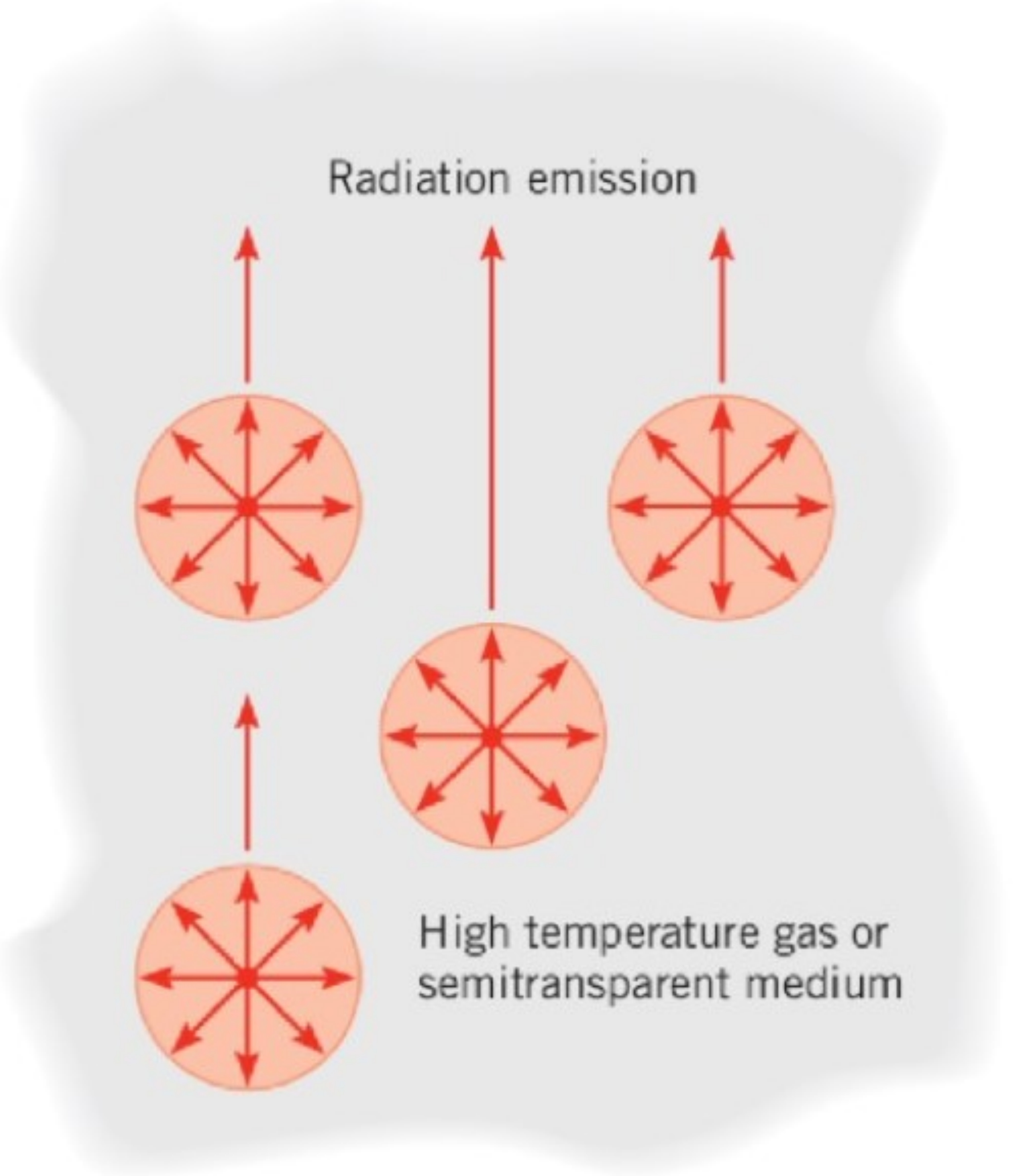
