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**
- 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!!