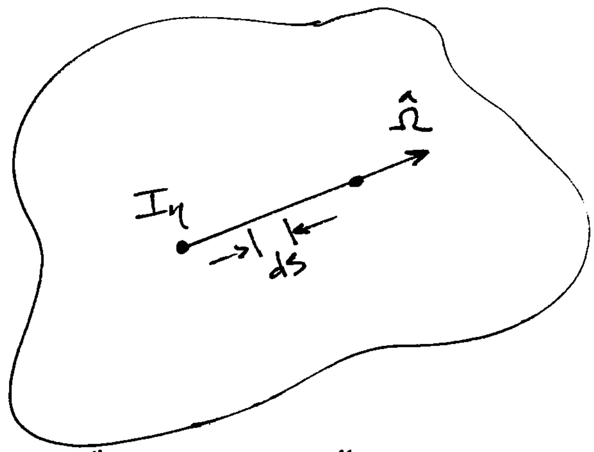


"BLOB OF GAS"

EQUATION OF RADIATIVE TRANSFER —

$$\frac{dI_\eta}{ds} = \underbrace{-K_{a\eta} I_\eta}_{\text{ABSORPTION}} \underbrace{- K_{s\eta} I_\eta}_{\text{SCATTERING}} + \underbrace{K_{a\eta} I_{b\eta}(s)}_{\text{EMISSION}} + \frac{K_{s\eta}}{4\pi} \int I'_\eta \, \Phi(\hat{\Omega}' \to \hat{\Omega}) \, d\Omega'$$

$\uparrow$ $I'_\eta(\hat{\Omega}', s)$

.. CAN INTEGRATE OVER η, ONLY WHEN $K_{a\eta}$, $K_{s\eta}$ ARE η INDEPENDENT

$\Longrightarrow$ GRAY MEDIUM

$f \equiv$ DISTRIBUTION FUNCTION $f(t, \bar{r}, \bar{v})$

BOLTZMANN EQN.:

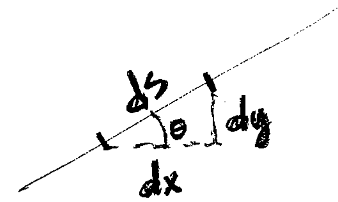
$$\frac{\partial f}{\partial t} + \bar{v} \cdot \bar{\nabla}_r f + \bar{a} \cdot \bar{\nabla}_v f = \left(\frac{\partial f}{\partial t}\right)_s$$

$\leftarrow$ SCATTERING $\left\{ \begin{array}{l} \text{INELASTIC}: \omega_{in} \neq \omega_{out} \\ \text{ELASTIC}: \omega_{in} = \omega_{out} \end{array} \right\}$

INTENSITY:

$$I = \frac{|\bar{v}| \hbar\omega f D(\omega)}{4\pi}$$

$s = s(x, y, z)$



$$\frac{dI_\eta}{ds} = \frac{\partial I_\eta}{\partial x}\frac{\partial x}{\partial s} + \frac{\partial I_\eta}{\partial y}\frac{\partial y}{\partial s} + \frac{\partial I_\eta}{\partial z}\frac{\partial z}{\partial s}$$

