EQN OF STATE

$$p = n K T \qquad \frac{N}{V}$$

$n =$ number of particles per unit volume (number density)

$\Rightarrow \; p = f(\rho, T) \rightarrow$ Assuming Isothermal $\quad p \propto n$, $\; p = K_B T \cdot n$

For adiabatic: $p \rho^{-\gamma} = \text{const.}$, $\quad \gamma = \frac{C_p}{C_V}$

This is the third and last relation to close the fluid representation of the system.

Diff. coeff.

$$\frac{\partial T}{\partial t} = D_T \nabla^2 T \quad \leftarrow \text{diffusion eqn. for heat}$$

$$T v_T = -D_T \nabla T \quad \leftarrow \text{heat flux}$$

v_T: Characteristic velocity for temperature propagation.

L – length scale

T – time scale

$$v \sim \frac{L}{T}$$

$$V_T = -D_T \frac{\nabla T}{T} \approx -D_T \frac{1}{L}$$

$V_T \gg u$ – smooth variation

$V_T \ll u$ – adiabatic

HEAT CAPACITIES

$$\gamma = \frac{C_p}{C_V}$$

$$C = \frac{Q}{\Delta T} = \frac{\overset{\text{internal energy}}{\Delta U} - \overset{\text{work}}{W}}{\underset{\text{change in temp.}}{\Delta T}} \quad , \quad W = -P\Delta V$$

Specific heat capacities:

$$C_V = \left(\frac{\Delta U}{\Delta T}\right)_V \rightarrow \left(\frac{\partial U}{\partial T}\right)_{V = \text{const}}$$

$$C_p = \left(\frac{\Delta U - (-P\Delta V)}{\Delta T}\right)_p \Rightarrow \left(\frac{\partial U}{\partial T}\right)_p + P\left(\frac{\partial V}{\partial T}\right)_p$$

For ideal gas:

$$\frac{C_p}{C_V} = \frac{5}{3} \qquad C_V = \frac{3}{2} nk \qquad C_p = C_V + nk$$