BEAM INSTABILITIES[30]

Name	Conditions	Saturation Mechanism
Electron-electron	$V_d > \bar{V}_{ej},\ j = 1, 2$	Electron trapping until $\bar{V}_{ej} \sim V_d$
Buneman	$V_d > (M/m)^{1/3}\bar{V}_i$, $V_d > \bar{V}_e$	Electron trapping until $\bar{V}_e \sim V_d$
Beam-plasma	$V_b > (n_p/n_b)^{1/3}\bar{V}_b$	Trapping of beam electrons
Weak beam-plasma	$V_b < (n_p/n_b)^{1/3}\bar{V}_b$	Quasilinear or nonlinear (mode coupling)
Beam-plasma (hot-electron)	$\bar{V}_e > V_b > \bar{V}_b$	Quasilinear or nonlinear
Ion acoustic	$T_e \gg T_i,\ V_d \gg C_s$	Quasilinear, ion tail formation, nonlinear scattering, or resonance broadening.
Anisotropic temperature (hydro)	$T_{e\perp} > 2T_{e\parallel}$	Isotropization
Ion cyclotron	$V_d > 20\bar{V}_i$ (for $T_e \approx T_i$)	Ion heating
Beam-cyclotron (hydro)	$V_d > C_s$	Resonance broadening
Modified two-stream (hydro)	$V_d < (1+\beta)^{1/2}V_A$, $V_d > C_s$	Trapping
Ion-ion (equal beams)	$U < 2(1+\beta)^{1/2}V_A$	Ion trapping
Ion-ion (equal beams)	$U < 2C_s$	Ion trapping

For nomenclature, see p. 50.

Name	Parameters of Most Unstable Mode			
	Growth Rate	Frequency	Wave Number	Group Velocity
Electron-electron	$\frac{1}{2}\omega_e$	0	$0.9\frac{\omega_e}{V_d}$	0
Buneman	$0.7\left(\frac{m}{M}\right)^{1/3}\omega_e$	$0.4\left(\frac{m}{M}\right)^{1/3}\omega_e$	$\frac{\omega_e}{V_d}$	$\frac{2}{3}V_d$
Beam-plasma	$0.7\left(\frac{n_b}{n_p}\right)^{1/3}\omega_e$	$\omega_e - 0.4\left(\frac{n_b}{n_p}\right)^{1/3}\omega_e$	$\frac{\omega_e}{V_b}$	$\frac{2}{3}V_b$
Weak beam-plasma	$\frac{n_b}{2n_p}\left(\frac{V_b}{\bar{V}_b}\right)^2\omega_e$	ω_e	$\frac{\omega_e}{V_b}$	$\frac{3\bar{V}_e^2}{V_b}$
Beam-plasma (hot-electron)	$\left(\frac{n_b}{n_p}\right)^{1/2}\frac{\bar{V}_e}{V_b}\omega_e$	$\frac{V_b}{\bar{V}_e}\omega_e$	λ_D^{-1}	V_b
Ion acoustic	$\left(\frac{m}{M}\right)^{1/2}\omega_i$	ω_i	λ_D^{-1}	C_s
Anisotropic temperature (hydro)	Ω_e	$\omega_e\cos\theta \sim \Omega_e$	r_e^{-1}	$\bar{V}_{e\perp}$
Ion cyclotron	$0.1\Omega_i$	$1.2\Omega_i$	r_i^{-1}	$\frac{1}{3}\bar{V}_i$
Beam-cyclotron (hydro)	$0.7\Omega_e$	$n\Omega_e$	$0.7\lambda_D^{-1}$	$\gtrsim V_d$; $\lesssim C_s$
Modified two-stream (hydro)	$\frac{1}{2}\Omega_H$	$0.9\Omega_H$	$1.7\frac{\Omega_H}{V_d}$	$\frac{1}{2}V_d$
Ion-ion (equal beams)	$0.4\Omega_H$	0	$1.2\frac{\Omega_H}{U}$	0
Ion-ion (equal beams)	$0.4\omega_i$	0	$1.2\frac{\omega_i}{U}$	0

For nomenclature, see p. 50.

In the preceding tables, subscripts e, i, d, b, p stand for "electron," "ion," "drift," "beam," and "plasma," respectively. Thermal velocities are denoted by a bar. In addition, the following are used:

m	electron mass	r_e, r_i	gyroradius
M	ion mass	β	plasma/magnetic energy density ratio
V	velocity		
T	temperature	V_A	Alfvén speed
n_e, n_i	number density	Ω_e, Ω_i	gyrofrequency
n	harmonic number	Ω_H	hybrid gyrofrequency, ${\Omega_H}^2 = \Omega_e \Omega_i$
$C_s = (T_e/M)^{1/2}$	ion sound speed		
ω_e, ω_i	plasma frequency	U	relative drift velocity of two ion species
λ_D	Debye length		