Scientific session of the Division of General Physics and Astronomy and the Division of Nuclear Physics of the Academy of Sciences of the USSR (22–23 February 1984)

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On 22 and 23 February 1984 at the P. N. Lebedev Physics Institute of the USSR Academy of Sciences the joint scientific session of the Division of General Physics and Astronomy and the Division of Nuclear Physics of the Academy took place. The following papers were heard at the session:

February 22

1. *B. B. Kadomtsev*. The physics of tokamaks.
2. *L. M. Kovrizhnykh*. Stellarators.
3. *D. D. Ryutov*. Open traps.

February 23

4. *A. A. Borovoĭ, Yu. L. Dobrynin, S. N. Ketov, V. I. Kopeĭkin, L. A. Mikaēlyan, M. D. Skorokhvatov, and A. N. Kheruvimov*. Neutrino experiments in the Rovno Atomic Power Station.
5. *V. M. Lobashev and P. E. Spivak*. On the question of measurement of the mass of the electron antineutrino.

A brief summary of one of these papers is given below.

L. M. Kovrizhnykh. *Stellarators.* In this paper we report the current state and the program of research on toroidal magnetic traps of the stellarator type. This program is a part of the overall program of research on controlled thermonuclear fusion.

The difference of a stellarator from a tokamak lies in the method of creating the stabilizing magnetic field. In a tokamak it is produced by the current flowing in the plasma, while in a stellarator it is produced by a system of special current-carrying conductors (helical windings). The principal advantage of a stellerator in comparison with a tokamak is the possibility of its operation in a stationary regime, which for a tokamak is still problematical. Its main deficiency is the relatively high loss of heat and particles due to the existence of so-called locally trapped particles. In its development (more precisely, in the size of the installations) the stellarator program is behind the tokamak program by 5–10 years, as the result in particular of the pessimistic attitude of most specialists towards stellarator systems, which developed after the unsuccessful experiments in the American C stellarator.

However, significant and very promising results (both in theory and experiment) obtained in the last 3–4 years have shown that stellarator systems are quite promising and apparently can be regarded as one of the alternative systems for a future thermonuclear reactor. At the present time in the world one can count about twenty operating installations of the stellarator type, and there are being planned and in the near future will come into operation (in the USSR, West Germany, Japan, and the USA) several more installations of larger size.

The existing stellarators have produced a plasma in the current-free mode with density $\sim 10^{14}$ cm^{-3}, temperature $\gtrsim 1$ keV, and energy lifetime of the order of tens of milliseconds. These data are comparable, and in certain parameters even exceed, those obtained in tokamaks of similar size. The existing results, like the theoretical calculations, in which significant progress has also been made, permit one to hope that in the installations of the next generation one will obtain a plasma with still higher parameters.

In addition, estimates which have been made, although it is true that they are not very reliable, have shown that in systems of reactor scale it is possible to obtain plasma with sufficiently high pressure $\beta = 8\pi p/B^2$ and parameters satisfying the Lawson criterion.

However, for the final solution of the question of the possibility of using stellarator systems for a thermonuclear reactor it is necessary to solve a number of additional purely physical problems, the answer to which may be of decisive significance. Among these, first of all, we note the following: a) experimental verification of the possibility of reaching the maximum values of β predicted by the theory (which are necessary for an economically justified thermonuclear reactor), b) study of the nature of the energy loss in the rare-collision mode, comparison of experimental data with theoretical predictions, and finding sufficiently reliable scalings which permit estimation of the energy lifetime of a plasma in systems with reactor parameters.

The solution of these problems will require construction of new installations of larger size, comparable in dimensions with the newly constructed tokamaks (TFTR, JET, TEXTOR, and JT-60).

Experiments in such installations will be able to provide a definitive answer to the question of the possibility of using stellarator systems as thermonuclear reactors.

The material in this report has been published in the following articles:

1. Proceedings of the Ninth International Conference of MAGATE on plasma physics and controlled fusion, Baltimore, USA, September, 1982.
2. Proceedings of the Eleventh European Conference on Plasma Physics and Controlled Fusion, Aachen, West Germany, September 1983.
3. Plasma Physics and Controlled Fusion **26**, No. 1A (January 1984).
4. Stellarator Status and Future Direction: Joint US-Euratom Report IPP-2/254, *1981*.

Translated by Clark S. Robinson