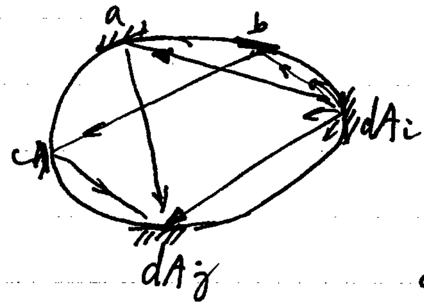
1. Review of last lecture.

a. Radiation network method

b. Partially diffuse & specular



$$dF^{s}_{dA_i-dA_j} = \frac{\text{Intercepted } \left\{ \begin{array}{l} \text{diffuse} \\ \text{specular} \end{array} \right.}{P^{(d)}_{dA_i}\ (\text{total diffuse})}$$

$$dF^{s}_{dA_i-dA_j} = dF_{dA_i-dA_j} + \rho^s_a\, dF_{dA_i(a)-dA_j} + \rho^s_b \rho^s_c\, dF_{dA_i(bc)-dA_j} + \cdots$$

energy balance

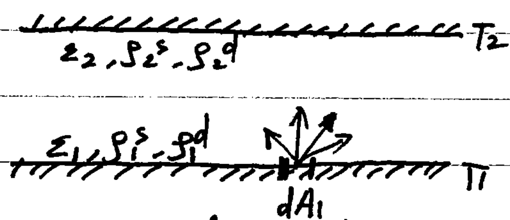
$$q(\vec{r}) = \varepsilon E_b(\vec{r}) - \alpha H(\vec{r})$$
$$= \varepsilon(r)\left[E_b(\vec{r}) - H(\vec{r})\right]$$

$$q(\vec{r}) = J^{tot} - H(\vec{r})$$
$$= \underline{\rho^d H} + \rho^s H + \underline{\varepsilon E_b} - H$$
$$= J - [1-\rho^s] H$$

↑ Diffuse part only

$$H(\vec{r}) = \int_A J(\vec{r}')\, dF^{s}_{dA-dA'} + H_o^{s}$$

Example :



2 infinite parallel plates

$$dF^{(s)}_{d1-2}$$
$$= 1 + \rho_2^s \rho_1^s + (\rho_2^s \rho_1^s)^2 + \cdots$$
$$= \frac{1}{1-\rho_1^s \rho_2^s}$$
$$= F^s_{1-2}$$

since every area behave same.

reciprocity F^s_{2-1}

$$F^s_{1-2} > 1$$

but each time, absorbed $(1-\rho_2^s)$

⌊ specular part only.

$(1-\rho_2^s) F^s_{1-2} \Rightarrow$ fraction absorbed.

↳ Summation rule $\sum_{j=1}^{N} (1-\rho_j^s) F^s_{i-j} = 1$

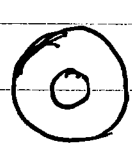
$$q_1 = J_1 - [1-\rho_1^s] \; J_2 F^s_{1-2}$$

$$q_2 = J_2 - [1-\rho_2^s] \; J_1 F^s_{2-1}$$

$$q_1 = \frac{\varepsilon_1}{\rho_1^d} [(1-\rho_1^s) E_{b1} - J_1]$$

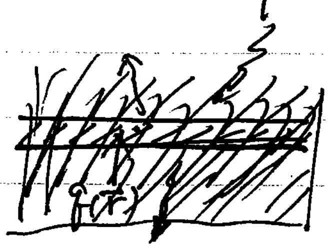
$$q_2 = \frac{\varepsilon_2}{\rho_2^d} [(1-\rho_2^s) E_{b2} - J_2]$$

$$\Rightarrow \quad q_1 = \frac{E_{b1} - E_{b2}}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1}$$ — for both specular & diffuse



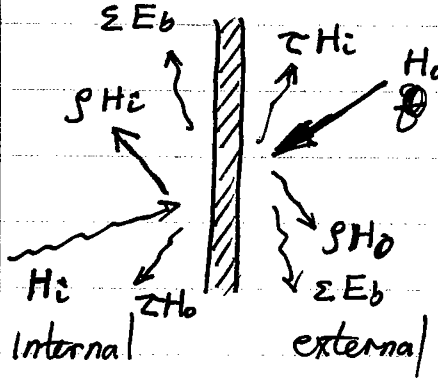
Concentric spheres / cylinders $q_1 = \dfrac{E_{b1} - E_{b2}}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2}\frac{A_1}{A_2} - \frac{A_1/A_2 - \rho_2^s}{1-\rho_2^s}}$

* Semi transparent.



previous concepts are valid
only thing that needs to be
changed is energy balance

~~$q(\vec{r}) \neq \varepsilon(\vec{r}) E_b(\vec{r})$~~



$$q_o = \varepsilon E_b + \rho H_o + \tau H_i - \underbrace{H_o}_{\text{leaving}}$$

$$q_i = \varepsilon E_b + \rho H_i + \tau H_o - \underbrace{H_i}_{\text{leaving}}.$$

$$\underset{\uparrow \text{supply}}{q} = q_i + q_o.$$

$\boxed{\text{Additional sheet}}$

* Non-gray Surfaces

$$E_b = \int_0^\infty E_{b\lambda} d\lambda = \sum_{m=1}^{M} E_{bj}^{(m)}$$

$$q = \int_0^\infty q_\lambda \, d\lambda = \sum_{m=1}^{M} q^{(m)}$$

· M-bands, properties $\varepsilon_\lambda, \alpha_\lambda, \cdots$ constant in each band

$$\left.\begin{aligned} q_\lambda &= J_\lambda - H_\lambda \\ &= \varepsilon_\lambda E_{b\lambda} - \alpha_\lambda H_\lambda \end{aligned}\right\} \qquad q_\lambda^r = \frac{E_{b\lambda} - J_\lambda}{(1-\varepsilon_\lambda)/\varepsilon_\lambda}$$

