Core Summary

March 27th
The Chuck**, George* and David segment
of the Keith Burrell show

*But you should not blame him
** You should blame him

Statistics

- 21 talks - 3 NS in 6 sessions
- 51?? posters
    - Theory/Modeling 14 talks (up from last year)
    - Experiment 5 talks (down from last year)
    - 2 overlap talks
    - 2 non tokamak presentations (down from last year)
- ~ 1 discussion session

Comments

- Balance of theory - experiment too heavily weighted toward theory at present
  - must stress inter-species communication (theorists should aim for experimentalists and experimentalists should aim at theorists)
- Good assimilation of non-tokamak presentations (continued 2 way interactions)
- Excellent posters...we will not discuss these since they were not parallel and there were many
- Real progress on previous focus areas
  - Validation, High k diagnostics, electron channel modeling, physics of zonal flows

Plenary Talks

- C. Holland - Validation of Nonlinear Simulations of Core Tokamak Turbulence: Current Status and Future Directions
- J. Chen - Terascale direct numerical simulation of turbulent combustion
- B. LaBombard - Scrape-off layer flows, toroidal rotation and critical gradient phenomena in the tokamak edge
- J. Kinsey - Development and Validation of the Next Generation Trapped Gyro-Landau-Fluid Transport Model

Validation

Composite validation metric combines simple metric with primacy hierarchy, sensitivity

Multiple measures across primacy hierarchy, sensitivity landscape builds confidence in validation

Composite metric weights measures with different primacy levels, sensitivities

Illustrative example uses two composite metrics:

$$M_S = \sum_i B_i P_i S_i W_i \frac{1}{10} \qquad M_n = \frac{1}{n} \sum_i^n B_i P_i S_i W_i \frac{1}{10}$$

	Definition	Range	Meaning
B_i	Value of simple metric for measure *i*	0 – 1	0 – poor 1 – good
P_i	Normalized value on primacy hierarchy	1 – 5	5 – lowest 1 – highest
S_i	Sensitivity weight	1 – 2	1 – lowest 2 – highest
W_i	Repetition weight – on same primacy level	$W_i = (0.5)^{i-1}$	Penalty for single level

Validation issues

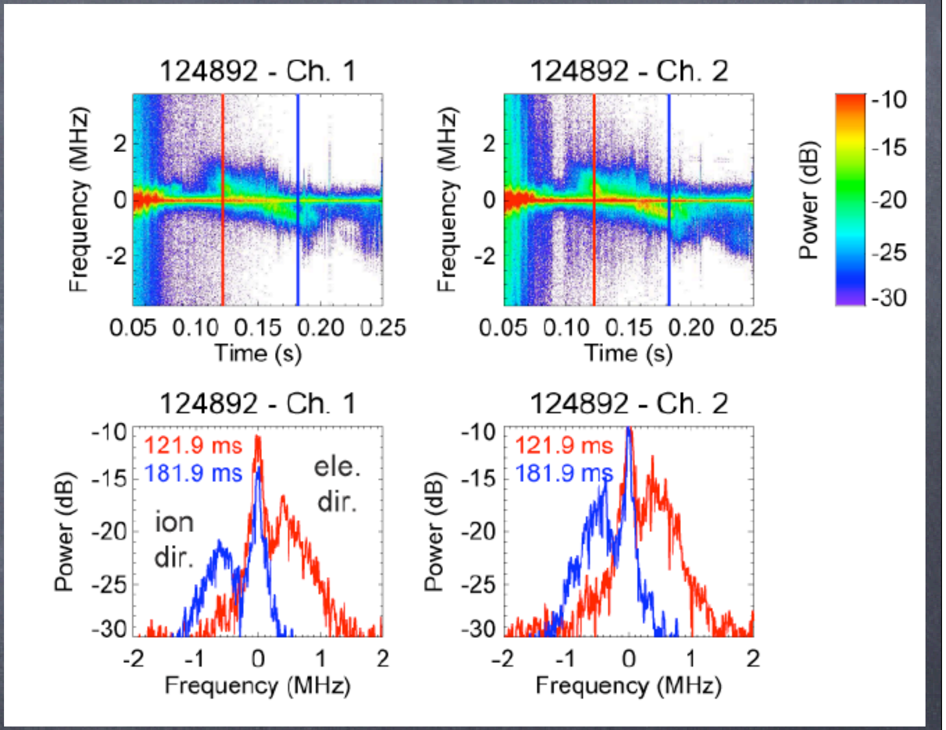
- C. Holland suggested two example composite metrics

