JOINT INSTITUTE FOR FUSION THEORY

NEWSLETTER

JUNE 1984

Joint Institute For Fusion Theory

The Institute for Fusion Studies in Austin and the International Center for Fusion Theory in Nagoya work together to form the Joint Institute for Fusion Theory (JIFT). The primary purpose of JIFT is to foster the exchange of scientific research by providing a planned set of exchange visits and workshops between U.S. and Japanese theoretical plasma physicists working on the problems associated with the development of fusion systems.

The JIFT Steering committee representatives are Mr. I. Kawano, Director of Physical Research in the Ministry of Education, Prof. Y. Ichikawa, Director of ICFT Nagoya, Prof. K. Nishikawa of Hiroshima University and Dr. D. Nelson, Director of Applied Plasma Physics in the Department of Energy, Prof. M. Rosenbluth, Director of IFS, Austin, and Prof. J. Dawson of the University of California at Los Angeles.

Exchange Scientists for 1984 to 1985

Prof. Atlee Jackson, University of Illinois, Visiting Professor to IPP Nagoya.

"Nonlinear Plasma Processes and Solitons in Plasma Confinement"

Dr. Jon Mondt, Los Alamos National Laboratory, Visiting Scientist to University of Kyoto, Heliotron Laboratory

"Studies of Stellarator Confinement"

Prof. J. Todoroki, Institute for Plasma Physics Nagoya to IFS, Austin

"Transport and Stability in 3D Systems"

Prof. H. Naitou, Institute for Plasma Physics Nagoya to IFS, Austin (3 months) and UCLA (3 months)

"MHD Equilibrium and Stability"

Institute for Fusion Studies, University of Texas at Austin, Austin, Texas 78712. For suggestions write to Prof. W. Horton. Tele (512) 471-1594, FTS 770-5269.

Workshops for 1984-1985

Japan to US:

(1) **Magnetic Field Reconnection in Fusion Systems**

Organizers: P. Diamond and T. Sato
Location: University of Texas, Austin
Time: December 10-14, 1984

(2) **Stochasticity and Turbulence in Plasmas**

Organizers: Wendell Horton, Linda Reichl, Yoshi Ichikawa and John Krommes
Location: University of California, Santa Barbara
Time: March 26-29, 1985

Japan to US:

(1) **Transport in Open Ended Systems**

Organizers: T. Kamimura and R. Cohen
Location: Nagoya
Time: July 30-August 3, 1984

(2) **Anomalous Transport Processes in Confined Plasma**

Organizers: M. Wakatani and R. Waltz
Location: University of Kyoto
Time: February 1984 5

Reports from 1983-84 Workshops

RF Heating and Current Generation:

Organizers: C.S. Liu, M. Porkolab, S. Tanaka and R. Sugihara
Location: GA Technologies, San Diego
Time: December 19-21, 1983

Experimental results on LH heating and current drive on PLT, ALCATOR C, WT-2, VERSATOR II, JIPP TII and JFT2-M were reported to agree in general that a current can be sustained by RF alone. Density thresholds were observed on all except ALCATOR C which was using a much higher frequency. There were some interesting discrepancies. Smaller machines such as WT-2 and VERSATOR required a preformed electron tail, created by ohmic field or ECH, to sustain a current, whereas larger devices such as PLT and ALCATOR C have no such restriction. The smaller tokamaks also reported relaxation oscillations during current drive which were infrequent on larger tokamaks. The current drive efficiency was consistently higher for bigger machines. Electron heating by LH waves was very efficient while ion heating was inconsistent at best.

Most of the LH theories aimed at explaining various aspects of the experiments. Density scattering and toroidal effects were invoked for the modification of the wave spectrum leading to an upshift in parallel wavenumber necessary for significant current drive. LH wave induced instability was suggested to explain the large perpendicular tail temperature and relaxation oscillations. Various ion heating mechanisms were proposed to correlate with the density threshold. In addition, it was pointed out that LH damping on alpha particles is significant for FED parameters. The damping length estimated from a straight orbit model is less than 10 cm. This may be a serious obstacle for LH current drive and ICRF heating in reactors and hence warrants further investigation.

A most critical problem facing ICRF and LH heating is impurity control at high power levels. Enhanced impurity levels were reported on PLT at high powers. Understanding of the cause of increased impurities is only preliminary. It could be due to unconfined ions, or a more subtle alteration of ion transport, or plasma edge effects. Theoretical studies in these areas are just beginning. The roles of Faraday shields and antenna configurations also need to be ascertained. On an optimistic note, ion Bernstein wave heating has been proposed to be reactor compatible and free of many of the problems associated with other waves such as wave coupling with ICRF, penetration with LH, as well as alpha particle heating for most schemes. Intense theoretical examination of this promising technique is called for.

