Simulations of EXTRAP-T2R RFP with n=12 RMP fields

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EXTRAP T2R is an RFP machine with $R=1.24\,\text{m}$ and $a=0.183\,\text{m}$. Typical plasmas are characterized by $I_p \sim 100\,\text{kA}$, $T_e = 300-400\,\text{eV}$ and $N_e \sim 10^{19} \,\text{m}^{-3}$.

Typical discharge duration is between 70 and 90 ms.
Experiments aim to quantify RMP screening effects:

- **The effect of the RMP on the plasma is quantified by monitoring the dynamics of its corresponding TM**: it is known that a static RMP affects the corresponding TM island by amplifying and suppressing its amplitude and producing acceleration-deceleration to its velocity, depending on the relative phase between RMP and TM.

- **The plasma flow is varied by applying non-resonant perturbation** (non-RMP), that via the neo-classical viscosity (NTV) torque modifies in a relatively controlled way the plasma velocity.
Initial equilibrium was very problematic

- In initial simulation attempts, all modes grew rapidly, virtually independent of grid resolution or viscosity/resistivity.

- Allowed equilibrium to adjust (transfer_eq=T, n=0 simulations, wrote new EFIT from results, reran nimset with transfer_eq=F).
  - Side note: When following this procedure $B_t$ changes sign? Why does definition of FF' in EFIT output routine have -sign?

- New equilibrium is shifted outboard, has slightly different q-profile (n=12 still resonant in core).
With only \( n=12 \) fields RFP (almost) reaches new saturated state

- Ramp until 0.1 ms, \( n=12 \) mode continues to grow, then oscillates
- New (almost) steady conditions between 0.2 and 0.4 ms. Lower velocity, oscillations similar to experiment.
Structure of the three continuously growing modes at 0.35 ms

n=11 $B_{\text{tor}}$
(m=1)

n=1 $B_{\text{tor}}$
(m=0)

n=13 $B_{\text{tor}}$
(m=1)
Toroidal rotation hovers at reduced values, briefly (kin_visc=10)

Toroidal rotation profile: Initially slows, then hovers at 40 km/s, then 35 km/s, before finally dropping rapidly toward zero.

Experiment finds steady state value at ~25 km/s
A lot of margin for error in the experimental viscosity (esp. near edge)

In simulation with kin_visc=1000 nothing happens (very small 1/12 island, no profile changes)
Island forms, rotates briefly, finally plasma becomes fully stochastic.
Ongoing work

• Question: Why does rotation eventually crash, rather than maintaining a new steady state? (May try cylindrical geometry)

• Viscosity scan to cover range of experimental uncertainty

• Case beginning with applied $n=9$ initial velocity profiles

• More careful comparisons with experiment as well as mode screening theory