JOINT INSTITUTE FOR FUSION THEORY

NEWSLETTER

AUGUST 1983

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 met on February 4, 1983 in Austin to approve the exchange scientist and Workshop plans for the period from April 1983 to March 1984. The committee representatives were 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. The recommendations of the JIFT Steering Committee for next year's exchanges were approved by the May 1983 Fusion Committee Meeting in Hawaii.

Present and Upcoming Exchange Visits

Dr. Jack Byers, LLNL to Nagoya, March-June, 1983.

Dr. David Montgomery, William & Mary to Nagoya, May-August 1983.

Dr. Wonchull Park PPPL to Nagoya, June-August 1983.

Dr. Dan Barnes, IFS to Nagoya, September 1983.

Dr. Viktor Decyk, UCLA to Kyoto, April-June 1984.

Dr. Akio Ishida, Niigata University to Cornell University or IFS, September-February 1983-84.

Dr. Taeguhiro Watanabe, Hiroshima University to IFS, Nov. 1983 to April 1984.

Institute for Fusion Studies, University of Texas at Austin, Austin, Texas 78712. For suggestions write to Prof. M. Rosenbluth. Tel: (512) 471-3591, FTS 770-3269.

Workshops for 1983-1984

Japan to U.S.:

(1) **Wave Heating and Current Generation**

Organizers: C. S. Liu and M. Porkolab
S. Tanaka and R. Sugihara
Location: GA Technologies (December 1983)

The Japanese delegation will also visit rf facilities at MIT and Princeton as part of the Workshop.

(2) **3D MHD Simulation Studies**

Organizers: B. Carreras and T. Sato
Location: ORNL (February 1984)

U.S. to Japan:

(1) **Statistical Plasma Physics**

Organizers: John Greene and Yoshi Ichikawa
Location: Nagoya (January 1984)

(2) **Transport and Instabilities in Open Ended Systems**

Organizers: R. Cohen and T. Kamimura
Location: Nagoya (August 1984)

Reports From Exchange Scientists

John M. Dawson, at IPP, Nagoya, September-December 1982

In the last two months of the four month visiting Professorship at Nagoya, John Dawson gave a set of five lectures covering the theory and simulations of velocity space instabilities produced by energetic hot ring and shell distributions, two-component fusion experiments, the laser electron accelerator, plasma heating by 1-10 MeV ion injection and models for beam plasma heating with ion tail pulling.

At Nagoya Dawson attended a number of program reviews at the request of Dr. Kakihana, the Director of IPP, including a review of the R Project which is Nagoya's key experiment for the future. The idea of the R Project is to produce a significant fusion burn at perhaps $Q \approx 0.3$ while maintaining sufficiently low activation levels by a suitable choice of wall materials such as a special aluminum alloy to allow hands-on maintenance. The scope of the R Project necessitates building a new laboratory site which requires some final governmental decisions.

The December 1982 JIFT Newsletter contains accounts of Dawson's visits to Hiroshima, Fukuoka and his polarized nuclei work at Nagoya.

During November and December Dawson made visits to the Heliotron at Kyoto University, the RF current drive and mirror stabilization labs at Kyoto University,

the GAMMA-10 and the High Energy Physics Lab at Tskuba, the magnetic fusion projects at JAERI and the tokamak and plasma programs at the University of Tokyo, and the laser fusion project at Osaka University. Unfortunately, only a few of Dawson's comments can be mentioned here, but he could make available a more extensive summary upon request.

The Heliotron in Kyoto is scheduled for 1 ~ 2 MW of NBI, 400 kw of ECRH and 1 MW of ICRF. Some combination of these heating processes is predicted to raise β to 2-5% — near the predicted theoretical beta limit. Conversations with Drs. Abe, Itatani and Tanaka were most productive according to Dawson.

The JAERI research programs visited included JT-60, NBI and high power klystron source development, and super-conducting magnet work. The NBI runs at full power for 10 seconds, and the super-conducting coil was delivered on schedule to the international magnet development project.

A brief brochure prepared for the visit of Prime Minister Margaret Thatcher shows the '82 Japanese fiscal year fusion budget with approximately $175 million for JAERI (77%), $50 million for Universities and others (23%) for a total of $225 million excluding personnel cost. Of the $175 million for fusion at JAERI FY '82 the JT-60 costs are reported to be 84%.

