Pedestal Physics Possibilities

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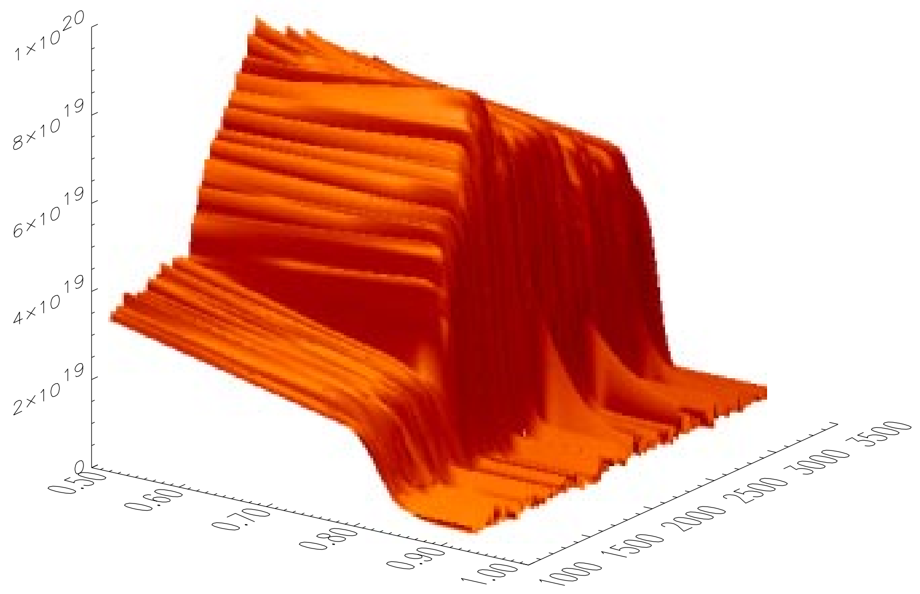
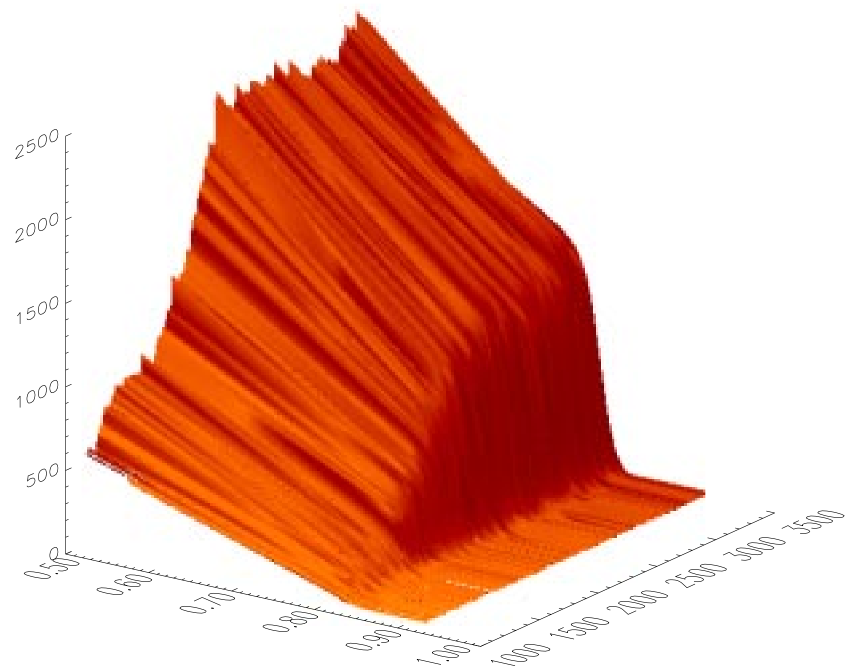
H-mode Transport Barrier (Pedestal) Provides Interface Between Core and SOL

