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• Two identical beams with Maxwellian distribution (thermal velocity $V_T$) propagate in opposite directions with velocity $v = \pm v_0$. Find a condition when two stream/bump in tail instability is suppressed.

\[
f = \exp\left\{-\frac{(v \pm v_0)^2}{(2v_T^2)}\right\}
\]
\[
\partial_v^2 f(v = 0) \rightarrow v_0 = V_T
\]

• Plasma has a distribution function $f = \exp^{-v/v_T}/v_T$ ($f$ is one-dimensional distribution). Find (i) thermal corrections to the real part of dispersion relation of Langmuir waves in the limit $v_{ph} = \omega/k \gg v_T$; (ii) damping rate $\Gamma(k)$ as a function of $z = kr_D$, where $r_D$ is Debye radius.

\[
< v^2 > = 2v_T^2, \omega^2 = \omega_p^2(1 + 6(kv_T/\omega_p)^2)
\]
\[
\epsilon_\parallel = 1 - \frac{\omega_p^2}{\omega^2}(1 + 3k^2 < v^2 > /\omega^2) - i\pi \frac{4\pi e^2}{m_0k} \int vf' \delta(v - \omega/k)dv \rightarrow
\]
\[
(-i\pi) \frac{4\pi e^2}{m_0k} vf'(v = \omega/k) = (\omega \rightarrow kv) = (-i\pi) \frac{\omega_p^2}{k^2} f' =
\]
\[
(-i\pi) \frac{\omega_p^2}{k^2} e^{\omega/k/(v_T)} \frac{1}{v_T^2}
\]

• An ion beam is propagating along magnetic field $B_0$ with velocity $v_0$. Plasma has density $\rho$. What is a condition for a beam to emit an Alfven wave at anomalous cyclotron resonance $\omega = \omega_B = \omega_B/k v_0 = -\omega_B/\gamma$ (note the minus sign on the rhs). What is the frequency of the emitted Alfven waves?

\[
v_A k - kv_0 = -\omega_B
\]
\[
v_0 > v_A, k = \frac{\omega_B}{v_0 - v_A}
\]
\[
\omega = v_A k = v_A \frac{\omega_B}{v_0 - v_A}
\]