Jack Byers, Nagoya, March-June 1983

At IPP, Nagoya, Jack Byers worked with Tetsuo Kamimura on new simulation methods for bounce averaged particle orbits, extending techniques developed by Byers at LLNL. Byers reports enthusiastically about his work at Nagoya as well as his visits to Tsukuba, Hiroshima, Osaka and Kyoto.

On his visit to Tsukuba Byers reports on his work with Katanuma on stochasticity in GAMMA 10. The stochasticity boundary in GAMMA 10 is similar to that in MFTF-B. He also benefitted from the reports of Kiwamoto, Inutake, and Kawabe on the various aspects of that major mirror experiment.

At Hiroshima May 11-14, Byers enjoyed participating in the 5th Anniversary celebration of the Hiroshima Institute for Fusion Theory. On that occasion he gave a special lecture on the "Role of Super Computers in Scientific Research." The Vlasov models of T. Watanabe et al., and the 3D MHD simulations of T. Sato et al., both at HIFT, are of particular interest reports Byers.

May 28-June 1, Byers attended the Tenth Anniversary of the Institute of Laser Engineering at Osaka University. The GEKKO-XII glass laser at ILE is near completion and is comparable in size to LLNL laser systems. The lively anniversary party was in the target room with a full band on a balcony overlooking the experiment, playing selections including "STARS AND STRIPES FOREVER."

On the way back to Nagoya, Byers visited K. Yoshikawa of the Institute of Atomic Energy in Kyoto and had brief discussions on the Tandem Mirror MARS Reactor design.

Charles (Ned) Birdsall

An old hand at collaboration with the Japanese is Ned Bridsall who writes enthusiastically about his recent six month sabbatical in Nagoya from September '81 to February '82 and a short followup visit in September '82. Ned made his first trip to Japan in 1964 and spent nine months at Nagoya in 1966.

Birdsall is working with T. Kamimura and S. Ishiguro in modeling plasma-surface interactions. Large fluctuations and double-layer potentials are observed in their one dimensional simulations. The objective of the work is to eventually explain plasma surface experiments and to test competing theories, but a number of important effects such as 2D, external magnetic fields and electromagnetic induction remain to be analyzed. For these problems Birdsall and Kamimura look forward to the establishment of the U.S.-Japan computer link joining the Facom VP-100 which has 250 megaflops with the CRAYS and Cybers of MFECC.

JIFT Steering Committee, Austin, February 4, 1983. From left to right, Y. Ichikawa, I. Kawano, K. Nishikawa, H. Ikegami.

Reports on JIFT Workshops

(1) Statistical Physics and Chaos in Fusion Plasmas — Dec. 13-17, 1982

Organizers: W. Horton, L. Reichl and Y. Ichikawa
Location: IFS, Austin, Texas

The statistical plasma physics workshop attracted a number of physicists from outside the fusion community in both the U.S. and Japan. The meeting was attended by eight scientists from Japan, approximately fifty U.S. scientists and several European scientists. Professor John Wheeler made opening remarks that revealed his deep interest in both the fusion problem and in the statistical foundations of the underlying physical processes. His opening remarks, the program, list of participants and the concluding remarks of Green, Kuramoto, Ott, Mori, Balescu and Grad are contained in the IFS Report #79, available from W. Horton upon request.

(2) Hot Electron Physics - January 10-14, 1983

Organizers: J. W. Van Dam and T. Watanabe
Location: IFS, Austin

The problem of the equilibrium and stability of a hot electron plasma in a thermal plasma and the problem of maintaining the hot electron component were discussed by the Japanese scientists, H. Sanuki (Nagoya), Y. Kiwamoto (Tsukuba)

and Watanabe (Hiroshima) and approximately fifteen U.S. scientists. The studies are primarily directed toward understanding the bumpy torus and tandem mirror end cells and plugs although some of the questions posed by these devices are of universal interest to plasma dynamics.

New results were presented for the stability windows in the parameter space describing the hot and thermal plasma components. The question of the degree of coupling between the two components for various modes of oscillation was actively debated and worked on during this workshop.