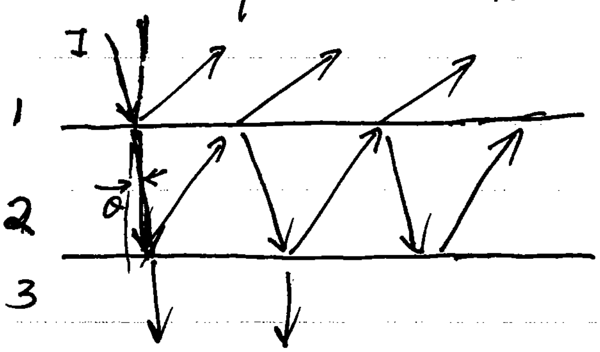
$$q = \sum_m q^{(m)} = \sum_m \left(J_\lambda^{(m)} - H_\lambda^{(m)}\right)$$

what is known

$$H_\lambda(\vec{r}) = \int J_\lambda(r) dF_{dA-dA'} + H_o(\vec{r})$$

$$H_\lambda^m = \int J_\lambda^m \, dF_{dA-dA'} + H_o^m$$

Semitransparent sheet   P. 96



$I = Ie^{-\alpha \ell}$

$= Ie^{-\alpha d/\cos\theta}$

$$R_{slab} = \rho_{12} + (1-\rho_{12})\,\tau \cdot \rho_{23} \cdot \tau\,(1-\rho_{21})$$

$(\rho_{21} = \rho_{12})$

$$+\ \tau^2 (1-\rho_{12})^2 \left[\rho_{21}\, \tau \cdot \rho_{23} \cdot \tau \cdot (1-\rho_{21})\right.$$

$$+ \cdots$$

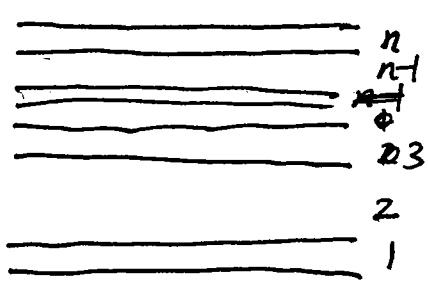
$$= \rho_{12} + \rho_{23}\,(1-\rho_{12})^2 \tau^2 \left[1 + \rho_{12}\rho_{23}\tau^2 + (\rho_{12}\rho_{23}\tau^2)^2 + \cdots\right]$$

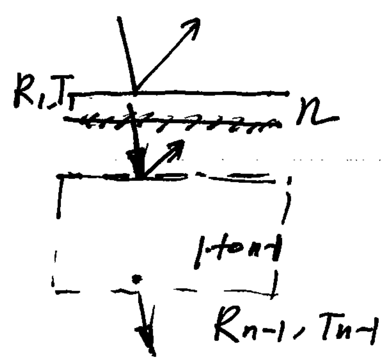
$$= \rho_{12} + \frac{\rho_{23}(1-\rho_{23})^2\tau^2}{1-\rho_{12}\rho_{23}\tau}$$

$$\tau_{slab} = \frac{(1-\rho_{12})(1-\rho_{23})\tau}{1-\rho_{12}\rho_{23}\tau}$$

$$A_{slab} = 1 - R_{slab} - \tau_{slab}$$

parallel sheet





Treat as one interface

$$R_n = R_1 + \frac{T_1^2 R_{n-1}}{1 - R_1 R_{n-1}}$$

recursive formula

$$\Rightarrow \quad q^{(m)} = J^{(m)} - \left(\int J_\lambda^{(m)} \, dF_{dA-dA'} + H_o^{(m)} \right)$$

N surfaces

$$q_j^{(m)} = J_j^{(m)} - \sum_{i=1}^{N} J_i^{(m)} F_{i-j} + H_o^{(m)}$$

$m \times N$ equations

$$q_j^{(m)} = \frac{E_{bj}^{(m)} - J_j^{(m)}}{(1-\varepsilon_j^{(m)})/\varepsilon_j^{(m)}} \qquad m \times N \text{ equations}$$

$E_{bj}(T_j) \Rightarrow$ need another N equations

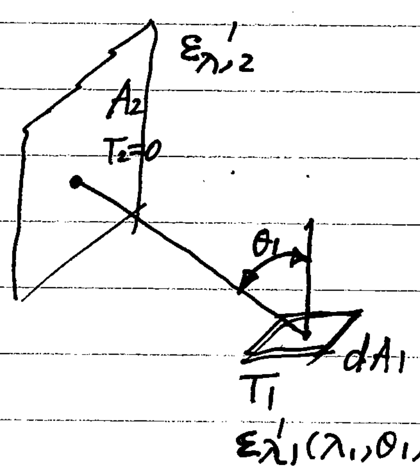
$$q_j = \sum q_j^{(m)} \qquad N \text{ equations.}$$

* Monte Carlo Method (chapter 20)

statistical method, random walk — ~~every~~ next step independent of previous steps

↳ Markov Chain.

To get an idea, let's take the folloing example



How much radiation exchange $dQ_{1\to 2}$?

(1) Total emitted power

$$dQ_{e,1} = \varepsilon_1(T_1)\sigma T_1^4 dA_1$$