$$M_1 = \frac{1}{4}\left\{\left(\frac{\left|Q_i^{expt} - Q_i^{sim}\right|}{\sigma_i^{sim}}\right)^\alpha + \left(\frac{\left|Q_e^{expt} - Q_e^{sim}\right|}{\sigma_e^{sim}}\right)^\alpha + \left(\frac{\left|\delta n^{expt} - \delta n^{sim}\right|}{\sigma_n^{expt} + \sigma_n^{sim}}\right)^\alpha + \left(\frac{\left|\delta T_e^{expt} - \delta T_e^{sim}\right|}{\sigma_{Te}^{expt} + \sigma_{Te}^{sim}}\right)^\alpha\right\}$$

$$M_2 = \frac{1}{8}\left\{\left(\frac{\left|Q_i^{expt} - Q_i^{sim}\right|}{\sigma_i^{sim}}\right)^\alpha + \left(\frac{\left|Q_e^{expt} - Q_e^{sim}\right|}{\sigma_e^{sim}}\right)^\alpha + \left(\frac{\left|\delta L_r^{expt} - \delta L_r^{sim}\right|}{\sigma_{Lr}^{expt} + \sigma_{Lr}^{sim}}\right)^\alpha + \left(\frac{\left|\delta L_z^{expt} - \delta L_z^{sim}\right|}{\sigma_{Lz}^{expt} + \sigma_{Lz}^{sim}}\right)^\alpha \right.$$
$$\left. + \left(\frac{1}{f_2 - f_1}\int_{f_1}^{f_2} df\, \frac{\left|S_n^{expt}(f) - S_n^{sim}(f)\right|}{\sigma_{S_n}^{expt}(f) + \sigma_{S_n}^{sim}(f)}\right)^\alpha + \left(\frac{1}{f_2 - f_1}\int_{f_1}^{f_2} df\, \frac{\left|S_{Te}^{expt}(f) - S_n^{sim}(f)\right|}{\sigma_{S_{Te}}^{expt}(f) + \sigma_{S_{Te}}^{sim}(f)}\right)^\alpha\right\}$$