Extensive measurements of the genera of fluctuations were studied in charts prepared by Hiroe. A possible classification was proposed by theoreticians as (i) 10 KHZ—ion diamagnetic frequency or Kelvin-Helmholtz, (ii) 20-100 KHZ—interchange of the surface plasma outside the ring, (iii) 100-200 KHZ—hot electron interchange, (iv) 10 MHZ—compressional Alfvén coupled to precessional wave and (v) 10 GHZ—whistler instability.

Two dimensional analytic and three dimensional computational MHD-Vlasov models for the equilibrium and stability were presented by Watanabe. Electromagnetic-Vlasov stability for general equilibrium was reviewed by Antonsen using ballooning mode theory.

Numerous problems in this field remain for a future workshop. Reproduction of the viewgraphs, the program, the list of participants, and a synopsis of the conclusions are given in IFS Report #77, January 1983.

(3) Anomalous Transport and Critical Beta Value - February 28-March 4, 1983

Organizers: Y. Terashima and B. Coppi
Location: IPP, Nagoya

Recent results for the anomalous transport and critical beta values were reported by five U.S. participants and approximately twenty-five Japanese participants.

The behavior of electron thermal conduction during beam injection was a principal topic of discussion after talks by B. Coppi, M. Okamoto and S. Yamamoto. Studies of anomalous electron transport and fluctuations due to drift wave turbulence were discussed by K. Kawahata, R. Waltz, T. Tange and M. Wakatani. Particle loss processes from waves and geometry were presented by T. Takizuka, M. Shigeta and A. Fukuyama. Saturation and transport due to the trapped ion instability was described by M. Ogasawara.

Studies of x-ray spectra and radiation losses were given by K. Miyamoto, S. Tsuji, and Y. Terashima. Fishbone discharges characterized by high level m=n=1 MHD activity and the ejection of high energy ions were actively discussed.

The dependence of the critical beta value on FLR, guiding center wave resonances, finite $E_{\parallel}$, hot electron components and shaping of the plasma cross section were discussed in various talks by T. Tuda, S. Tokuda, T. Ogino, M. Rosenbluth, Wm. Tang and W. Horton. Rather substantial variations were reported in the critical β due to these effects. Finally, the Chuba Economic Federation of Japanese industrialists asked Professor Rosenbluth to give a lecture on the future of fusion power and technology to a special luncheon and meeting of their society.

(4) 3-D MHD Simulations - March 7-11, 1983

Organizers: T. Sato and B. Carreras
Location: IPP, Nagoya

Recent results for the simulation of Tokamaks, Stellarators, RFP's, Spheromaks and Tandem Mirrors were presented by six U.S. and approximately ten Japanese participants.

Tokamaks. The common trust was to go beyond the simple reduced MHD equations to describe more accurately present-day high β experiments. The JAERI and PPPL groups show that their new codes reproduce well the behavior of the ideal internal kink. Disruption studies now include ω_*(ORNL) and finite β effects (JAERI). These effects, however, do not substantially modify the disruption mechanism.

Stellarators. The search for stable high beta configurations continues with the results of NYU, Kyoto and ORNL suggesting such configurations are experimentally achievable. There is the possibility of comparison of the theoretical simulation results with the Heliotron E experiment in the near future.

Field Reversed Pinch. Nonlinear stability studies of g-modes and tearing modes were presented with the long-term goal of understanding the dynamo effect. Progress has been made through correlation of multiple helicity tearing mode simulations with related fluctuation measurements. The formation mechanism, reported by Hiroshima, and the maintenance of field reversal, reported by Tokyo University remain important issues.

Spheromak. Progress was reported on the simulation of the tilting instability and spheromak merging process by the Hiroshima group. The present results provide an understanding of the instability processes and offer hope for eventual control of the tilting instability.

Tandem Mirrors. Preliminary results of equilibrium studies and reduced MHD equations were presented by LLNL.

Planning for 1984-1985 Exchanges

Planning is now underway for the JIFT program for the year, May 1984-April 1985. As in previous years, the program will include approximately three long-term exchange visits to each country plus two workshops in each country. We are considering the addition of a third category, joint computational projects, which would involve shorter visits coupled to long-term collaboration using the planned computer link. Suggestions for topics, participants, and host institutions in any of the three categories should be communicated to Wendell Horton by November 1983.