Summary
H-mode/Pedestal/Edge

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A Quick Overview

- The Edge group focuses on a few problems
  - Physics of L-H Transition
  - Physics of Pedestal structure
  - SOL Transport
  - ELM threshold and fast dynamics
- These problems are thorny, as outlined in Leonard's Plenary Talk
- Much solid progress is being made worldwide on these problems, as evidenced by the presentations at this meeting
- There is good prospects for us to make major progress in understanding within the next few years, due to the on-going of theoretical models, as also evidenced by presentations at this meeting

- ECC participated for in Edge sessions for 3rd year in a row - this has been an enormous benefit to the group and truly provides a forum for experiment, modeling and theory

Status of L-H Transition Physics

- Affect of configuration on L-H Threshold well recognized
  - Good evidence that this is linked to flows on open field lines
- New evidence that toroidal rotation velocity also affects power threshold
  - Guess what - plasma configuration also plays a role here
- Still lacking knowledge of the trigger
  - There has been accumulating evidence for several years that something akin to Reynold's Stress spin-up might be occurring, but this is not pinned down
- In general, not a lot of effort on L-H in the US

L-H Transition Talks at This Meeting

- A.E. Hubbard Two-phase L-H transitions in unfavorable configurations in Alcator C-Mod
  - Location of X-point controls direction of edge flows (not Grad B drift)

- Schlossberg (Schafer) Dependence of Edge Turbulence Dynamics and the LH Power Threshold on Toroidal Rotation
  - For unfavorable direction of ion Grad B drift direction, power threshold is reduced as co-torque is reduced

- J.E. Maggs Rotation induced L to H mode transition of a cylindrical plasma column
  - L-H transitions observed in LAPD, a non-toroidal system
  - Very good opportunities to study L-H physics
  - We are invited to propose L-H experiments on the machine

- M.A. Malkov Dynamics of the L-H and H-L Transitions, and Implications for the Pedestal

Steps Towards Developing A Predictive Pedestal Model (Leonard Preview Talk)

- General realization that we are unlikely to get pedestal height prediction from scaling studies
- We need validated theoretical models which can be used to predict pedestal height (with no free parameters)
- Given that we have good models for pedestal pressure gradient, these models need to embody the transport processes in the pedestal
  - Kinetic models required
- The very good news is that at least three kinetic models are in development: TGLF, XGC-1 and TEMPEST
- In order to test these models when they are available
  - We need to know how energy is lost from the pedestal
  - So, we need power balance (interpretive) transport analysis in the pedestal
  - And, we need to have a good characterization of turbulence in the pedestal

Steps Towards Developing A Predictive Pedestal Model – 2

- There are some good developments on the experimental front
  - Improved analysis techniques, using statistical approach, are providing better edge profiles
  - Experimentalists attempting to find how various control parameters affect pedestals within their own machines
    - Hope to find the most important control parameters
  - In addition, well-chosen joint experiments are being performed within ITPA
    - (Just in the last month: C-MOD/JET and DIII-D/AUG)
  - Important diagnostic improvements are here
    - Edge Ti and rotation on C-Mod
    - High resolution edge Thomson on JET – perhaps the best hope for getting size scaling of the Te and ne pedestals

Presentations on Theoretical Transport Models for Edge

Kinetic

- C.S. Chang Can the H-mode be sustained by neoclassical mechanisms?
  - XGC-0 and XGC-1 have neoclassical physics
  - Some verification has been performed
  - Edge Er can be explained by ion loss through X-point and rapid electron flow in SOL
- Z. Xiong (Cohen) TEMPEST Simulations of the Geodesic Acoustic Mode
  - Code has neoclassical physics now
  - Verification performed for geodesic acoustic mode
- Park, G. Kinetic simulation of 3D magnetic field perturbation effects on pedestal and ELM
  - XGC-1 can produce Er profile observed in RMP experiments (to control ELMs)

Presentations on Theoretical Transport Models for Edge – II

Kinetic

- A.Y. Pankin (G. Bateman) Dynamic Modeling of Equilibrium in XGC Gyrokinetic Simulations of Pedestal Evolution
- Y. Xiao Gyrokinetic Simulation of Trapped Electron Mode in Tokamak Edge Plasmas
- Belli Unified Gyrokinetic Simulations of Drift Wave Turbulence and Neoclassical Transport
- Ku Verification of XGC, a gyrokinetic edge particle code

Other

- J.D. Callen Paleoclassical H-Mode Pedestal Model
  - Has a model for Te in pedestal – in ball park of experimental measurements
  - Is pushing a small group activity to benchmark edge transport code calculations

Tests of Models for Edge

- U. Stroth Experimental study of the electromagnetic component of drift-wave turbulence
  - 3D structure of drift wave turbulence measured in TJ-K Torsatron – agrees well with DALF3 and GEM3
- R.J. Groebner Initial Tests of TGLF Transport Model With Experimental H-Mode Pedestal Data in DIII-D
  - Initial comparisons of linear growth rates, computed by TGLF, with experimental ExB shearing rates in the pedestal
- Dahlburg Helimak Fluctuation Analysis comparing Fluid Simulations and Data