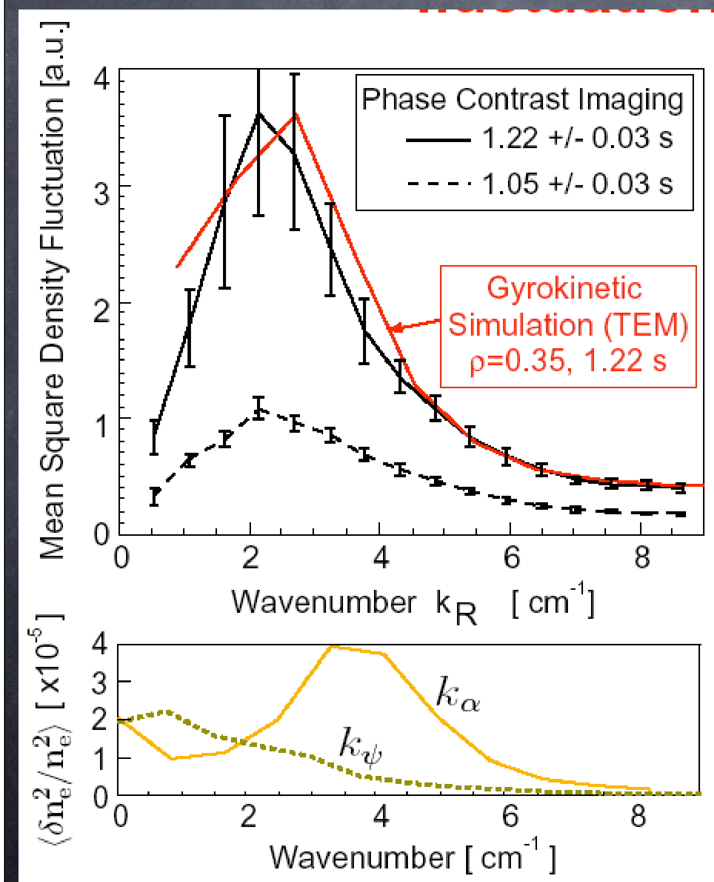
Electron scale transport

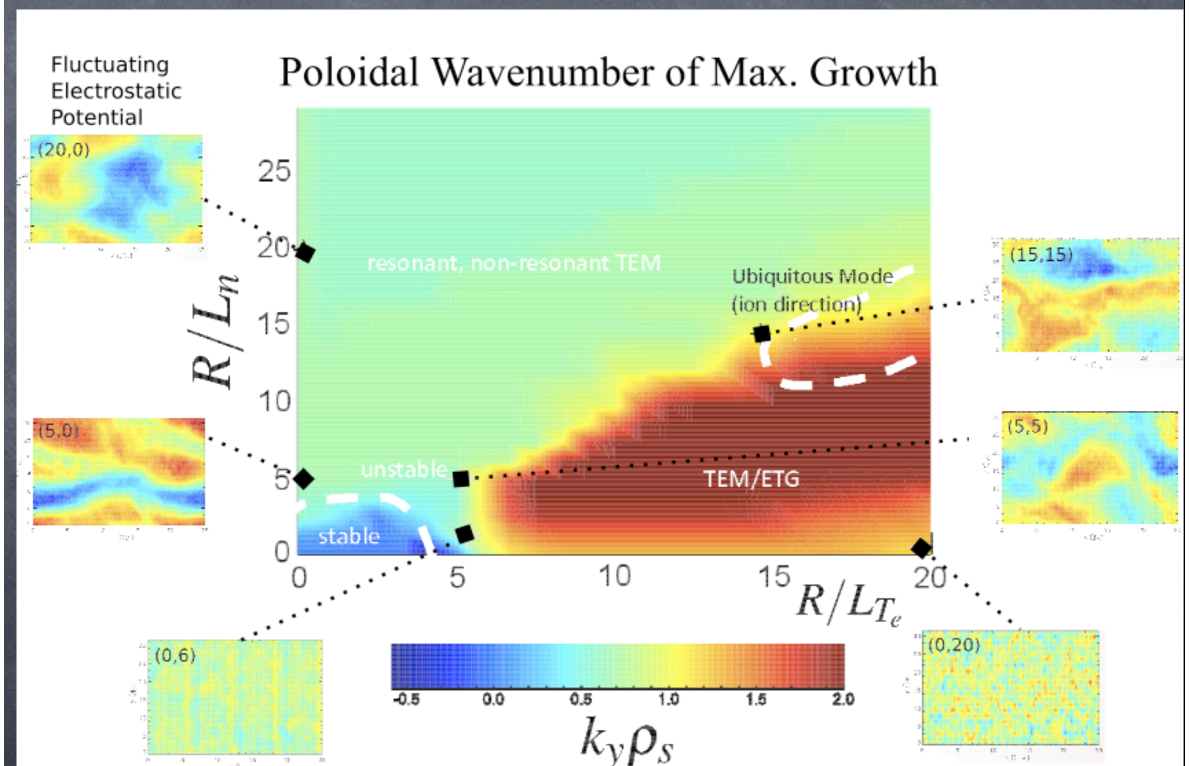
- D.R. Smith showed NSTX has electron gyro-scale fluctuations which are consistent with ETG turbulence, frequency in electron direction (doppler shifted into ion direction). Fluctuations in the turbulence amplitude coincident with fluctuations in ExB flow shear...saturation mechanism. However growth starts when gradient is sub-critical.



Electron scale transport

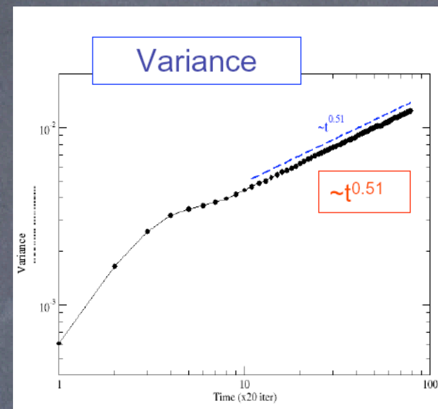
- D.R. Ernst showed Zonal flow induced Nonlinear Upshift of the TEM Critical Density Gradient and as well as the existence of a variety of different regions in parameter space. The fundamental importance of synthetic diagnostics in comparing to real data was demonstrated.

