AS552 General Plasma Physics II
April 26, 2001

Problem Set #7 (due May 4, 2001)

Question 1: Drift instabilities

(a) Write down the linearized drift kinetic equation for the electrons. Solve for f_1, the perturbed distribution function, with the equilibrium distribution being a spatially (x) dependent Maxwellian, i.e.:

$$F_m = n_0(x) \left[\frac{m}{2\pi T(x)}\right]^{3/2} exp[-E/T(x)]$$

with $E/T = (v_\perp^2 + v_z^2)/(2v_{te}^2)$.

(b) Use the result from part (a) to calculate the perturbed electron density response in the usual adiabatic limit, $\omega/k_\parallel \ll v_{te}$, keeping the first order corrections needed for an instability of the collisionless drift wave. This is like we did in class, except now you are to keep the effects of a finite electron temperature gradient (which you can write in terms of the parameter $\eta_e = d\ln T_e/d\ln n_e$.

Using quasineutrality, combine your electron response with the fluid ion response we got in class:

$$\frac{n_{i1}}{n_0} = \frac{|e|\Phi}{T_e}\left[\frac{\omega_{*e}}{\omega} - b_s + \frac{k_\parallel^2 c_s^2}{\omega^2}\right]$$

to calculate the growth rate (or damping rate) of this mode in the usual limit $v_{ti} \ll \omega/k_\parallel \ll v_{te}$.

(c) Is positive η_e stabilizing or destabilizing for this usual collisionless drift wave?