Plans and progress on M3D-C1 modeling with impurities

by

Brendan C. Lyons[1]

with
Nathaniel M. Ferraro[2], Stephen C. Jardin[2]

[1]General Atomics

[2]Princeton Plasma Physics Laboratory

CTTS Disruption Mitigation Call
February 12, 2018

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- **Continuity equations advanced for each charge state of impurities**
- **KPRAD calculates ionization, recombination, and radiation**
- **2D nonlinear modeling of DIII-D shot 137611**
  - Radiation leads to decrease in thermal energy
  - Timescale far too slow compared to Izzo PoP 2013

Thermal Energy

$n_{Ar} = 0$

$n_{Ar} = n_D/3$

$TE \ (B_0^2/4\pi \ L_0^3)$

$t \ (\tau_{A0})$

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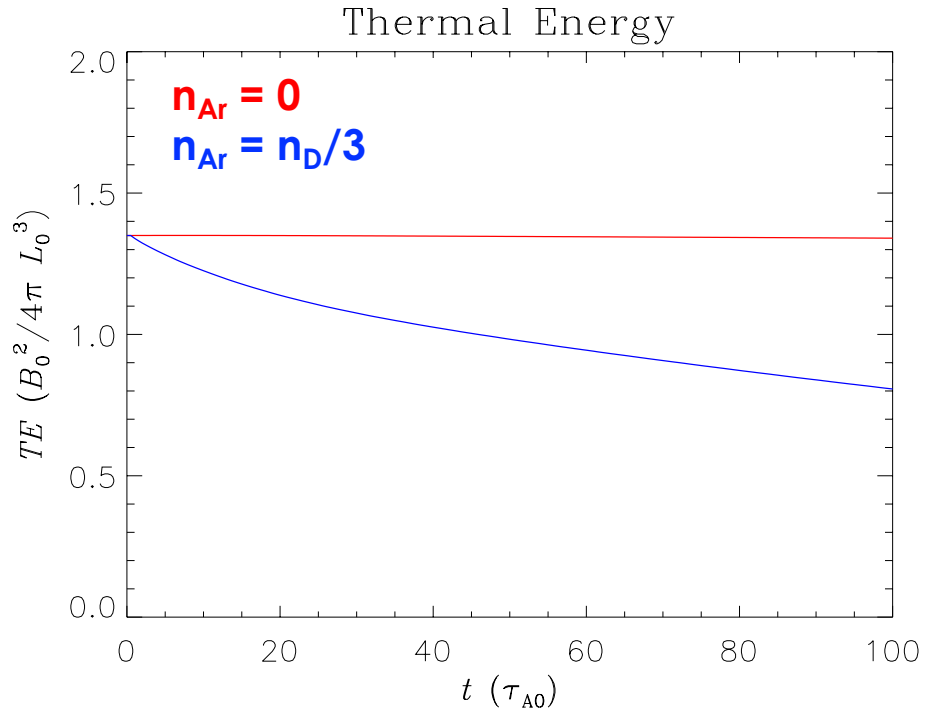
Equations in M3D-C1 being improved

- **Currently impurities just advect and radiate power, but this misses important physics**

- **New single-fluid equations developed based on reduction from full multi-fluid model**

- **Implementation in M3D-C1 underway to capture important effects, including**

  - Impurity contribution to total momentum

  - Increase in electron density as impurities ionize

  - Dilution cooling as impurity density increases

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Future work

- **2D nonlinear benchmark with NIMROD**
  - Use DIII-D 137611 with initial argon distribution
  - Compare radiative cooling to verify KPRAD coupling
- **3D nonlinear modeling of same discharge**
- **Explore impurity profile effects on thermal and current quench**
- **Couple to pellet ablation model for more sophisticated mitigation modeling**

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