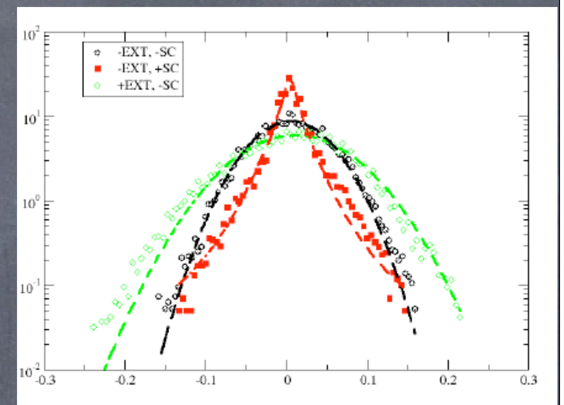


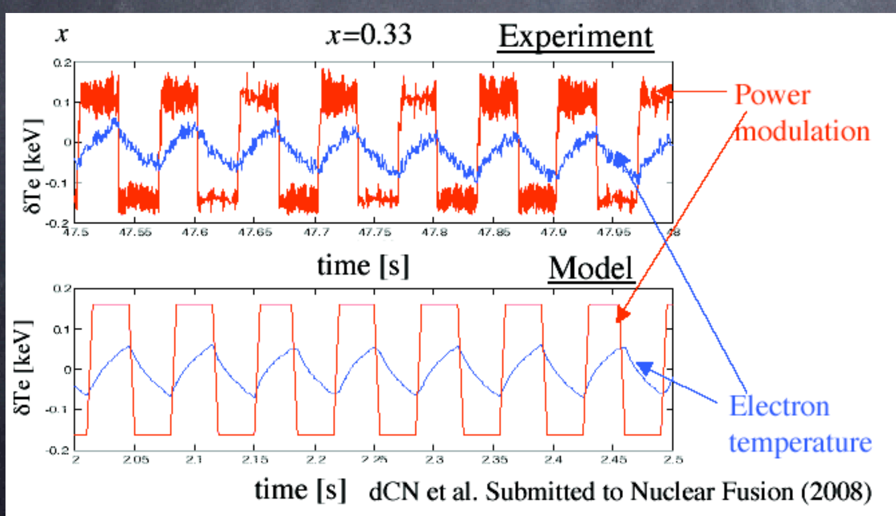


Transport dynamics

R. Sanchez found that the inclusion of a sheared flow fundamentally changes the transport dynamics in gyrokinetic simulations. Self- consistent flow made transport sub-diffusive with levy tails, while external flow was only sub diffusive and no flow was diffusive (both with gaussian tails).







dCN et al. Submitted to Nuclear Fusion (2008)

- D. del-castillo-Negrete showed that nonlocal fractional diffusion models of transport are able to fit both cold pulse propagation and power modulation experiments (each of which provides a different constraint

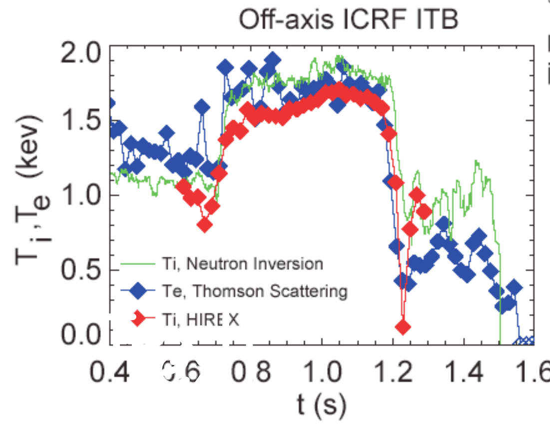
Intensity spreading

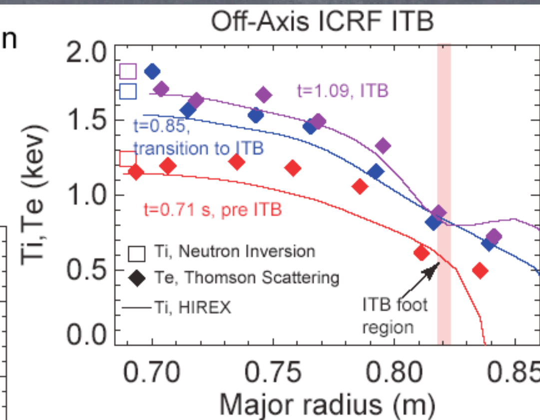
- A sleepy japanese cat, L.T. Neko, discussed propagation of intensity fronts (an important potential mechanism for core edge coupling as mentioned in Holland's plenary talk) which can be both diffusive and ballistic. A simple envelope model was developed followed by a more compete model for CTEM turbulence based on clump theory.

Barriers

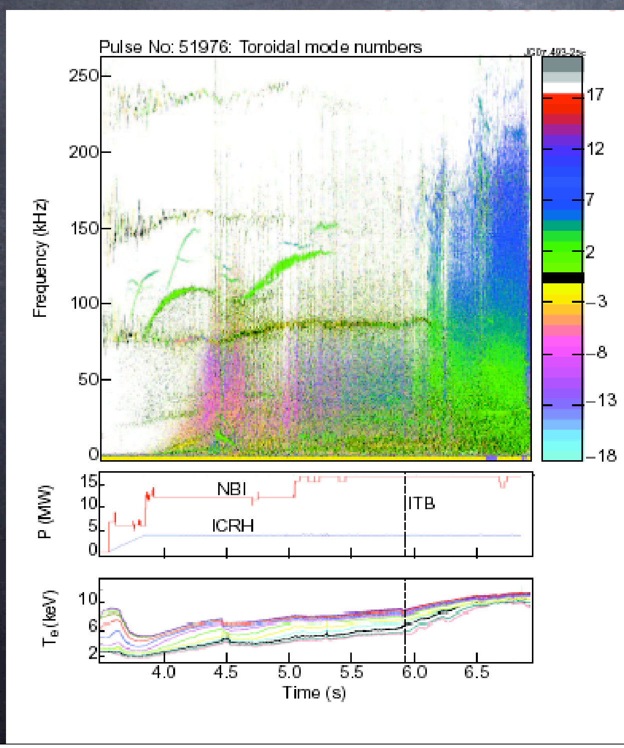
- C.L. Fiore showed results from Alcator C-Mod ITB studies including the new Ti and impurity transport results. PCI observes fluctuations when simulations suggest no unstable TEM modes

Excellent agreement is found between T_i from HIREX, central Ti from neutrons, and T_e from Thomson Scattering.





