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Conversion of *AEs to Kinetic Alfven Waves

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N. N. Gorelenkov, N. A. Crocker, others….

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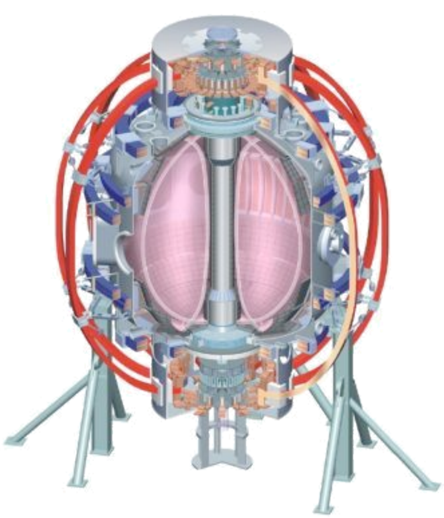

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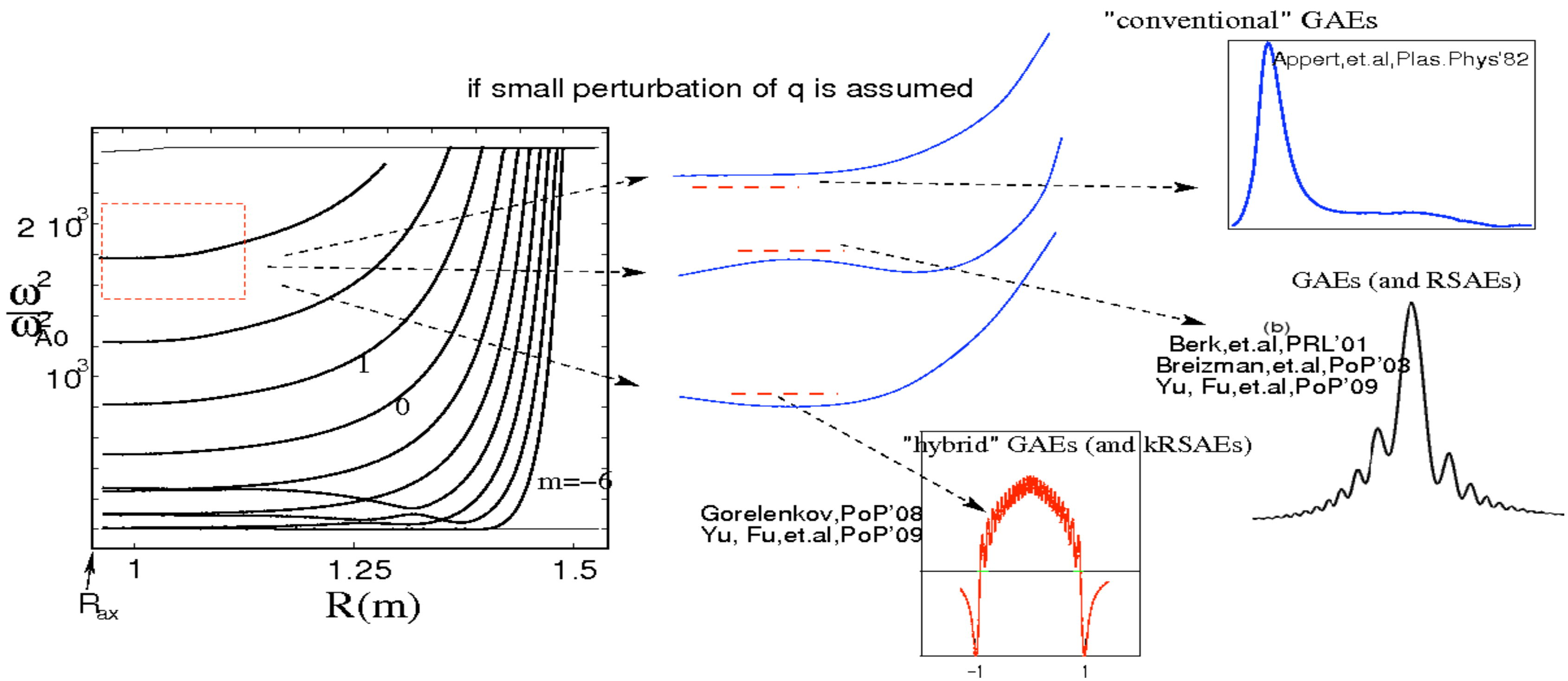
*AE – KAW couple near the Alfvén continuum

Kinetic Alfvén Waves (KAW) will helpt to resolve outstanding issues for robust predictions of *AE stability and their effects:

- Radiative damping
- Interaction with continuum – continuum damping
- Small scale structure effect on WPI
- Generation of parallel electric fields for GAE driven e-transport

Example of high-f GAE (RSAEs are similar) – KAW interaction (schematic):



*AE – KAW interaction can change how fast-ions heat plasma

- Continuum interaction of reverse shear Alfvén eigenmodes and TAEs is common in **NSTX** and is expected to excite KAW
- KAWs have short radial scale $\Rightarrow$ damp on background plasma electrons
  - For upsweeping RSAE: KAW radiates away from continuum intersection
  - KAW k_r ranges from $m^{1/4}/(\rho a)^{1/2}$ near continuum to $1/\rho$ further away ($\rho \sim \rho_i$, ρ_s)

    $\rho \sim 1$ cm, $a = 85$ cm, $m \sim 10 \Rightarrow \sim 1\ \text{cm}^{-1} > k_r > \sim 0.2\ \text{cm}^{-1}$

    $\lambda=2\pi/k_r$ scale seems measurable with reflectometer/BES
- Coupling to KAWs (a.k.a. *radiative damping)* can efficiently damp RSAEs $\Rightarrow$ changes how fast-ions heat plasma

Proposed experiment: Observe and characterize KAWs excited by continuum interaction of RSAEs (GAEs) (1 day)

1. Create **reverse shear NB-heated** plasma to excite RSAEs – **key requirement**
   - Easier to interpret/model (w/NOVA) than multiple TAE solutions
2. **High density is required** - use close-spaced reflectometer array to detect KAWs
   - 5 channel closely spaced (Δf = 350MHz) reflectometer array
   - frequency adjustable (Test Cell entry required): 3.4 – 7.4 x 10^{19} m^{-3} (53 GHz – 78 GHz)
   - channels span 1.4 GHz (~ 2 % of center frequency ⇒ short radial span)
3. ***q*-profile evolution** would guarantee that continuum moves interaction region through reflectometer measurement region:
   - *q*-profile minimum forms "well" in continuum
   - q_{min} sweep causes upward RSAE frequency sweep from bottom of "well"
   - RSAEs intersect continuum during sweep — intersection moves radially outward as RSAE frequency sweeps up
   - set reflectometer to reflect inside RSAE "well" outboard of q_{min} radius
4. **Scan KAW scale parameters** — ρ_i, ρ_s and m (depends on n and q_{min}) — and compare with measurements

- Model shot (?) to be determined – constraints include:
  - monotonic density profile, density in ***range 3.4 – 7.4 x 10^{19} m^{-3}*** near q_{min} radius
  - reflectometer sensitivity limits: need KAW scale > ρ_i, ρ_s and > $1.63(L_n/k_0^2)^{1/3}$ (microwave "Airy width")
    - L_n = density gradient scale, k_0 = microwave vacuum wavelength ~ 5 mm