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XP1062: NTV behavior at low ion collisionality and maximum variation of ω_E - Update

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NSTX Results / Theory Review

December 1st, 2010

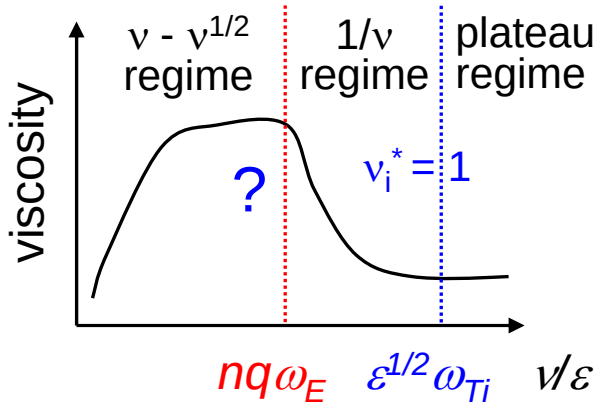
PPPL

V1.0

XP1062 started: Verify NTV physics for next-step devices (NSTX-U to ST-CT / ITER), and support NSTX rotation control system design

Present goals

- Investigate NTV-induced magnetic braking over range of collisionality, ω_E (i.e. $(\nu_i/\varepsilon)/|nq\omega_E|$)
  - Key for ITER, ST Component Test Facility
  - If $(\nu_i/\varepsilon)/|nq\omega_E| << 1$: NTV saturated (indep. of ν)
  - If $(\nu_i/\varepsilon)/|nq\omega_E| > 1$: NTV ~ $1/\nu$
  - If low ω_E ($< \omega_{\nabla B}$): NTV maximized (indep. of ν) (superbanana plateau: Shaing, et al, PPCF **51** (2009) 035009)



- Determine NTV offset rotation
  - Standard approach: observe offset by operating at near-zero ω_ϕ
  - Consider new approach using RF (based on RF XPs from 2009) – not yet run!

$$\left\langle \hat{e}_t \bullet \vec{\nabla} \bullet \overleftrightarrow{\Pi} \right\rangle_{(1/\nu)} = B_t R \left\langle \frac{1}{B_t} \right\rangle \left\langle \frac{1}{R^2} \right\rangle \frac{\lambda_{1i} p_i}{\pi^{3/2} \nu_i} \varepsilon^{3/2} (\omega_\phi - \omega_{NC}) I_\lambda$$

XP1062 started: Verify NTV physics for next-step devices (NSTX-U to ST-CT / ITER), and support NSTX rotation control system design

- Motivation
  - Verify neoclassical toroidal viscosity physics for next-step devices (NSTX-U to ST-CT / ITER), and to support design of NSTX rotation control system

- Goals / Approach (Progress) – 18 new shots
  - Compare magnetic braking with largest variation of ν_i^* using LLD
    - Target a comparison of two conditions: low vs. high ν_i^* , favor low ν_i^* condition
    - RESULT: NTV braking detail measured at ν_i reduced by at least a factor of 4 in region of maximum braking torque (due to lack of prefill gas) in 3 braking shots
    - RESULT: Variation in plasma rotation damping observed as ν_i varied
  - Generate greater variation of key parameter $(\nu_i/\varepsilon)/|nq\omega_E|$
    - Concentrate on low ω_E to further examine superbanana plateau regime/theory
    - RESULT: NTV braking brought plasma to low rotation (< 7kHz core, < 2kHz ~ q=2) – increased braking torque observed at low ω_E, analysis continues
  - Determine NTV offset rotation
    - Standard approach: observe offset by operating at near-zero ω_ϕ
    - RESULT: Latest data (as past data): no large NTV offset counter-rotation
    - NTV offset is small co-rotation if any; similar to JET, opposite to DIII-D claim
    - Consider new approach using RF (based on RF XPs from 2009) – not yet run!