•A temperature barrier was found previously with sawtooth heat pulse measurements and inferred from pressure profile increase
•Ion temperature profile from HIREX confirms T_i transport barrier.



- S.E. Sharapov found bifurcations into broad band magnetic turbulence is seen during transitions to high confinement regimes in JET plasmas

Magnetic transport

R. Gatto developed an action angle theory for electron transport given a turbulent spectrum. In this theory q′/q is an important drive. The full transport equations give both diffusivities and pinch velocity.

J. Callen/G.M. Hogeweij showed Paleoclassical Theory to be consistent with discrete jumps (barriers) observed in RTP ECH heated plasmas

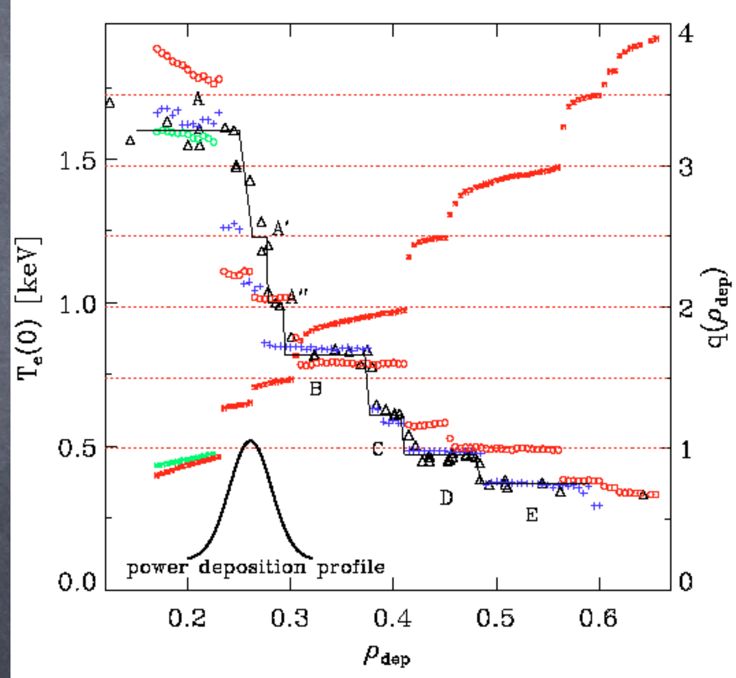


Figure 7: Transport simulations of Fig. 1 RTP data: $T_e(0)$ from experiment (blue triangles), paleoclassical model (circles,asterisks) with (red) & without (green) imposed sawteeth, and empirical model (pluses).

Transport modeling

- J. Candy discussed progress on the development of TGYRO a TGLF based transport model which is designed to run multiple instances of GYRO (in parallel) at different radii. Two versions developed, local for small ρ_* systems and global for large ρ_* systems. Local and diffusive??

- G. Bateman presented developments in the PTRANSP in which TRANSP gets "enhanced" to do predictive modeling. New modules, upgrades on existing modules and uniform module interface.

Zonal Flow Generation and Impact

R. Waltz suggested that the ZF-DW nonlinear saturation paradigm appears universal: ExB Shear from n=0 accounts for nearly all nonlinear saturation for ITG and TEM low-k turbulence