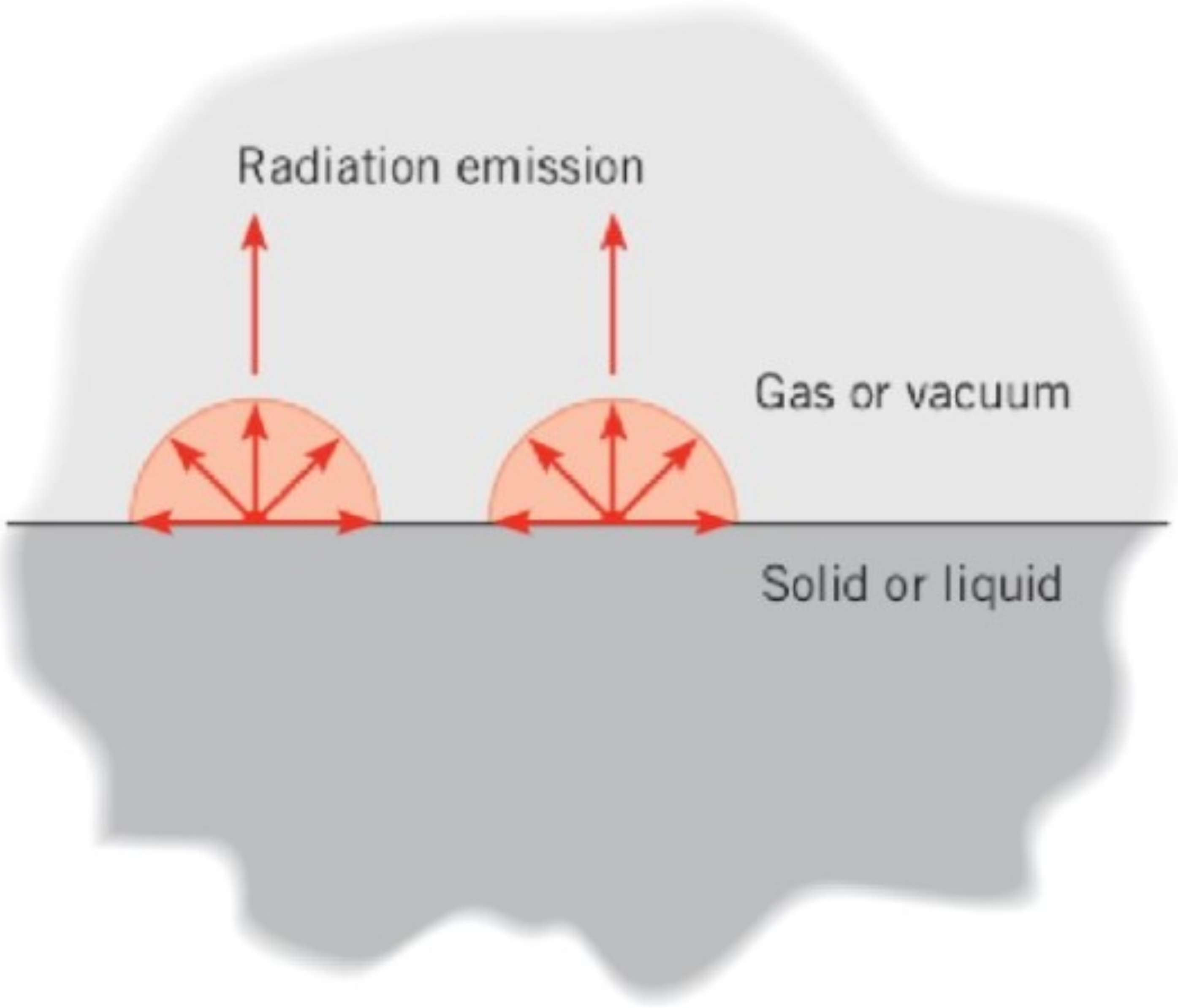