Evolution of n_e Profile

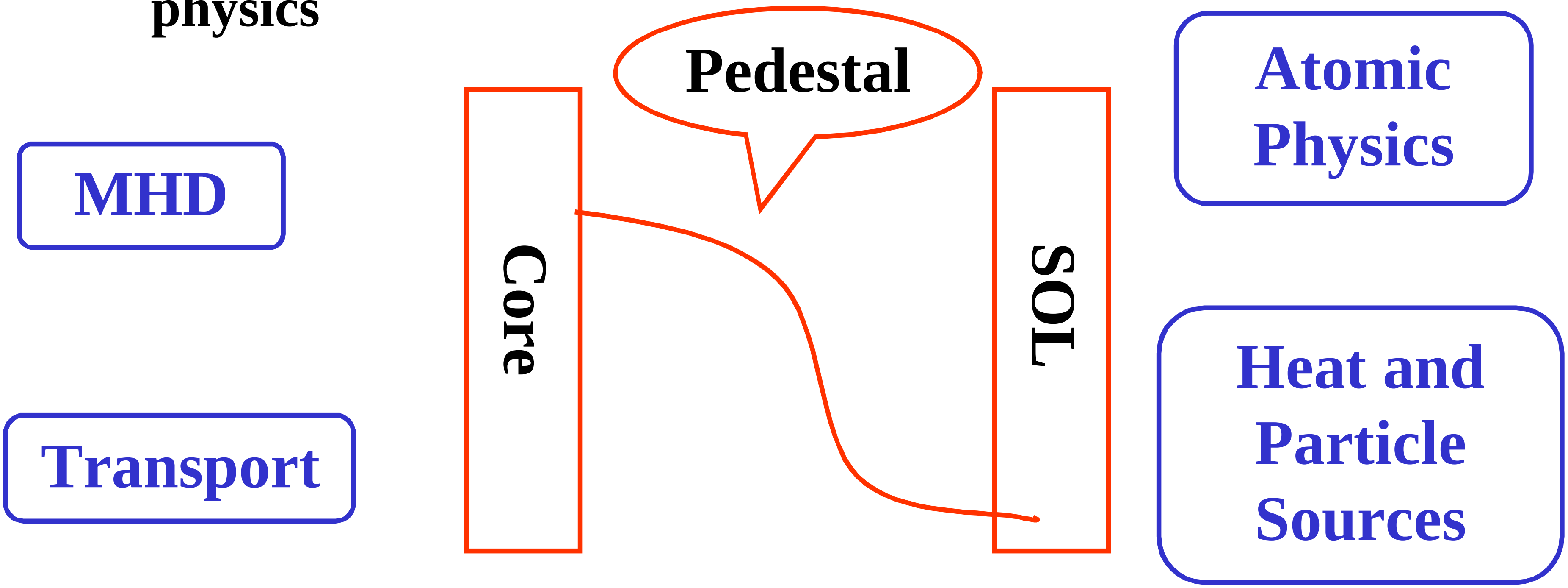


Evolution of T_e Profile



Pedestal Issues Cut Across Many Boundaries!

- **Pedestal is interface between core and scrape-off layer**
  - **All three regions must be considered simultaneously**
- **Pedestal is a self-consistent solution which incorporates sources, transport, MHD stability and possibly atomic physics**



Motivation for Pedestal Studies

- **In standard H-mode discharges, core confinement increases as H-mode pedestal height increases**
  - **Desirable for high performance operation**
  - **Large pedestals necessary for BPX devices**
- **Large pedestals tend to have large ELMs**
  - **ELMs are deleterious to high performance operation**
  - **ELMs may severely limit divertor lifetime in BPX devices**
- **Long term goal of pedestal studies:** ***Develop the physics understanding that allows us to predict and control the H-mode pedestal height and ELM size***
  - ***So that we can produce a boundary which supports high stored energy in the core with acceptable heat pulses to the divertor/wall***

Pedestal Physics Includes Many Topics (*Focus is Needed!*)

- **Pedestal structure**
  - **Scaling and physics of pedestal height and width**
- **MHD stability**
  - **Threshold conditions for ELMs and other MHD phenomena**
- **ELM size**
  - **Scaling and physics of heat and particle losses from ELMs**
- **Transport**
  - **Scaling and physics of heat and particle transport in pedestal**
- **Density limit**
  - **Origin and physics of H-mode density limit (Greenwald limit)**
- **H-mode transition**
- **Pedestal control**