$$= \nabla I_\eta \cdot \hat{e}_\Omega$$

$dx = ds\cos\theta \longrightarrow \cos\theta = \frac{dx}{ds}$

$dy = ds\sin\theta \longrightarrow \sin\theta = \frac{dy}{ds}$

$$\hat{e}_\Omega = \hat{e}_s = \hat{x}\cos\theta + \hat{y}\sin\theta$$

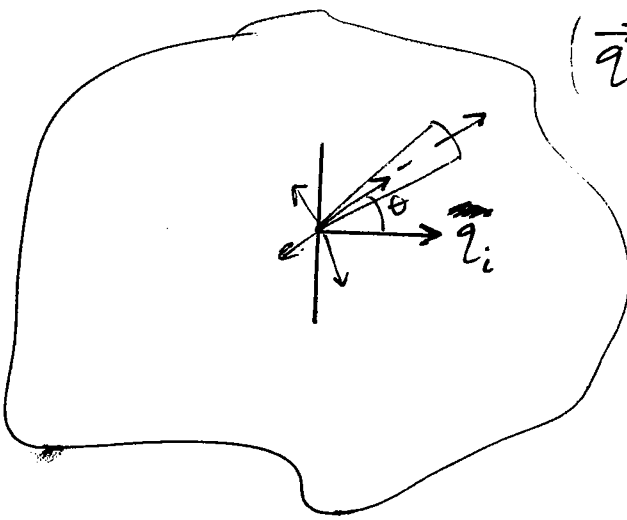
$$= \hat{x}\frac{\partial x}{\partial s} + \hat{y}\frac{\partial y}{\partial x}$$

$\lim_{\Delta s \to 0} \frac{dx}{ds} \to \frac{\partial x}{\partial s}$

$I_\eta(\bar{r}, \hat{\Omega})$ ← θ, ϕ

note: heat flux is a vector.

$(\vec{q}'')$



$$I_\eta = \frac{P_\eta'}{A_\perp \Delta\eta \Delta\Omega}$$

$$\Rightarrow q_i'' = \int \frac{P_\eta'}{A}\, d\eta\, d\Omega$$

$$q_i'' = \int_0^\infty \int_{4\pi} I_\eta \cos\theta\, d\eta\, d\Omega$$

$d\Omega = \sin\theta\, d\theta\, d\phi$

★ HERE $|\bar{v}|$ IS JUST THE SPEED OF LIGHT AND IS ~~A~~ CONST.

IF INDEX OF REFRACTION VARIED, OR IF SPEED VARIED BY SOME MEANS, WE'D HAVE TO $\int$ OVER ALL SPEEDS.

HEAT GENERATION: $-\overline{\nabla}\cdot\overline{q}''_r$

IF NO CONDUCTION | CONVECTION (i.e., RADIATION EQUIL.)

$$\overline{\nabla}\cdot\overline{q}''_r = 0$$

OPTICAL

$$d\tau_\eta = (K_{a\eta}+K_{s\eta})\,ds \Rightarrow \tau_\eta = \int_0^s (K_{a\eta}+K_{s\eta})\,ds = \frac{s}{1/K_{e\eta}}$$

IN NON-DIMENSIONAL FORM

SOURCE TERM $S_\eta(\tau_\eta, \hat{\Omega})$

DEPENDS ON LOCAL

$$\frac{dI_\eta}{d\tau_\eta} = \underbrace{-I_\eta}_{\text{LOSS}} + \underbrace{(1-\omega_\eta)I_{b\eta}}_{\text{EMISSION}} + \underbrace{\frac{\omega_\eta}{4\pi}\int I'_\eta\,\Phi(\hat{\Omega}'\to\hat{\Omega})\,d\Omega'}_{\text{SCATTERING IN}}$$

INTEGRO-DIFFERENTIAL EQUATION
(CAN SOLVE BY DECRETIZING)

IN COMPACT FORM ....

$$\frac{dI_\eta}{d\tau_\eta} = -I_\eta + S_\eta$$

GLOBAL WARMING DISCUSSION TOPICS

1. HISTORICAL TREND | HUMAN FACTORS | EVIDENCE | COUNTER ARGUMENTS

2. HOW MUCH SOLAR RADIATION IS ABSORBED BY EARTH?

   FACTORS: GAS, PARTICLES, LAND, SEA

3. HOW MUCH EARTH RADIATION ESCAPES?

   FACTORS: GAS, PARTICLES, LAND, SEA

4. WHAT HAPPENS IF EARTH'S TEMPERATURE RISES BY 1°–5°C
   - SIMPLE CLIMATE MODEL
   - ΔT / year