BOOK REVIEW

Selection of books for review is based on the editor's opinions regarding possible reader interest and on the availability of the book to the editor. Occasional selections may include books on topics somewhat peripheral to the subject matter ordinarily considered acceptable.

Proceedings of the Fourth International Symposium on Heating in Toroidal Plasmas

Editors	H. Knoepfel and E. Sindoni
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Reviewer	Roger McWilliams

The Fourth International Symposium on Heating in Toroidal Plasmas was held in Rome in late March 1984. The contributed and invited papers have been assembled in two rather formidable tomes edited by Heinz Knoepfel and Elio Sindoni. The participants gave detailed papers on recent work in neutral beam heating, Alfvén wave heating, lower hybrid heating and current drive, and ion cyclotron and electron cyclotron heating. Additional papers and panels discussed related physics and technology such as antenna design, power supplies, and power handling. An interesting addition to the symposium was the attendance of Pope John Paul II at the group photo session.

The neutral beam heating results concentrated naturally on the recent discovery and phenomenology of the H mode. The H and L modes are characterized by particle and energy confinement times with the tokamaks run in divertor mode, which are high or low compared to the ohmic phase. D-III reported confinement studies with up to 7.5 MW of neutral injection. Typical durations of 120 ms of the H mode were reported by the Axially Symmetric Divertor Experiment (ASDEX). Energy confinement times of 65 ms with 2 MW of injection were reported for the H mode, about double the L-mode times. Confinement times were roughly independent of injection power up to 3 MW on the Poloidal Divertor Experiment (PDX). Edge-located modes appeared during the H mode and seem to affect the confinement times. The papers show it to be too early to have determined density scaling laws for these modes. An invited theory paper discussed modeling of the fishbone magnetohydrodynamic instability.

Alfvén wave heating results for both theory and experiment were presented. Identification of global eigenmodes in inhomogeneous plasmas was stressed in theory while experiments identified antenna types tested and plasma responses for power levels of up to a few hundred kilowatts.

Copious amounts of ion cyclotron resonance frequency work, covering from the Joint European Torus (JET) to the Tandem Mirror Experiment-Upgrade, show considerable effort and success with ion cyclotron heating. Theory work showed progress in coupling calculations, wave absorption, energy deposition, and mode conversion. Little theory effort has been made on transport coefficients and edge impurity production. Experimental results on second harmonic heating were reported for JFT-2M, along with studies of the use of a novel transmission electron microscopy electric field coupler. The Princeton Large Torus (PLT) program included discussion of improved understanding of wave physics such as heating and current drive and work aimed at producing 5 MW of heating power. An example of new techniques for higher powers was the rotating limiter. TFR reported the carbon protection of limiters and antennae that led to an order of magnitude reduction in metallic impurity concentrations. The direct utilization of ion Bernstein waves for plasma heating was done on the JIPPT-II-U tokamak. Ion heating of up to 600 eV was observed for a wave power of <100 kW.

Lower hybrid wave contributions generally discussed electron current drive at lower densities and energetic ions at higher densities. ASDEX showed current maintenance in diverted plasmas for 900 ms. Parametric decay was observed at higher densities and showed spectra with sideband peaks separated by the ion cyclotron frequency at the mouth of the waveguide grill. Alcator C succeeded in launching over 1 MW. Toroidal currents up to 230 kA have been driven for densities $<10^{14}$ cm^{-3} using 4.6 GHz. Petula-B maintained 200 kA with 140 kW of 1.25 GHz. The PLT was able to do ramp-up experiments. Additionally, PLT produced a target plasma and then raised the current to over 100 kA with radio-frequency alone. Experiments of a similar nature were done on the JIPPT-II-U tokamak. Theory addressed ideas for the $n_\parallel$ shifts thought to be needed to explain the current drive electron distribution functions.

Electron cyclotron heating experiments were reported by T-10, D-III, Elmo Bumpy Torus, and PDX. Supplies of 60 GHz at 100 kW have been tried. Electron temperature changes of ~1 keV were reported for PDX.

Of special interest are the papers presenting operating parameters for JET and Tokamak Fusion Test Reactor.

Workers in the field of heating in toroidal plasmas will find these two volumes to be handy references for many ideas and results. People not directly involved will find a rare need for access to the volumes and will want a library to have copies, but will not need personal copies. The organizers and editors have done an excellent job of selecting and presenting the work represented in these volumes.

Roger McWilliams received his PhD from Princeton University in 1980 for his work on lower hybrid current drive. He then joined the faculty of the Department of Physics at the University of California, Irvine. His research interests have been mainly in basic experimental plasma physics. He is presently interested in such topics as laboratory simulation of ion acceleration processes in the lower magnetosphere of the earth, fast wave current drive, transport in turbulent plasmas, simulation of pulsar radiation production, and studies of the electrostatic ion cyclotron instability.