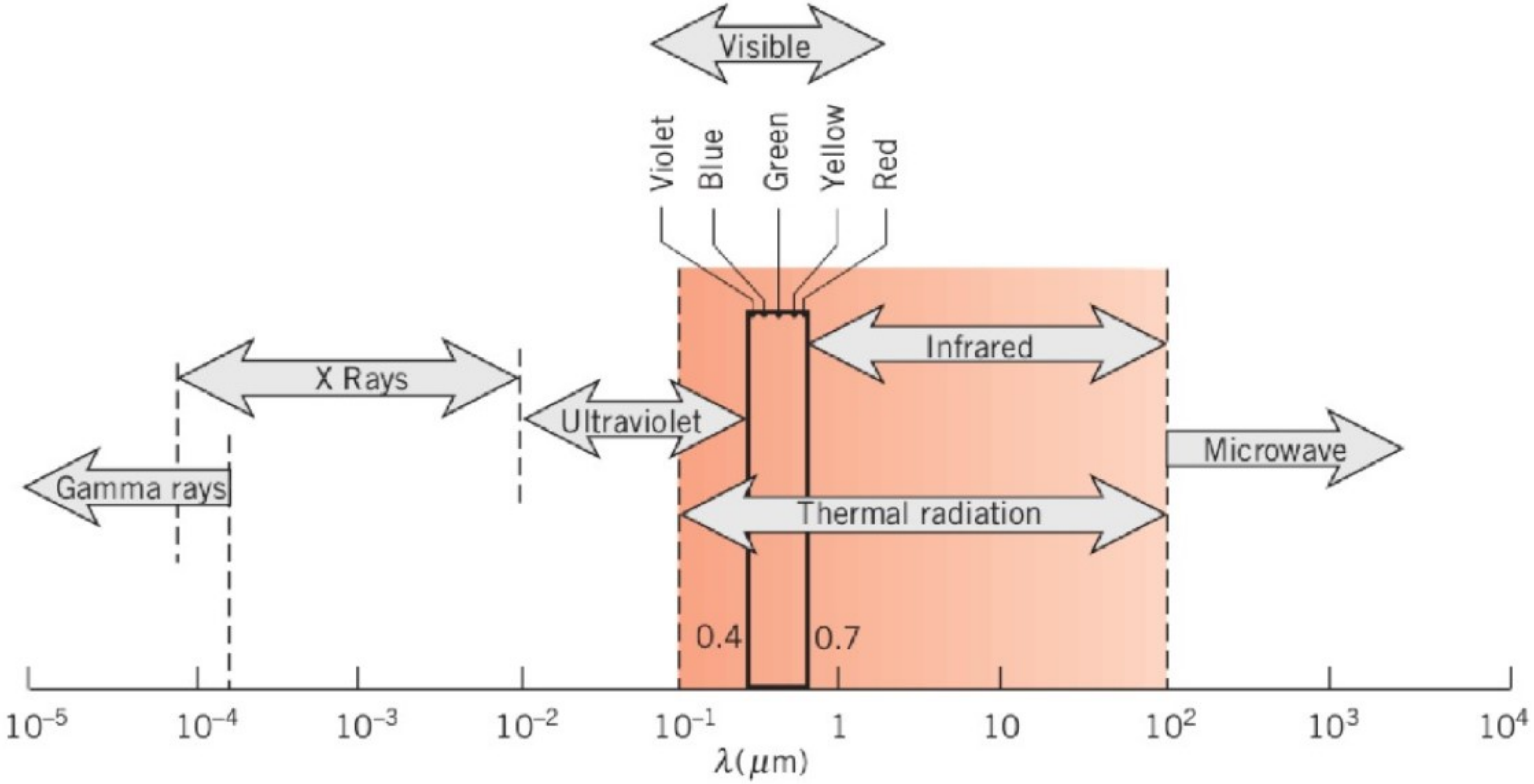
