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Particle Density: Point and Wave

Particles N $\equiv$ Natural Oscillations[1] of blackbody within a range of frequency spectrum[2] $(\nu, \nu + d\nu)$ $\equiv$ Vibration Modes $\equiv$ Points $\equiv$ exactly one of each possible wavevectors $\vec{k}$

$a \equiv$ particle size (radius, extension) of each individual particle $i = [1, N]$

$\frac{\pi}{a} =$ Grid Constant $\equiv$ next point distance between those N points

$0 \neq m_i = \frac{2a}{\lambda_i} \in \mathbb{N}_+ \qquad \lambda = \frac{c}{\nu} = \frac{\omega}{k}\frac{1}{\nu}$

$|\vec{k}| = k = \frac{\pi}{a}\sqrt{\sum m_i^2} = \frac{\omega}{c} = \frac{2\pi\nu}{c} = \frac{2\pi}{\lambda} \equiv$ Sphere Radius (containing the grid of particles inside)

$\sum m_i^2 \gg 1 \iff k \gg \frac{\pi}{a} \iff \lambda \ll 2a$: N in blackbody independent of geometrical form

$$N = \frac{1}{3}\frac{1}{2\pi^2}\left(a\frac{\omega}{c}\right)^3 = \frac{1}{3}2^2\pi\left(a\frac{\nu}{c}\right)^3 = \frac{4\pi}{3}\left(\frac{a}{\lambda}\right)^3$$

$$N(\omega) = \frac{1}{3}\frac{1}{\pi^2}\left(\frac{\omega \cdot a}{c}\right)^3$$

$$N(\nu) = \frac{1}{3} \cdot 2^2 \cdot 2\pi \left(\frac{\nu \cdot a}{c}\right)^3$$

Density:

$$n = \frac{N}{V} = \frac{N}{A^3} = \frac{8\pi}{3}\left(\frac{\nu}{c}\right)^3 = \frac{1}{3}\pi\left(\frac{2}{\lambda}\right)^3$$

$$n_\nu = \frac{dn}{d\nu} = 8\pi\frac{\nu^2}{c^3} = 3\frac{n}{\nu}$$

$$n_\lambda = -\frac{dn}{d\lambda} = 8\pi\frac{1}{\lambda^4} = 3\frac{n}{\lambda}$$

[1] Eingenschwingungen, intrinsic
[2] Frequenzintervall