

Class 9

The Outlook for Magnetic Fusion

→ Devices

USA

DIII-D; 30+
 NSTX-U → ongoing
 Alcator C-Mod → closing
 +

EUROPE

JET; 35+
 MAST → ongoing
 AUG → 2017
 WEST → new (I)

(*) W7X → brand new
 + stellarator

ASIA

(*) EAST (PRC) - 2008 (SC) } Long pulse
 (*) KSTAR (Rok) - 2008 (SC) } steady state

(*) LHD (Japan) - (15-20) stellarator

HL-2M (PRC) - constr. + (~ DIII-D)

JT60SA (Japan) - constr. - (SC) (I)
 +

Future

→ USA (??) - high power density, compact
(MIT)
~ proposed, not funded.

→ EU

W7X
MAST
WEST (I)

→ Asia

EAST, KSTAR, HL-2M, JT-60SA
+
CFETR(??) K-Demo(??)

(+)

ITER (France/EU/World)

(severe delays, cost over-runs)

→ >10 yrs to interesting work.

Foci : (10 yrs.)

- SS/Lang Pulse: EAST, KSTAR
- ST: MAST, NSTX
- Helical systems: W7X

Scientific Issues Confinement → Power Mgmt.

→ Boundary (Heat Loads)

- SOL widths
- Divertor Design
- ELM mitigation

→ Impurity Control / Transport (Metal wall - Tritium retention)

→ Disruptions and their Avoidance

→ Density Limits (Wall saturation, Lang Pulse)

- long known
- poorly understood
- turbulence (P_1), MHD (P_2)

→ α 's, Burning Assembler

- α confinement: TAE, etc
 $v_\alpha \sim v_A$.

→ as α population rises,

$P_{\alpha's} > P_{ext} \Rightarrow$ "self-heated" regime

\Rightarrow deposition, profiles

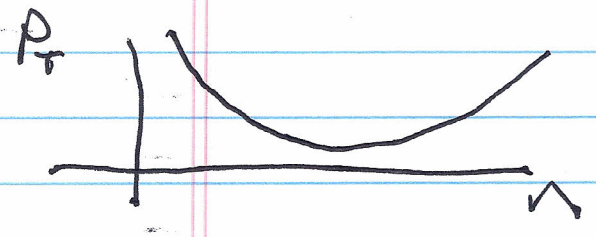
Today: electrons, ions +
Tomorrow: α 's, electrons, ions +...

Confinement Questions

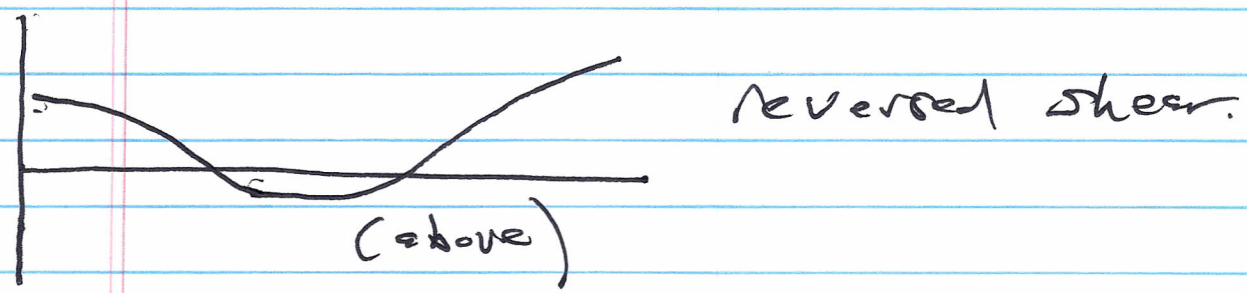
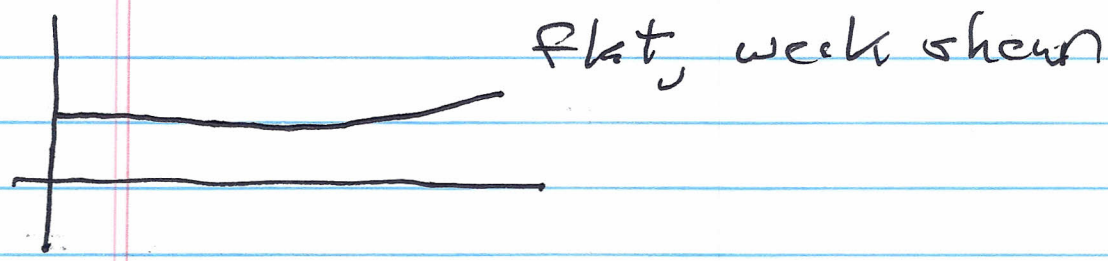
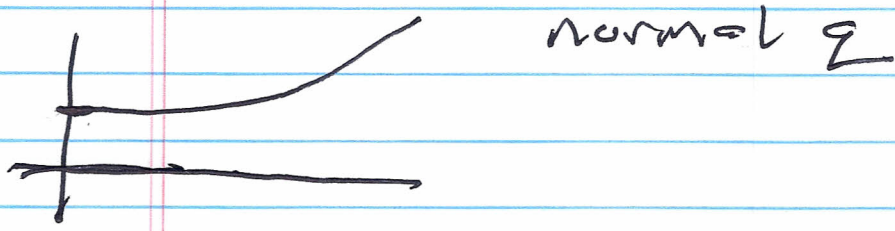
→ Alternative to H-mode

\Rightarrow I-mode { no ELIMs
impurities expelled
!

→ H-mode possible? how maintain?



→ Z profile effects



point: curvature $\frac{1}{\rho}$

$$K \rightarrow \omega_0 = k_0 v_A (\cos \theta + \hat{\sigma} \sin \theta)$$

↑
geodesic

$$\hat{\sigma} = \frac{r \Sigma'}{g}$$

$\hat{\sigma} \rightarrow 0$ reduced
 "effective gravity"
 in Rayleigh-Bénard-like
 model

⇒ 'Flat Z' - de-stiffened profiles
 - also ITR.

Very promising to optimize core confinement.

→ Taming the H-mode

- QH ⇒ EHO
- QH ⇒ turbulent.

→ Scenarios - putting the pieces together

- Flat Z + I-mode edge
- weak shear + QH-mode
- +
- ⋮

What will survive α's ?