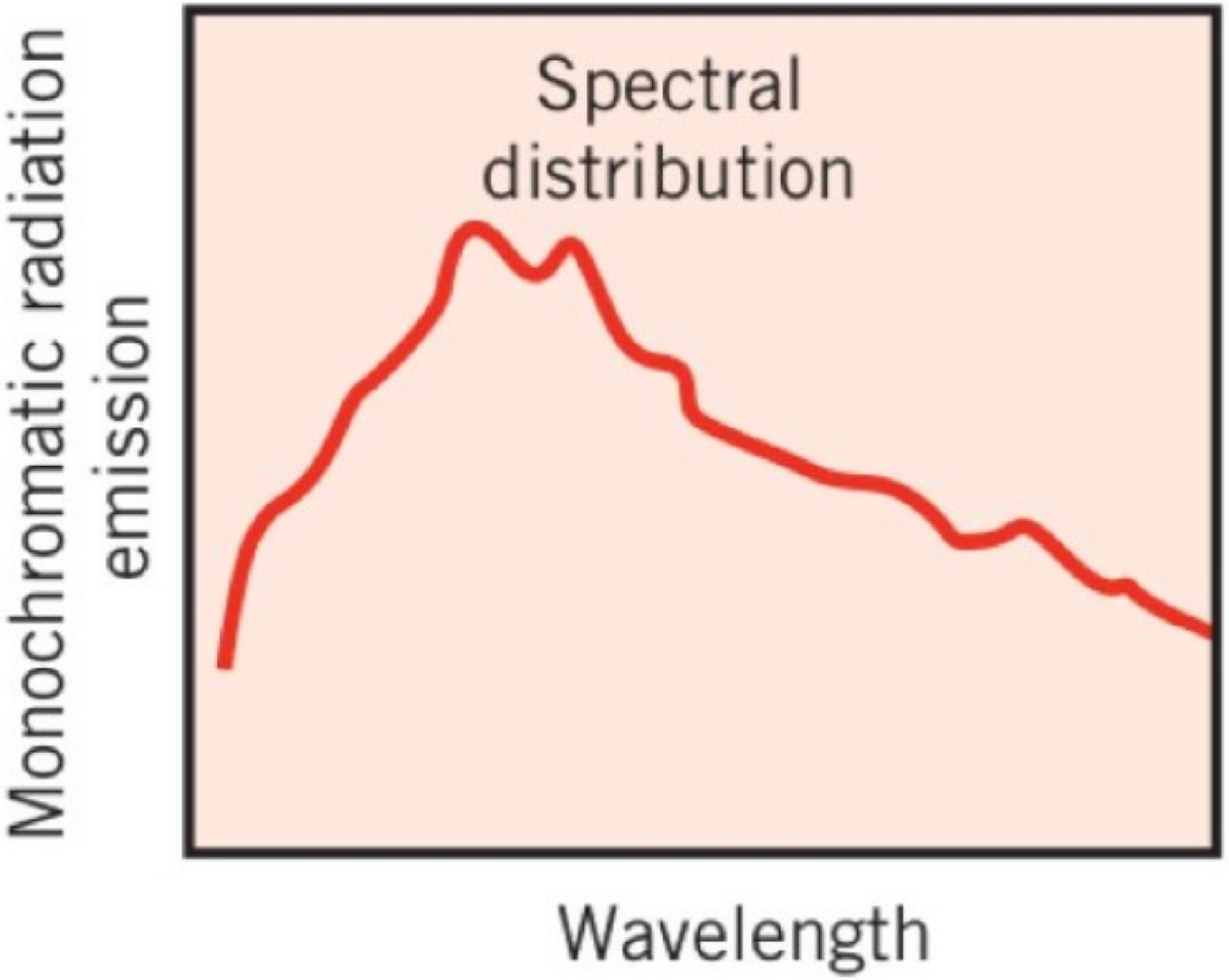

