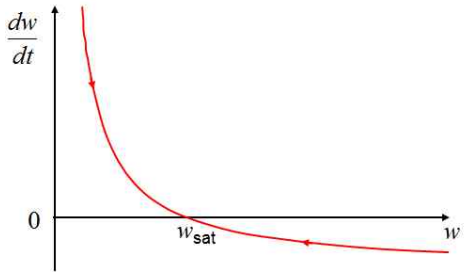
Fusion Reactor Engineering 2 (459.761)

Final Examination

15 December, 2020

1. Neoclassical tearing mode can be described with the modified Rutherford equation as follows;

$$0.82\frac{\tau_r}{r_s^2}\frac{dw}{dt} = \Delta' + a_2\sqrt{\varepsilon}\frac{\beta_\theta}{w}\frac{L_q}{L_p}$$



(1) (10 points) What is △′ and why is it destabilising?

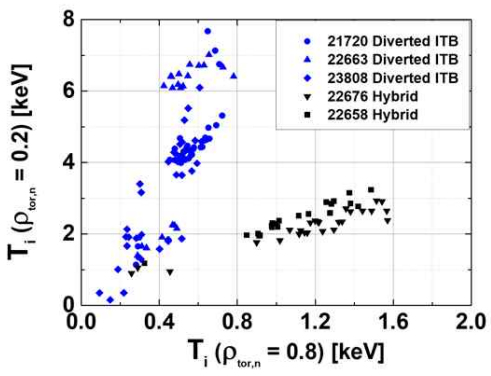
(2) (10 points) Calculate the saturated island width from the equation above.

(3) (10 points) Discuss the beta-limit with the derived saturated island width.

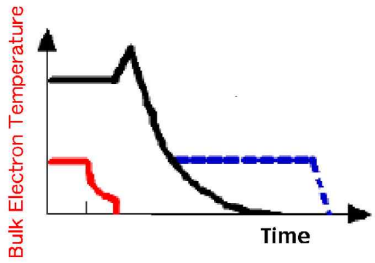
(4) (10 points) Discuss the limitation of the above equation and suggest possible modification required for this equation.

(5) (10 points) Discuss how to stabilise NTM based on the above equation.

2. (10 points) Explain why the ion temperature profiles in KSTAR behave as shown in the figure below.



3. (1) (10 points) Describe the time evolution of the plasma disruption in terms of the electron temperature (red) and the plasma current (black and blue).



(2) (10 points) How to avoid disruption?

4. Consider that the hydrogen beam energy is 110 keV, the density is 10^{20} m^{-3}, and the electron temperature is 10 keV in hydrogen discharges on KSTAR.

(1) (10 points) Attenuation of a neutral beam particles in a plasma can be described as

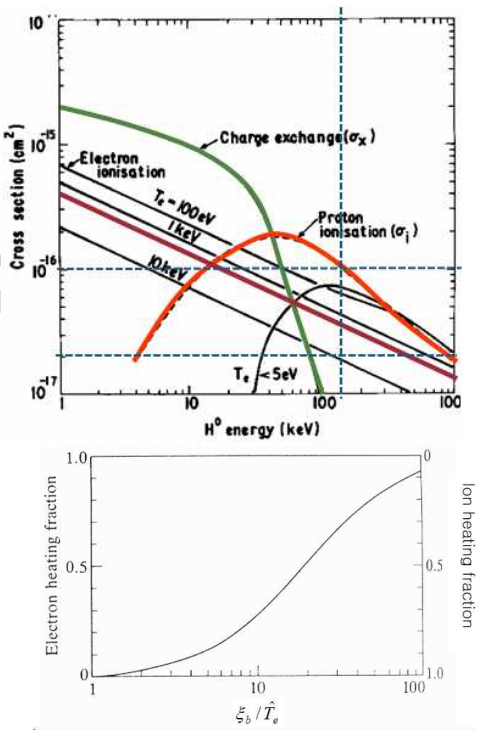
$$\frac{dN_b(x)}{dx} = -N_b(x)n(x)\sigma_{tot}.$$

Evaluate the penetration length of the beam in KSTAR.

(2) (10 points) The neutral beam injection power to ions and electrons can be expressed as below,

$$P = 1.71\times10^{-18}\frac{n_e\xi_b}{A_b\hat{T}_e^{3/2}}\left(1+\left(\frac{\xi_c}{\xi_b}\right)^{3/2}\right)\ [\mathrm{keVs^{-1}}],\quad \xi_c = \frac{14.8A_b\hat{T}_e}{(Z_iA_i)^{2/3}}$$

Evaluate how much power goes to ions in KSTAR.



한 학기 동안 모두들 수고 많으셨습니다.
좋은 결과 얻으시길 바랍니다.

"So we fix our eyes not on what is seen, but on what is unseen. For what is seen is temporary, but what is unseen is eternal." (2 Corinthians 4:18)