma leakage can be related not to buildup of oscillations due to instabilities, but rather to other mechanisms. Many physicists are of the opinion that anomalous losses may be related to uncompensated drift fluxes in the form of distinctive convective cells. The possibility of forming such large-scale plasma inhomogeneities was discussed theoretically at the conference by Furth and Rosenbluth.

It must be mentioned that in recent times interest in drift motions of individual particles in the plasma, and their related additional fluxes, has grown noticeably. In particular, Galeev, Sagdeev, and Furth, and later Kovrizhnykh, recently studied quantitatively the "intermixing" effect pointed out many years ago by Budker. This effect consists of a large increase in the classical transport coefficients in a discharge plasma as a result of larger drift displacements of particles with small longitudinal velocity which are trapped between local magnetic mirrors. This effect alone increases the coefficients of thermal conductivity and diffusion so much that they turn out to be sufficient, for example, to explain the leakage of the plasma from the "Tokamak" under high density conditions. The appearance in the plasma, at a result of its inhomogeneity, of electric fields whose equipotentials do not coincide with the magnetic surfaces could increase even further the corresponding effects.

In another important direction, that of adiabatic traps, progress in the understanding of plasma physics is perhaps even more apparent. It must be noted first of all that operation at low density up to 10^9 cm^{-3}, may be said to have been fully investigated. Here one has a sufficiently clear picture with respect to both the flute and cyclotron plasma instabilities. Extremely detailed investigations at the "Phoenix" installation (England), and also at "Ogra-2" (USSR) and at "Alice" (USA), yielded complete information on the behavior of plasmas obtained by injection of high-velocity neutral atoms. The data obtained with these installations on cyclotron-oscillation buildup in a non-equilibrium plasma is in good agreement with theory.

Among the results at higher densities, of most interest is apparently the absence of an obvious evidence for cone-drift instability, considered in recent years as one of the most dangerous. Whether this comes about as the result of an insufficient precision of the theoretical criteria, or from an insufficient precision in the performed experiments is difficult to say at the present. Another interesting result, obtained in adiabatic traps, is the discovery of a new plasma instability of the "negative mass" type. This instability, known in the theory of cyclic accelerators with weak focusing, is also evidenced quite distinctly in mirror traps. It is interesting that the corresponding experiments and their theoretical interpretation were performed completely independently in the USA (installation DSH-2) and in the USSR (PR-5 trap). Theoretical computations, performed in both cases by taking into account real plasma parameters and the magnetic field geometry, agreed rather well with the experimental data.

In connection with experiments on adiabatic traps, one should mention the quite interesting and recent work of Arsenin and Chuyanov in stabilizing large-scale plasma instabilities with the aid of negative feedback. The concept of stabilization was verified experimentally in the "Ogra-2" installation.

Rather extensive and interesting information was also presented at the conference on shock waves in discharge plasmas, on the interaction of beams of charged particles with the plasma, on the propagation and nonlinear interaction of plasma waves, on high-frequency containment and plasma stabilization, on the behavior of a dense plasma in θ pinches and at the plasma focus, etc.

A more detailed description of the papers on these topics is published in the journal "Atomnaya ênergiya."

In conclusion, it must be noted that the conference was quite successful, largely owing to its smooth organization and the pleasant scientific atmosphere of the academic town.

Translated by L. C. Garder