NSTX/NSTX-U Theory, Modeling and Analysis Results & Overview of New MAST Physics in Anticipation of First Results from MAST UPGRADE

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S.M. Kaye (PPPL), J. Harrison (CCFE) for the NSTX-U and MAST-U Teams
NSTX(-U) and MAST research address urgent issues for fusion science, ITER and next-step devices

• Core transport & turbulence studied over an extended range of $\beta$
  – Electrostatic and electromagnetic effects drive strong favorable $v_*$ scaling
  – Multi-scale effects (low- & high-$k$) must be considered

• Energetic particle effects and instabilities studied in portions of parameter space expected for $\alpha$-burning plasmas
  – Low and high frequency modes can have profound effect on EP distribution
  – Predictive models and phase-space engineering techniques being developed

• L-H and H-mode physics
  – Zonal flow to turbulence energy flow prior to L-H inconsistent with predator-prey

• SOL turbulence studies address processes controlling heat flux width
  – Filamentary structures/turbulence
  – Heat flux mitigation through innovative divertor designs