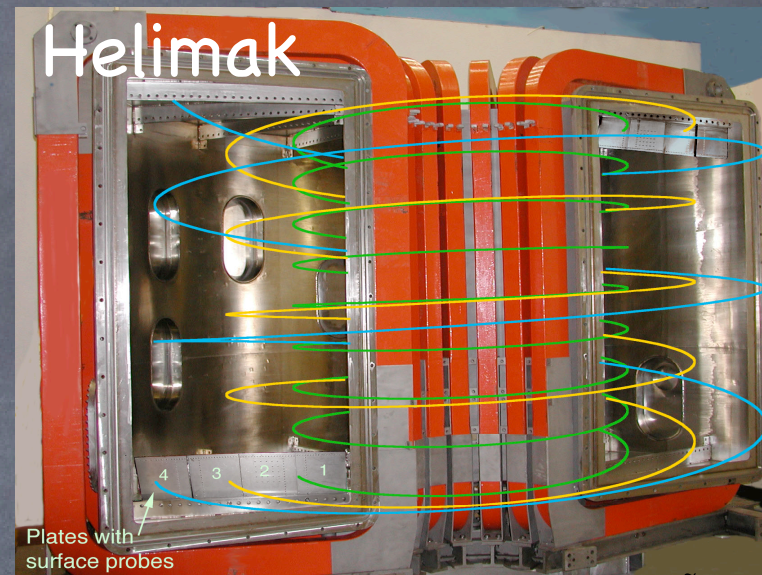
	ITG-ae	ITG/TEM		TEM*	
	χ_i/χ_{gB}	χ_i/χ_{gB}	χ_e/χ_{gB}	χ_i/χ_{gB}	χ_e/χ_{gB}
all n coupled	3.61±0.09	10.66±0.20	3.00±0.03	28.78±0.57	33.81±0.67
n=0 only	3.52±0.03	12.06±0.02	3.30±0.04	25.22±0.82	29.48±0.93
decoup n=0 $\delta\phi$	159±70	956±6	198±5	359±7	475±12
decoup n=0 δf *	0.003	0.004	0.04	0.20±0.07	0.17±.06
decoup n=0 $\delta\phi \,\&\, \delta f$	large	>300	>80	>300	>300

Landau damping of GAMs contributes to the entropy dissipation sink for the "transport" entropy generated source, but the "sink rate" is spread equally over all n

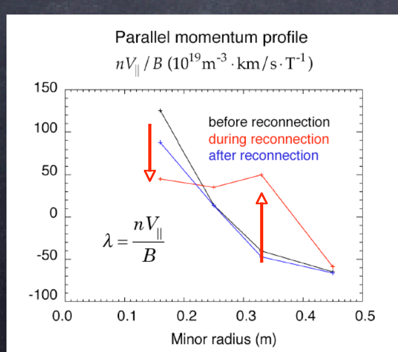
Turbulence Effects and Flows

K. Gentle: Drift-wave-like turbulence strongly impacted via application of ExB flow from end-plates of toroidal-vertical B-field plasma device:

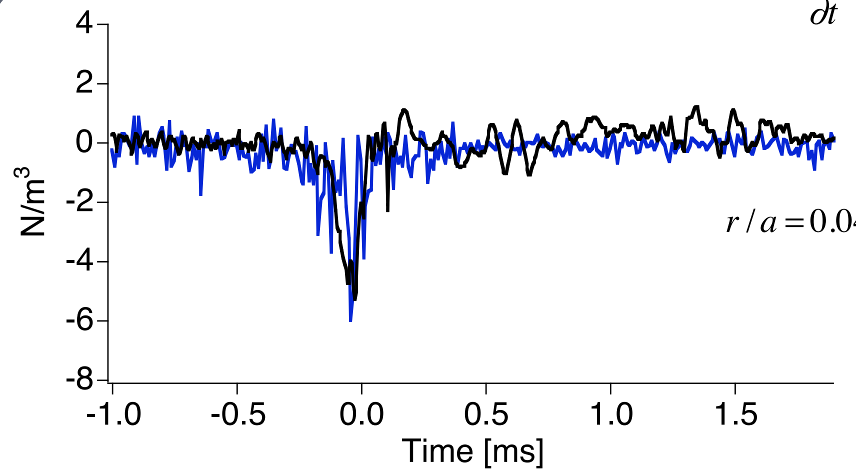
- Measured ExB shear does NOT have obvious consistent reduction to density or potential fluctuations, but does reduce net transport



D. Brower: Transport of parallel momentum from stochastic fields is found to be significant in the plasma core of MST RFP experiment



$$\frac{\partial<\rho V_{//}>}{\partial t}+T_{//,i}\nabla\frac{<\tilde{n}\tilde{b}_r>}{B}\approx 0$$



$-T_{//,i}\nabla\frac{<\tilde{n}\tilde{b}_r>}{B}$ (blue)

$\frac{\partial<\rho V_{//}>}{\partial t}$ (black)