Electron cyclotron heating results on DIII, PDX and TMX were in general encouraging although still at relatively low power levels. Interaction with MHD activities and indication of interplay with trapped particles stood out as interesting results. Theoretical identification of mode structures in Alfvén wave heating experiments was reported. Finally, a number of particle silumation studies were presented by the Japanese participants showing some interesting nonlinear effects.

Statistical Plasma Physics

Organizers: Y. Ichikawa and J. M. Greene
Location: Nagoya
Time: February 20-24, 1984

This was the fourth workshop in the series. It followed the traditions set previously. For one thing, many of the participants and most of the presentations were outside the usual fusion community and concerns. Thus this workshop gives opportunities to learn from other disciplines as well as other nations.

The 23 papers presented were classified into three subjects: 10 papers on "Nonlinear Maps and Chaos," 4 on "Solitons and Chaos," and 9 on "Statistical Properties of Plasmas." A short conference proceedings will be prepared.

One of the major themes in the first category concerned transport in Hamiltonian systems. The problem of finding the most appropriate description of the nature of chaotic orbits is an active field. When it is understood, it will have applications to a variety of diffusion and heating theories. Another theme in this section was the application of theoretical results to the design of stellarators that have good magnetic surfaces.

Several of the papers in the session on Solitons and Chaos dealt with a kind of turbulence in which the attractors have a small dimension. In the systems discussed, these dimensions can be identified with the solitons of approximating models. One of the papers in this session proved nonintegrability for wide classes of models with Henon-Heiles like potentials.

"3D MHD Computational Studies"

Organizers: B. Carreras and T. Sato
Location: Oak Ridge National Laboratory
Time: March 19-23, 1984

This is the fourth workshop in the series on 3D MHD studies. The twenty five participants reported results on stellerators, RFP, compact torii and tokamaks. The discussions were informal allowing a frank and open exchange of views between the participants. The proceedings of the workshop were published by ORNL and are now available from Dr. Carreras. The main presentation at the workshop can be summarized as follows:

(1) Stellarators

The first comparisons between MHD activity in Heliotron E and nonlinear MHD calculations (ideal and resistive interchanges) show reasonable agreement (K. Hanatani). The importance of the vertical field design to the access of high beta through a flux controlled equilibrium sequence for ATF was shown (J.A. Holmes). The calculations presented on equilibrium of helical axis configurations show the considerable progress made in this area in recent months and a beginning of understanding of the basic problems presented by such configurations (A. Reiman and T.C. Hender).

(2) RFP and Compact Torii

There has been impressive progress in the amount of work and understanding in the RFP. Two main approaches were presented, one emphasizing the role of external modes (T. Sato and D.C. Barnes) and the other, the m=1 (D.D. Schnack) tearing modes to interpret the self-reversal and the dynamo effect. Progress was also shown in simulation of the spheromak (T. Hayashi and A. Mirin). There is also a variety of numerical approaches in these calculations, spectral, pseudospectral and finite elements (M. Aizawa).

(3) Mirrors and EBT

Fast convergent methods for three dimensional equilibrium allow efficient and reliable calculations for tandem mirrors (B. McNamara). Equilibrium results for the new configuration, Elmo Bumpy Square, were presented (C.L. Hedrick).

(4) Tokamaks

One of the main themes was clearly expressed by the title of D. Monticello's talk — the total de-reduction of the reduced equations. A general trend has been to include in the calculations all the physics of the full MHD equations excluding only the fast Alfvén waves. Two main approaches were presented: 1) to continue the expansions to higher order (D. Monticello and M.S. Chu) or 2) to exclude the fast waves by numerical techniques (L.A. Charlton). The other area in which the

tokamak 3D calculations are moving is in the understanding of the nonlinear evolution of external kink modes (T. Tsunematsu and J.K. Lee).

Have you heard that...

Professor **John Malmberg** is spending his sabbatical at the Institute for Plasma Physics in Nagoya. He writes that he and his family are thoroughly enjoying their visit in Japan. John has traveled to Fukuoka to learn first hand of the well known works on plasma turbulence at Kyushu University.

In March he participated in the US-Japan workshop on Tandem Mirror Research at Tsukuba University. Malberg's pure electron plasma experiment at UCSD may be well suited for testing some transport properties of tandem mirrors.

In any event JIFT is glad to have assisted John in his visit to Nagoya and to learn that his visit is being so rewarding.

Dr. Dan Barnes, who has been a frequent US-Japan exchangee, has left the Institute for Fusion Studies to start a SAI office for fusion and other plasma physics research in Austin. For the next year, at least, he says that he will be on the inactive roll of the joint computational projects. Dr. Jean-Noel Leboeuf of the IFS will assume responsibility for continuing the joint computational work started by Dan.

A **JIFT Management Committee** has been created within the Institute for Fusion Studies in an effort to broaden the perspective and increase the productivity of the exchange program. Suggestions for exchanges or workshops will be received by any of the committee members: Wendell Horton (Chairman), Jim Van Dam, Toshi Tajima, or Jean Noel Leboeuf.