Thermal Instability

Thermal instability: Homogeneous gas, ρ, T in thermal equilibrium.

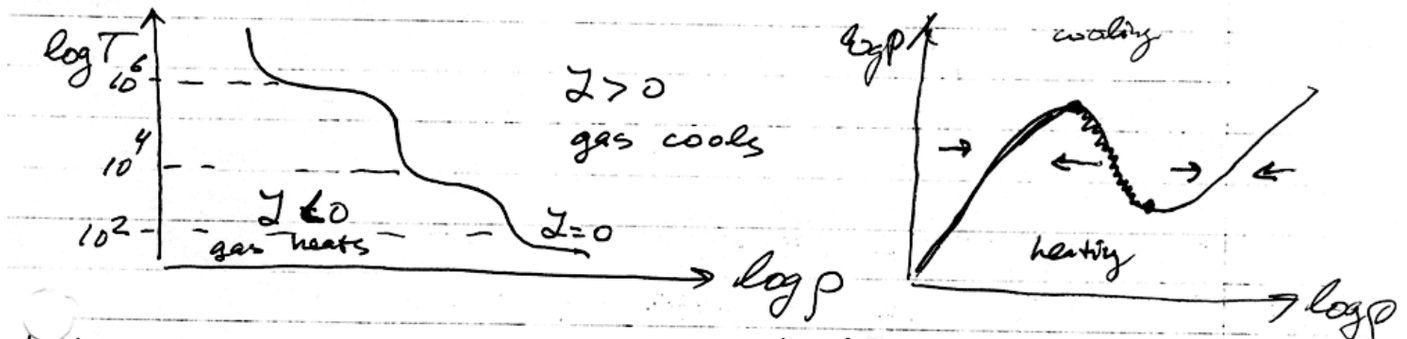
Optically thin gas. The gas is in thermal balance: rate of energy loss is equal to heating rate:

$$\Gamma - \Lambda = -\rho \mathcal{L} = 0 \qquad \left\| \rho \frac{d\varepsilon}{dt} = \frac{p}{\rho}\frac{d\rho}{dt} + \Gamma - \Lambda(\rho, T) \right.$$

$\Lambda(\rho,T) = n_H n_e \Lambda(T)$

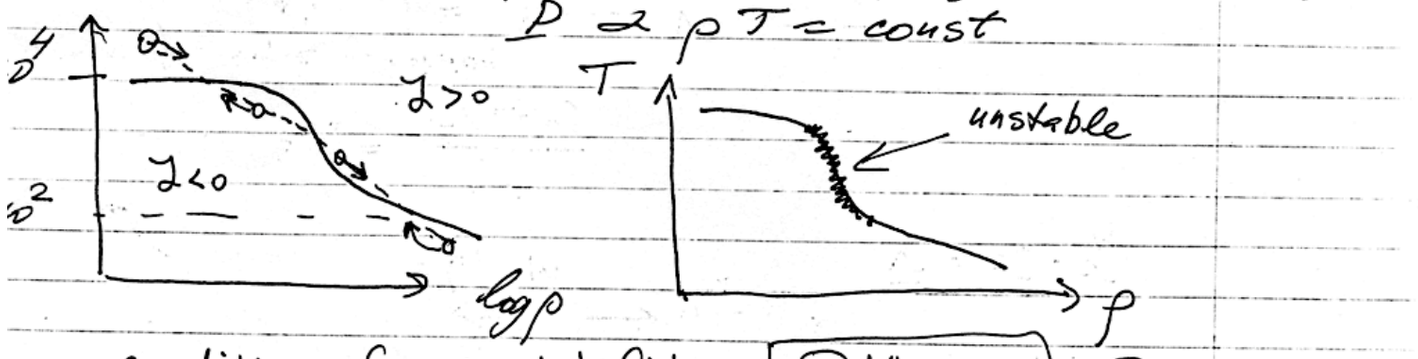
↑ heating ↑ cooling ↑ heat-loss function per unit mass

Usually $\mathcal{L}$ is a function of density ρ and temperature T



Homogeneous gas: consider a blob with small deviation from equilibrium parameters. The blob is in hydrostatic equilibrium: its pressure is always = ambient P

$P \propto \rho T = \text{const}$



condition for instability: $\left.\frac{\partial \mathcal{L}}{\partial T}\right|_p < 0$

Time-scale = = cooling time

This produces two-phase medium: cold clouds embedded into hot diluted gas