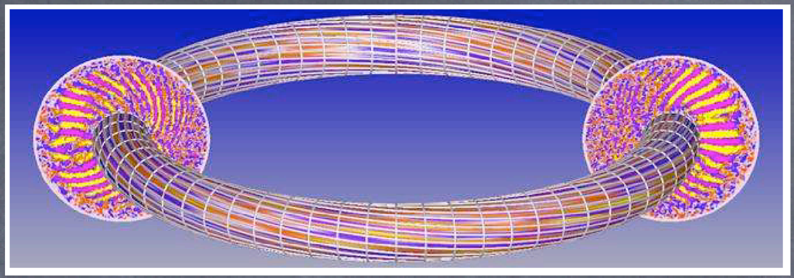
m=1, n=6,7,8,9

Magnetic fluctuation-induced (convective) flux drives parallel momentum d

Gyro-Kinetic simulations

- S.E. Parker presented new work on saturation mechanisms for TEM turbulence in which they found the importance of zonal flow saturation in saturation at low Te/Ti and low R/L_{Te}, and the importance of zonal density in other CTEM regimes...(is this experimentally observable??)
- G. Dif-Pradalier presented a simplified collision operator for gyrokinetic simulations on the full f code GYSELA. This collision operator was able to reproduce a number of neoclassical effects (NC transport and zonal flow damping) and led to interesting results in the turbulent regime.
- Y. Chen/G. Rewoldt presented GEM benchmark calculations and calculations for the first experimental cases

Gyro-Kinetic simulations



- Y. Xiao discussed some GTC convergence studies, as well as results from CTEM simulations. It was found that the zonal flows were very important in the saturation of the turbulence
- Y. Nishimura presented early results from GTC electromagnetic gyrokinetic particle simulations with kinetic electrons. The code was able to reproduce globel shear Alfven waves among other features. He showed results from em simulations with kinetic electrons...can in principle do entire range of scales including coupling Alfven cascades to other scales
- S. Lin presented a range of GTC simulations of turbulence and transport in tokamak plasmas including the apparent importance of different time scales in different systems. Suggested that one can compare transport/intensity as a validation characteristic some results questioned use QL theory in CTEM.

Discussion

- V&V: We are still in favor (??)
  - Validation award at next years meeting?
- Parallel sessions: We are still opposed (but not completely)
  - Fewer would be better (hybrid US-European model)
- Suggested topical areas for next year
  - Particle transport
  - Edge-core interface/interactions
  - Energetic particles and core transport
  - Non-diffusive transport
  - More electron scale transport

Today Wed 26 March 2008

8:30 - 10:00 Core I: Fundamentals I

- R. Sanchez Characterization of transport dynamics emergent from the self-consistent interaction between fluctuations and zonal flows in ITG gyrokinetic simulations with the UCAN code
- L.T. Neko Resonance Coherency, Transport Events and Spreading of CTEM Turbulence
- D. del-castillo-Negrete Nonlocal models of perturbative transport
- K.W. Gentle Mechanism of Turbulence Stabilization
- ~~L. Wang Theory of fine-scale zonal flow generation~~
- Discussion

10:30 - 12:10 Core II: Fundamentals II

- R.E. Waltz Numerical Experiments on the Drift Wave-Zonal Flow Paradigm for Nonlinear Saturation
- R. Gatto A model of electron transport from self-consistent action-angle transport theory
- G.M. Hogeweij Paleoclassical Transport Explains Electron Transport Barriers in RTP and TEXTOR
- ~~Wei, Sokolov & Sen A Basic Experiment on the Production and Identification of ETG Modes~~

Today Wed 26 March 2008

3:30- 5:30 Core III: Transport and Transport Barriers

- D.R. Smith Electron gyro-scale fluctuations in NSTX plasmas
- A.B. Sharapov Bifurcations of Magnetic Turbulence during L-H Transition and ITB Formation in JET Plasmas
- C.L. Fiore ITB Transport Studies in Alcator C-Mod
- D.L. Brower Parallel and Perpendicular Flows Associated with Stochastic Magnetic Field Driven Transport in MST
- Discussion

Thurs 27 March 2008

8:30 - 10:00 Core IV: Electron Transport

- D.R. Ernst Nonlinear Upshift of the TEM Critical Density Gradient and other TEM Developments
- S.E. Parker Zonal Flow and Zonal Density Saturation Mechanisms for Trapped Electron Mode Turbulence
- Y. Xiao CTEM Turbulence and Transport Dynamics
- Y. Nishimura GTC full torus electromagnetic gyrokinetic particle simulations with kinetic electrons
- Discussion

10:30 - 12:00 Core V: Transport Modeling

- ~~W.M. Nevins Gyrokinetic simulations at finite beta~~
- S. Lin GTC simulation of turbulence and transport in tokamak plasmas
- G. Dif-Pradalier A simplified collision operator for gyrokinetic simulations
- J. Candy Progress on TGYRO - The Steady-State Gyrokinetic Transport Code
- Discussion

3:30 - 6:00 Core VI: V & V and transport Models

- G. Bateman Predictive Particle Transport Modeling Using the PTRANSP Code
- G. Rewoldt Global gyrokinetic calculations for experimental cases
- C. Holland Comments on Metrics
- Discussion

