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Problem Set 10 (due Friday, 27.06.2014 in the lecture)

Questions

(Q1) What is the Boltzmann Stoßzahlansatz? What are the underlying assumptions?

(Q2) What does a Fokker-Planck equation describe?

(Q3) Under which circumstances is a fluid description of plasma adequate, under which conditions a Vlasov treatment?

(10.1) two-stream-instability: maximum growth rate

We found for the one-dimensional two-stream-instability dispersion relation

$$1 = \frac{\omega_{\mathrm{p}_\alpha}^2}{(\omega - k u_{\alpha 0})^2} + \frac{\omega_{\mathrm{p}_\beta}^2}{(\omega - k u_{\beta 0})^2}.$$

Calculate the maximum growth rate ω_i (i.e., the imaginary part of the complex frequency ω, taking k real) for the case of two counter-streaming electron beams $n_{\alpha 0} = n_{\beta 0}$ and $u_{\alpha 0} = -u_{\beta 0}$.

(10.2) two-stream-instability: maximum spatial growth

Show that for the conditions outlined in the lecture notes the maximum spatial growth k_i (i.e., imaginary part of complex k, taking ω real) occurs at the frequency

$$\omega_{\mathrm{max.growth}} = \frac{\sqrt{3}}{2}\omega_{\mathrm{p}} \frac{u_{\beta 0} + u_{\alpha 0}}{|u_{\beta 0} - u_{\alpha 0}|}.$$