Radiation emission
High temperature gas or
semitransparent medium


Radiation emission
Gas or vacuum
Solid or liquid


Visible
Violet
Blue
Green
Yellow
Red
Infrared
X Rays
Ultraviolet
Microwave
Gamma rays
Thermal radiation
0.4
0.7
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^{2}
10^{3}
10^{4}
$\lambda(\mu m)$


Spectral
distribution
Monochromatic radiation
emission
Wavelength

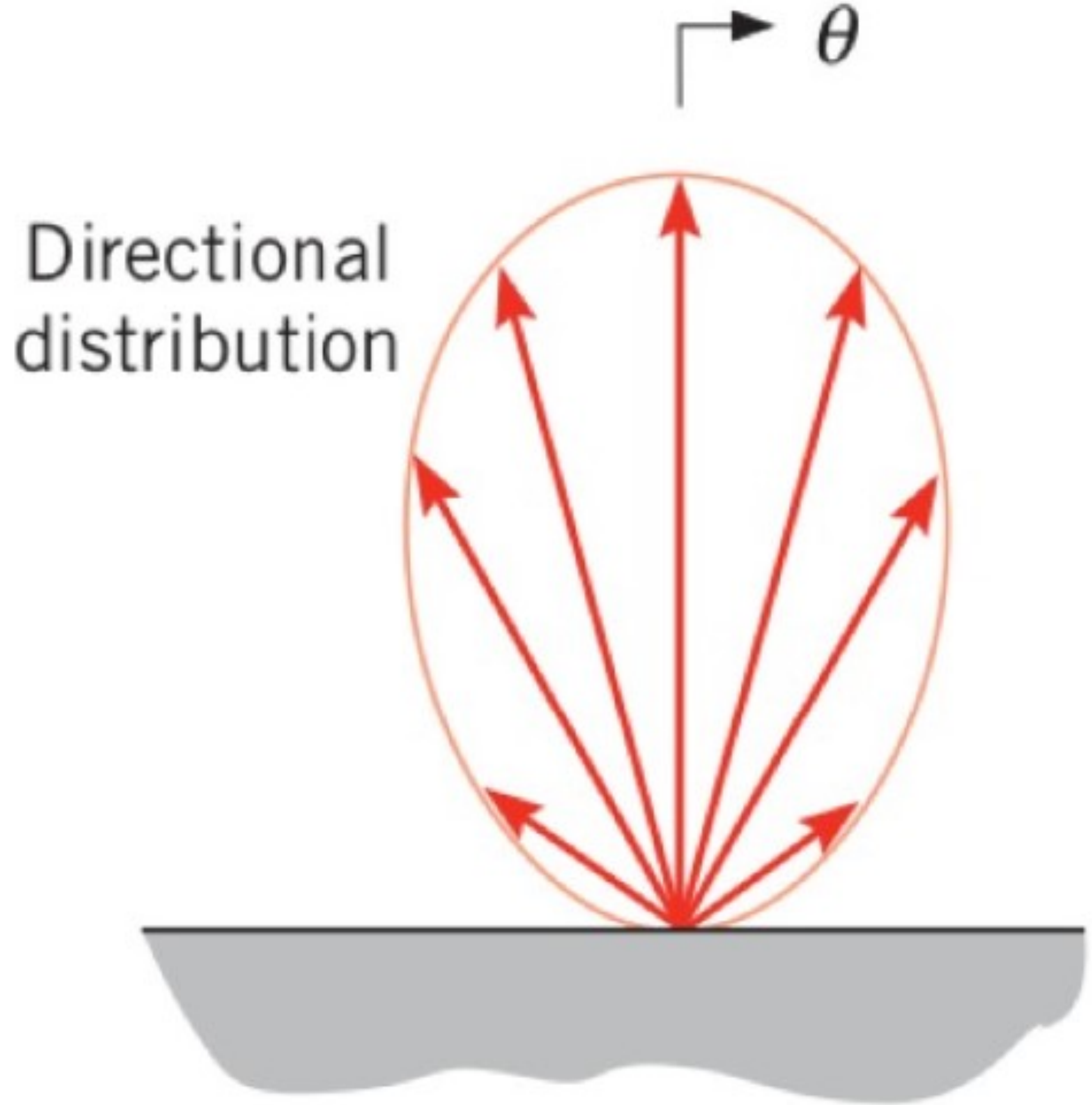
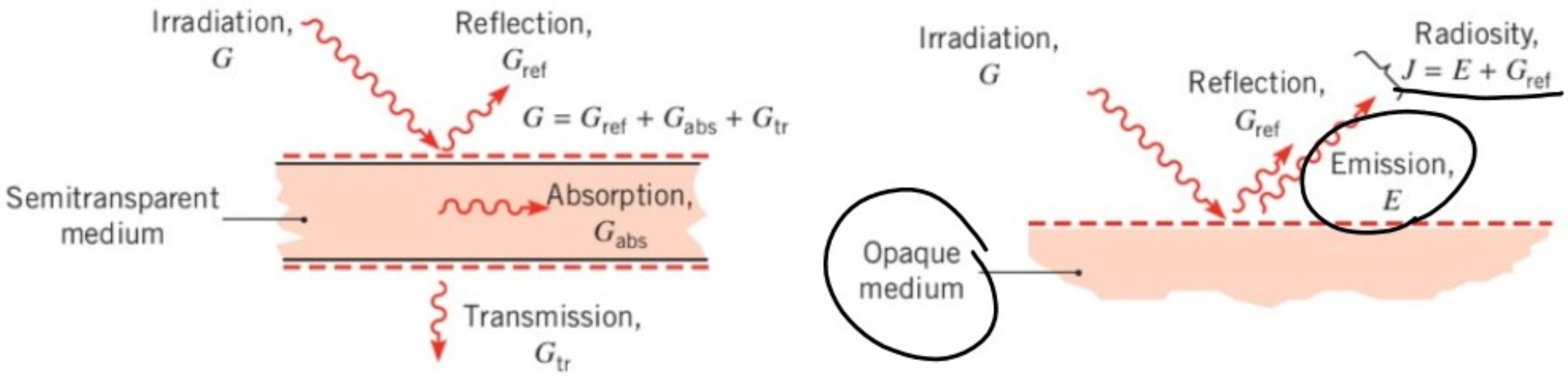