Posters

- P1 Angelino Gyrokinetic simulations of plasma microturbulence in a quasi-steady state regimes
- P2 Bespamyatnov Light Impurity Toroidal Rotation and Momentum Transport in Alcator C-Mod Plasmas
- P3 Chakrabarti Finite beta effects on the excitation of GAMs by drift waves
- P4 DeBoo Sensitivity of TEM and ITG Modes to Temperature and Density Gradient Scale Lengths and Collisionality
- P5 Delgado-Aparicio Impurity transport studies in neutral beam heated spherical tokamak H-mode plasmas
- P6 Hatch Nonlinear Excitation of Damped Eigenmodes in Microturbulence Simulations
- P7 Hinton Nonrandom collision method for delta-f PIC simulations
- P8 Houlberg The ITER Integrated Modelling Programme
- P9 Kim, J-H. Electron transport analysis of a four-phase TCV H-mode
- P10 Kritz Fusion Simulation Project
- P11 Leboeuf Particle characterization of transport in global gyrokinetic calculations of core turbulence in tokamaks
- P12 Lin, L. Turbulence Studies with the Phase Contrast Imaging in Alcator C-Mod
- P13 Muller Fast-camera imaging on linear devices for the validation of numerical simulations
- P14 Newman Characterization of transport dynamics in turbulent simulations in the presence of an externally imposed sheared flow
- P15 Perez Two-fluid simulation of anisotropic Drift-Alfven turbulence
- P16 Pletzer Core-edge-wall plasma transport simulations with FACETS
- P17 Romanelli Turbulence suppression and transition phenomena in Tokamak plasmas
- P18 Rowan Light Impurity Transport at an Internal Transport Barrier in Alcator C-Mod
- P19 Samaddar Scaling of transport dynamics in a simple fluid drift-wave turbulence model with shear flow
- P20 Staebler Extending the Trapped Gyro-Landau Fluid Transport Model
- P21 Stotler Development of a Coupled Kinetic Plasma - Neutral Transport Code
- P22 Tynan Testing Our Understanding of Nonlinear Drift Turbulence Dynamics Using Simple Laboratory Plasmas
- P23 Vadlamani Implementation of Language Interoperability Interfaces for transport models as part of the FMCFM project
- P24 Wang, Z. Pulse Propagation and Fast Transient Transport Phenomena Models with Electric Field Shear and Noise
- P25 Canik SOLPS modeling of ELM-free and inter-ELM H-mode edge plasmas
- P26 D'Ippolito Effect of intermittent transport on rf-specific impurities
- P27 Dorris Localized Measurement of Short Wavelength Plasma Fluctuations With the DIII-D Phase Contrast Imaging Diagnostic
- P28 Fasoli Fluctuations, turbulence and related transport in the TORPEX simple magnetized toroidal plasma
- P29 Ghendrih (Gunn) Parallel flow and turbulence interplay in Tore Supra & TOKAM-3D modelling effort
- P30 Gilmore Nonlinear Dynamics of Fluctuations in the Presence of Sheared Parallel and Perpendicular Flows in a Magnetized

Posters

- P31 Guzdar Excitation of GAMs by coupling with electron drift and ITG modes
- P32 Hassam 2D MHD simulations of fluctuations in MCX
- P33 Hughes Modifications to H-mode pedestal structure via particle control and topology variation on Alcator C-Mod
- P34 Kamberov Mehanism of plasma
- P35 Ku Gyrokinetic study of electrostatic turbulence transport across magnetic separatrix
- P36 Malkov Formation and Propagation of transport barriers in a coupled heat and particle flux model
- P37 Marr Calculated HFS impurity density profiles on Alcator C-Mod via CXRS
- P38 McKee Measurements of 2D Edge Turbulence Dynamics and Comparison with BOUT Simulations
- P39 Park Numerical study of kinetic edge transport in the presence of resonant magnetic perturbations
- P40 Rognlien Role of kinetic ion orbits in edge plasma flows for a single-null divertor tokamaks
- P41 Rost Comparison of a Synthetic Phase Contrast Imaging Diagnostic With Experimental Measurements
- P42 Smick Parallel and Perpendicular Plasma Flows in the Edge of Alcator C-Mod
- P43 Stacey Theoretical and experimental heat diffusivities in the DIII-D edge plasma
- P44 Strauss MHD Simulation of Resonant Magnetic Perturbations
- P45 Tritz ELMs and Electron Transport in NSTX
- P46 Umansky Effects of plasma collisionality on tokamak edge turbulence
- P47 Xu, M. Experimental Study of Nonlinear Energy Transfer in Frequency Domain
- P48 Yan The dynamics of the drift wave-zonal flow system
- P49 Zakharov Where is the plasma edge in tokamaks?
- P50 Halpern Comparison of GLF23 and Weiland Models for Turbulent-Driven Toroidal Momentum Transport
- P51 Nishimura, S. On the Determination of Plasma Rotation from Neoclassical Viscosity in Toroidal Plasmas