# PREFACE

# FIFTEENTH INTERNATIONAL STELLARATOR WORKSHOP

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The Fifteenth International Stellarator Workshop was held in Madrid, Spain, from October 3–7, 2005. The meeting was organized by the Laboratorio Nacional de Fusión-CIEMAT in the framework of the International Energy Agency (IEA) Implementing Agreement on the Stellarator Concept. This series of workshops is biennial except for the early years and already has a history of three decades. More than 120 experts in stellarator research from Japan, Spain, the United States, Germany, Russia, Ukraine, Austria, the United Kingdom, Australia, Italy, Ireland, Switzerland, Costa Rica, the Netherlands, Denmark, and Mexico gathered at this workshop. Fortunately, the annular eclipse of the Sun, which passed over Madrid on the first day of the workshop, was clearly visible, and all the participants enjoyed this magnificent spectacle.

Stellarators bring into reality net-current-free toroidal plasmas, which provide their intrinsic advantages: no disruption due to current-driven instabilities and no need of current drive. The issue of steady-state operation, which is a big challenge for tokamaks, is much mitigated in stellarators. Indeed, demonstration of steady-state operation has been progressing in experiments. While stellarators have the common feature of net-current-free toroidal plasmas, they have large diversity. Although this diversity provides potential for further concept innovation, the direction of optimization has not been sufficiently assessed to date. However, both experimental and theoretical studies and their synergetic work presented in this workshop certainly suggest that the major streams of concept optimization are beginning to converge.

The International Program Committee (IPC) arranged 4 review talks, 27 invited talks, and 101 contributed presentations, 12 of them oral. Review talks were allotted to an overview of the Large Helical Device (LHD), which is the largest and leading experiment in stellarator research, theoretical strategy and critical issues of optimization, physics of internal transport barriers in helical systems, and significance of magnetohydrodynamic (MHD) effects in high beta regime. In addition to the regular program, the IPC arranged a panel discussion, "Stellarator Research in the New Era." This panel discussion aimed at stimulating discussion on the assessment of stellarator research considering the reality of a paradigm shift due to the evolution of experimental devices and the rapid growth of theoretical approaches in stellarator research, as well as the coming of ITER and its related broader approach. Although the discussion has not yet reached the stage of coherent conclusions, a common argument was to maximize the competence of stellarators, in particular, steady state, high beta, and plasma-wall interactions, which will not be sufficiently explored, even in ITER. Also, the advantages of stellarators, i.e., no disruptions and high-density limit, were highly emphasized.

Indeed, steady extension of operational regimes as regards pulse length and beta has been reported by LHD (National Institute for Fusion Science, Japan). Rapid progress in understanding the effect of the helically corrugated magnetic field by detailed experiments in LHD, TJ-II (CIEMAT, Spain), Heliotron J (Kyoto University, Japan), and HSX (University of Wisconsin) and advanced computations to evaluate correctly a figure of merit has suggested the direction of stellarator research. In particular, the feasibility of anomalous transport reduction due to neoclassical transport optimization and

the completion of a physics model on stability and beta limit are primary challenging issues in the coming years. Although unfortunately we still have to wait for several years until the next generation of experiments—W7-X (Max-Planck-Institut für Plasmaphysik, Greifswald, Germany), NCSX (Princeton Plasma Physics Laboratory), and QPS (Oak Ridge National Laboratory)—arrives, the implications from the presently available data are quite favorable to their strategy of quasi-isodynamicity and quasi-axisymmetry.

On this occasion, the Stellarator Executive Committee of the IEA Implementing Agreement on the Stellarator Concept expressed its gratitude to Professor Iiyoshi, who has worked as chairperson of the committee during long years of leadership, with a commemorative gift.

This workshop has covered all aspects of fusion research on helical systems and related concepts. The topics are transport and confinement improvement, MHD equilibrium and stability, turbulence and transport, particle and power handling, divertors and impurity control/transport, plasma heating, diagnostics, configuration optimization, and reactor studies. The IPC believes it is very important to transmit the achievements of the stellarator community to those who do not participate in this workshop. While collections of conference papers are most useful to the participants, they should also reach the whole fusion community as well. For these reasons the IPC has strongly recommended submission of extended versions of the papers to *Fusion Science and Technology* (*FS&T*). This process has followed the tradition established in the last workshop, the Fourteenth International Stellarator Workshop (Greifswald, September 22–26, 2004). We would like to express our sincere thanks to Dr. N. A. Uckan, the editor of *FS&T*, for her tremendous effort to prepare the publication of the issues.

The conference was perfectly organized by the Local Organizing Committee, K. McCarthy, B. Ph. van Milligen, and A. Suarez, whom we would like to thank.

The next (Sixteenth) International Stellarator Workshop will be held in Toki, Japan, in 2007 and will be hosted by the National Institute for Fusion Science, Japan.