θ
Directional
distribution

TABLE 12.1 Radiative fluxes (over all wavelengths and in all directions)

Flux (W/m^2)	Description	Comment
Emissive power, E	Rate at which radiation is emitted from a surface per unit area	$E = \varepsilon \sigma T_s^4$
Irradiation, G	Rate at which radiation is incident upon a surface per unit area	Irradiation can be reflected, absorbed, or transmitted
Radiosity, J	Rate at which radiation leaves a surface per unit area	For an opaque surface $J = E + \rho G$
Net radiative flux, $q''_{\text{rad}} = J - G$	Net rate of radiation leaving a surface per unit area	For an opaque surface $q''_{\text{rad}} = \varepsilon \sigma T_s^4 - \alpha G$



$$q''_{rad} = J - G$$

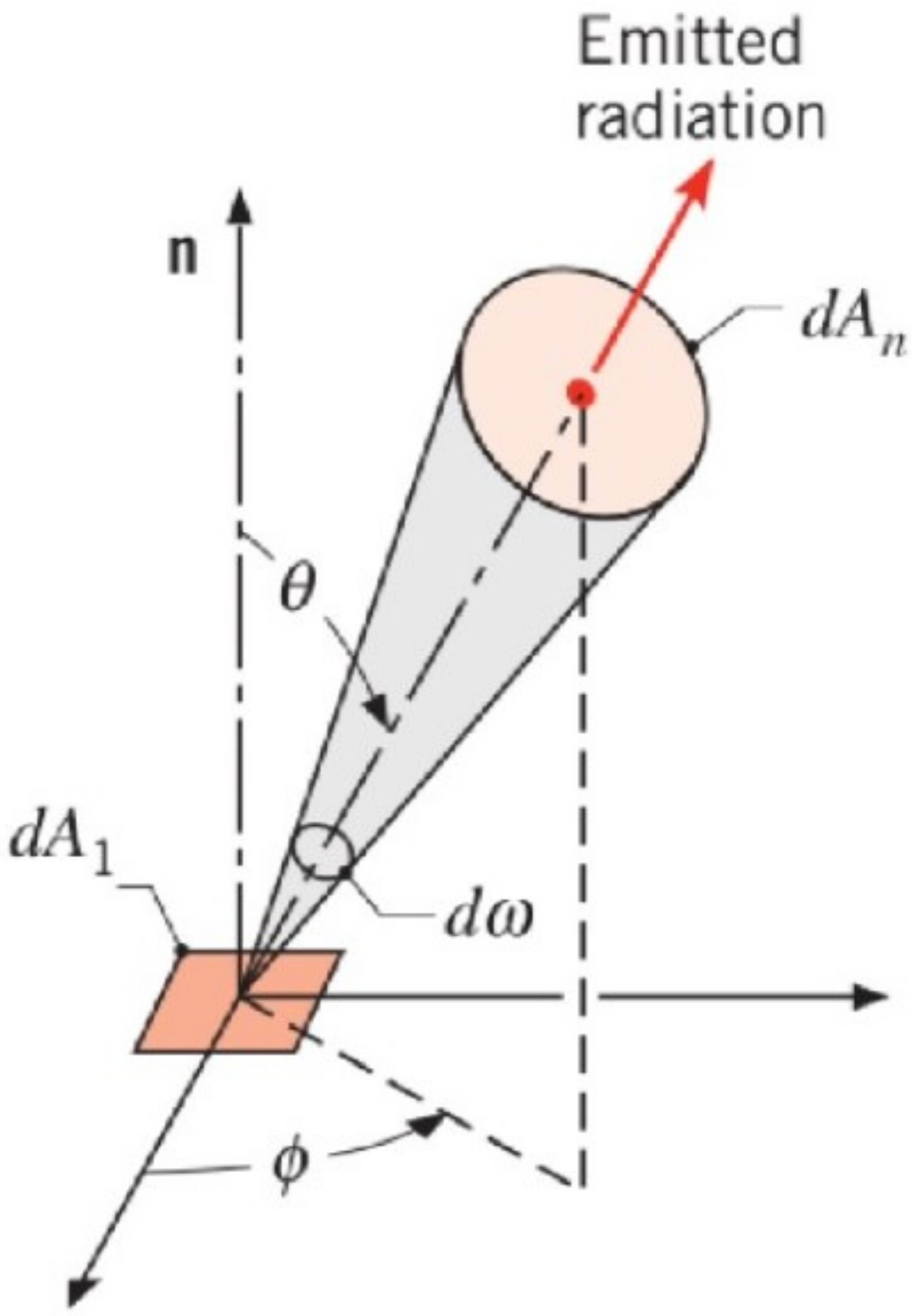
$$= E + G_{ref} - G$$

$$= E + \rho G - G$$

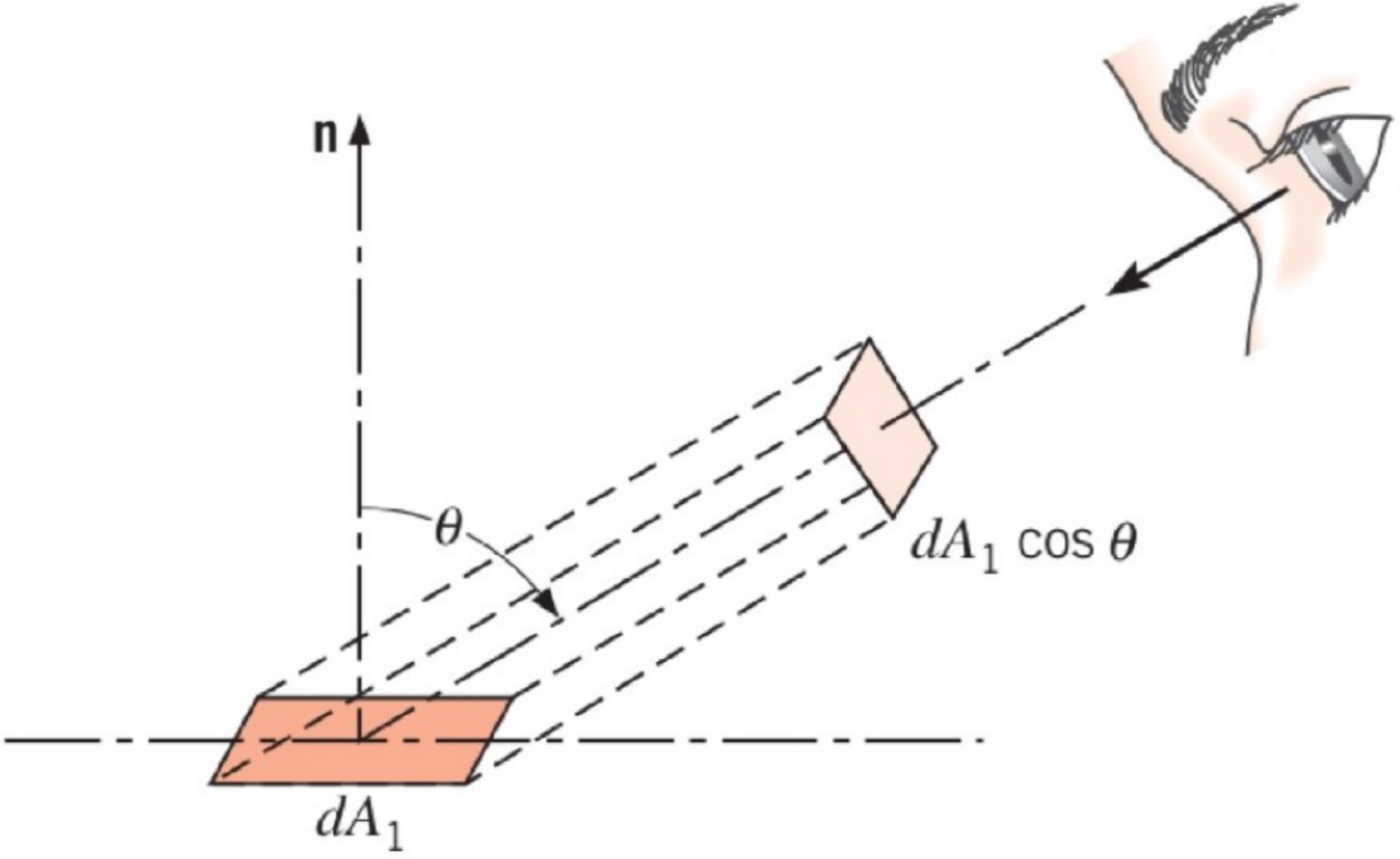
$$= \varepsilon \sigma T_s^4 - \alpha G$$