Study of Pedestal Structure

- **Can we obtain scalings for pedestal height and width purely in terms of dimensionless plasma physics variables?**
  - **What is the ρ* scaling? Must we also includes atomic physics? If so, what are the relevant dimensionless parameters?**
- **Answering these questions may require dimensional approach within and between machines**
  - **NSTX provides unique information due to small aspect ratio and B_T**
- **Good edge profile diagnostics are crucial**
  - **Spatially resolved measurements of T_e, n_e and T_i in pedestal**
    - **Sub-cm resolution may be required (at outer midplane)**
- **Atomic physics questions require additional diagnostics**
  - **Measurements of neutrals (ionization profiles) and impurity radiation - radial and poloidal resolution needed**

Study of ELM Stability

- **Is the model for ELM trigger, based on ideal medium-n peeling/ballooning modes, correct?**
  - **The theory is embodied in various codes, such as ELITE, which can be used to predict stability boundaries**
  - **MHD stability boundaries are cast in terms of pedestal pressure gradient and current density**
  - **With suitable measurements, theory can be tested with experiment**
- **NSTX provides unique opportunity to test the theory due to its low aspect ratio**
  - **Aspect ratio may have an impact on stability boundaries**
  - **Aspect ratio may affect boot strap current**
- **Measurements to test theory include:**
  - **Edge pressure gradient and plasma current density**
  - **Mode number identification for ELM precursors**

Study of Losses Due to ELMs

- **What physics determines the magnitude of energy and particle losses due to ELMs?**
  - **Can losses be determined from linear stability theory? Size of eigenfunctions?**
  - **Is non-linear evolution of ELM important?**
  - **Are atomic physics or divertor physics important for loss mechanisms?**
- **Characterization of magnitudes and timescales for losses are needed**
  - **Magnitude of prompt loss of energy and particles from plasma**
  - **Magnitude of energy deposition to divertor**
  - **Timescales for flows of energy and particles to divertor/wall**
  - **Evaluation of changes to divertor/SOL plasma parameters during ELM pulse**

Transport in the Pedestal

- **What physics controls transport in the pedestal?**
  - **Pedestal transport is poorly characterized experimentally**
  - **Theoretical understanding of transport is lacking**
- **Characterization of transport coefficients is required**
  - **Power balance measurements require excellent pedestal profile diagnostics, measurements of radiated power and measurements of ionization profile**
  - **Can modulation techniques be used to measure transport?**
- **Characterization of turbulent transport is required**
  - **2D imaging of turbulent quantities is highly desirable**
  - **Measurements of fluctuating fields (density is standard measurement - can we measure other fields also?)**
  - **Compare turbulence measurements and theoretical simulations**

Interaction Between Experiment, Theory and Modeling Is Needed

- **Strong Experiment/Modeling/Theory interaction are needed to advance understanding of pedestal physics**
- **Modeling/theory support for MHD phenomena is strong and MHD is an area ripe for advances**
- **Modeling/theory support for transport needs more effort**
  - **Fluid code BOUT is primary edge turbulence simulation code in US - physics development will continue**
  - **There is a need for a kinetic code for the edge - Gyro will push into this region - other codes?**
- **Integrated modeling is required to examine interactions between the various physics elements (sources, transport, MHD, and atomic physics)**
  - **Start with simple models and improve as the physics develops**

In Summary - - -

- **Results from tokamaks, spherical tori and stellarators show that H-mode pedestals are a general feature in toroidal magnetic geometry**
- **Theories for pedestal structure, edge MHD stability and pedestal transport must ultimately explain physics in these different devices**
- **In addition, there is good reason to believe that understanding the pedestal will require input from a variety of machines with different characteristics**
- **Due to its aspect ratio and low magnetic field, NSTX will provide unique and powerful tests of pedestal models and understanding**
  - **And it will provide unique insights into pedestal physics**