

category are included the research at Stockholm (Sweden) on rotating plasmas, which shows such gratifying agreement with theory, the elegant experimental demonstration of Landau damping at General Atomic, and the work at Culham and Leningrad (USSR) on propagation of electromagnetic waves through turbulent plasmas. The research on plasma production by laser evaporation of small droplets at Frascati and at United Aircraft (USA) is of interest in that it may mark the beginning of an active research field.

In general the experimental papers presented at the conference showed a high degree of scientific quality. As regards controlled fusion as a practical goal, more knowledge is needed to indicate whether this objective can or cannot be attained. Although both theory and experiment indicate a complexity of instabilities that is somewhat bewildering from a practical standpoint, stabilization of some of these modes appears possible, and adequate plasma confinement for a controlled fusion reactor may well prove feasible.

2. PLASMA THEORY

By Edward A. Frieman

As an appendix to Professor Spitzer's survey of the experimental papers presented at the Culham meeting, we here give a short survey of the theoretical papers with the intent of illustrating the present thinking rather than very explicit or detailed results.

Some time ago Rosenbluth and Post showed that the nonscalar pressure which necessarily results in mirror or open-ended containment devices leads to an electrostatic instability. At the conference, Galeev (USSR) presented a calculation which indicated that the nonlinear effects of this instability lead to an anomalously high diffusion in velocity space into the loss cone of the system. At the present time the only method proposed for curing this loss involves building a very short, fat device. As a consequence of these results, more attention has recently been focused on closed or toroidal containment systems.

The closed devices such as Tokamak (USSR), Zeta (UK), Levitron (USA), and stellarators (USA, USSR, Fed. Repub. of Germany) have had a checkered career at the hands of the theorists. It was demonstrated many years ago that sheared fields were necessary to avoid hydromagnetic instabilities induced by the curvature of the magnetic field in these devices. It was later found that even in the presence of shear, dissipative effects arising from electron-ion collisions lead to unstable behavior. In order to avoid these resistive modes it was then proposed that the sign of the curvature be changed; or in other words, that a minimum-B system be built which is stable against resistive modes. Unfortunately, Maxwell's equations will not cooperate in this endeavor to make

a minimum-B toroidal system and the best that can be done is to create a minimum-average-B device. At the present time there is therefore a high degree of interest in fields possessing this happy property. Contributions from the USA, UK, and USSR contingents on new systems of this type and calculations of their properties were presented and discussed.

At the same time stability calculations continue to supply employment for a large number of plasma theorists. There were contributions again from the USA, UK, and USSR on the stability of sheared devices both with and without the minimum-average-B property.

Two papers, (USA), indicated that at sufficiently high ion temperatures, the resistive modes discussed above are, in fact, stabilized by viscous effects. Thus, in principle, the new minimum-average-B systems are not needed. However, some preliminary work (USA) does indicate that the new systems will probably be better numerically, i.e., they will be easier to stabilize than the systems with shear and poor curvature.

Surveys (USSR, USA) of all low-frequency modes which are likely to occur in these systems, indicate that with high enough ion temperatures and large enough shear they are all either stable or else will grow to a small amplitude and be limited by nonlinear effects. Estimates of the anomalous diffusion resulting in this situation indicate that it should be quite small indeed. Thus, the theoretical predictions made at the meeting were optimistic. Perhaps by the time of the next meeting of this kind some experimental evidence will have accumulated to check these predictions.