no G_{tr}

$\rho + \alpha = 1$



Emitted
radiation
n
dA_n
θ
dA_1
$d\omega$
ϕ



n
θ
$dA_1 \cos\theta$
dA_1

$$I_{\lambda e}(\lambda, \theta, \phi) = \frac{dq}{dA_1 \cos\theta \, d\omega \, d\lambda}$$

$$E = \int_0^{\infty} E_\lambda(\lambda) \, d\lambda$$

$$= \int_0^{\infty} \int_0^{2\pi} \int_0^{\pi/2} I_{\lambda e}(\lambda, \theta, \phi) \cos\theta \sin\theta \, d\theta \, d\phi \, d\lambda$$

$$= \pi I_e$$

I_e total intensity

$G = \pi I_i$

$J = \pi I_{e+r}$

$$q''_{rad} = \int_0^{\infty}\int_0^{2\pi}\int_0^{\pi/2} I_{\lambda,e+r}(\lambda,\theta,\phi)\cos\theta\sin\theta\, d\theta\, d\phi\, d\lambda$$

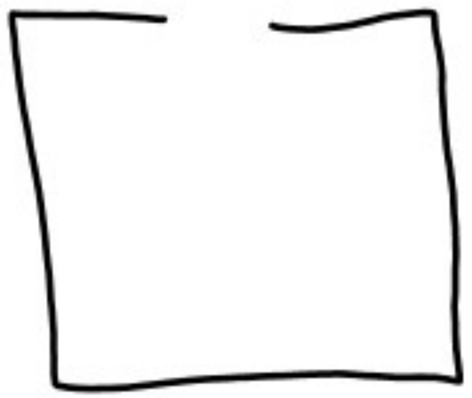
$$- \int_0^{\infty}\int_0^{2\pi}\int_0^{\pi/2} I_{\lambda,i}(\lambda,\theta,\phi)\cos\theta\sin\theta\, d\theta\, d\phi\, d\lambda$$

Blackbody radiation

1. absorbs all radiation

2. A a o specific temperature and wavelength a blackbody emits the most radiation

3. Emission is independent of direction



Plank distribution

$$I_{\lambda b}(\lambda, T) = \frac{2hc_0^2}{\lambda^5(\exp(hc_0/\lambda k_B T) - 1)}$$

$$E_{\lambda b}(\lambda, T) = \pi I_{\lambda b}(\lambda, T) = \frac{C_1}{\lambda^5(\exp(C_2/\lambda T) - 1)}$$

$h = 6.626 \times 10^{-34}\ J s$ plank const

$k_B = 1.381 \times 10^{-23}\ J/K$ Boltzmann const

$c_0 = 2.998 \times 10^{8}\ m/s$ speed of light

$C_1 = 3.742 \times 10^{8}\ \frac{W \mu m^4}{m^2}$

$C_2 = 1.439 \times 10^{4}\ \mu m\, K$