Other Edge Measurements

- C. Hidalgo On the Link Between Flows, Turbulence and Electric Fields on the Edge of Fusion Plasmas
- D.M. Thomas Edge Current Dynamics During ELMs
  - After ELM crash, current density recovers much more slowly than pressure gradient

Presentations on 2-D Interpretive Transport Analysis

- T.D. Rognlien An interpretive mode for the UEDGE transport code
  - Has developed "simple" interpretive mode for UEDGE - obtains chis in same ballpark as an edge interpretive analysis by Stacey, for same data
  - This potentially a tool for experimentalists
  - Also, this work may feed into a small group effort to benchmark codes (including ONETWO and ASTRA)
- W.M. Stacey Ion particle transport in the edge pedestal
- D.P. Stotler A Step Closer to a Validation Exercise
- Pigarov Simulation of parallel SOL flows with UEDGE
  - Using data from probes at multiple poloidal locations in C-Mod to simulate SOL flows and study role of configuration
- Umansky Progress in BOUT modeling of NSTX edge plasma

Other 2D modeling

- L. Chen Radial structures and nonlinear excitation of Geodesic Acoustic Modes
- Snyder Understanding the Power Dependence of the Pedestal
  - Power scaling (or lack of) of pedestal height can be linked to MHD stability effects
- Naulin Momentum transport in the edge and into the SOL
- R.D. Smirnov (S. Krasheninnikov) Modeling of dust in tokamak plasmas
  - DUSTT code is used to dust dynamics
  - Systematic studies of dust penetration as function of density and temperature

Presentations on Pedestal Turbulence Measurements

- Dorris, J. Localized Measurement of Short Wavelength Plasma Fluctuations with the DIII-D Phase Contrast Imaging Diagnostic
  - Evidence that fluctuations are largest near pedestal
  - Some systematic issues are being addressed so that turbulence can be localized with higher confidence
- Park, H. NSTX High-k Scattering System on NSTX: Status and Plan
- Rost Eigenmode Analysis of Turbulence Measurements from the DIII-D Phase Contrast Imaging Diagnostic
- Wang, G. Broadband Magnetic and Density Fluctuation Evolution Prior to First ELM in DIII-D Edge Pedestal

3D Magnetic Effects

- Several experiments show that 3D magnetic geometries can be used to control the pedestal
  - Ripple losses in JT-60U reduce pedestal height
  - Resonant Magnetic Perturbations in DIII-D stabilize ELMs
  - N=1 magnetic perturbation in JET has provided ELM control

Presentations on 3D Magnetic Effects

- R.A. Moyer Pedestal Turbulence and Transport Response to an External Magnetic Perturbation in DIII-D
  - Transport being characterized in RMP experiments
  - The mystery remains why Te is unaffected by Resonant Magnetic Perturbation
  - Some potential explanations, but more checking required
- Joseph Calculation of the Thermal Footprint of Resonant Magnetic Perturbations in Poloidally-Diverted Tokamaks
- Zeng Effects of Resonant Magnetic Perturbations on Edge Density Profile in DIII-D
- Yu Fast Imaging of ELM Structure in DIII-D

Characterization of BLOBS

- BLOBS (edge coherent structures) are universally observed in SOL or SOL-like conditions (in very different magnetic configurations)
- Very good agreement amongst experimentalists about their basic characteristics
- At this meeting, a picture is emerging that BLOBS originate from an instability which grows and saturates and then is ripped apart by a sheared magnetic field
- Region of growth is very near separatrix
- There are increasing observations of inward-moving holes as well as outward-moving BLOBS
- High quality data are being obtained and used to characterize BLOBS and to study their properties
- Theory is becoming more complete and has been successful in explaining many features of BLOBS
- Amount of transport due to BLOBS is under study - an open issue

Presentations on BLOBS or Coherent Structures

- S.H. Muller   Plasma blobs in a basic toroidal experiment: Origin, dynamics and induced transport
- I. Furno   Mechanism for plasma blob generation and transport in the TORPEX toroidal plasma
  - Muller and Furno showed beautiful 2D probe measurements of BLOBS
  - ExB shearing causes structures to bend and break
- K. Schneider   Extraction of coherent structures from turbulent edge plasma in magnetic fusion devices using orthogonal wavelets
- T.A. Carter   Structure and statistics of turbulently generated blobs and holes in LAPD
  - Infers that a current channel is associated with each filament (BLOB)
- J.A. Boedo (Rudakov)   Experimental Tests of Turbulent Transport Near Marginal Stability
  - In NSTX, generation of holes and BLOBS is near separatrix
- Rudakov   Statistical Properties of Electrostatic Fluctuations and Turbulent Cross-Field Fluxes in DIII-D SOL
- D.A. D'Ippolito   Recent progress in SOL turbulence simulations
  - Theoretical modeling consistent with many experimental observations

Presentations on Basic Plasma Physics

- Xu, M. Experimental Setup for Nonlinear Energy Transfer Measurements in the Frequency Domain
- Yan Magnetic-field scaling of turbulence-driven shear flows in a linear magnetized plasma
- Ramisch (Stroth) Observation of large-scale coherent structures under strong ExB shear
  - Strong ExB shear produces M=3 structure - why?

Thanks to presenters and participants in EDGE Group!!