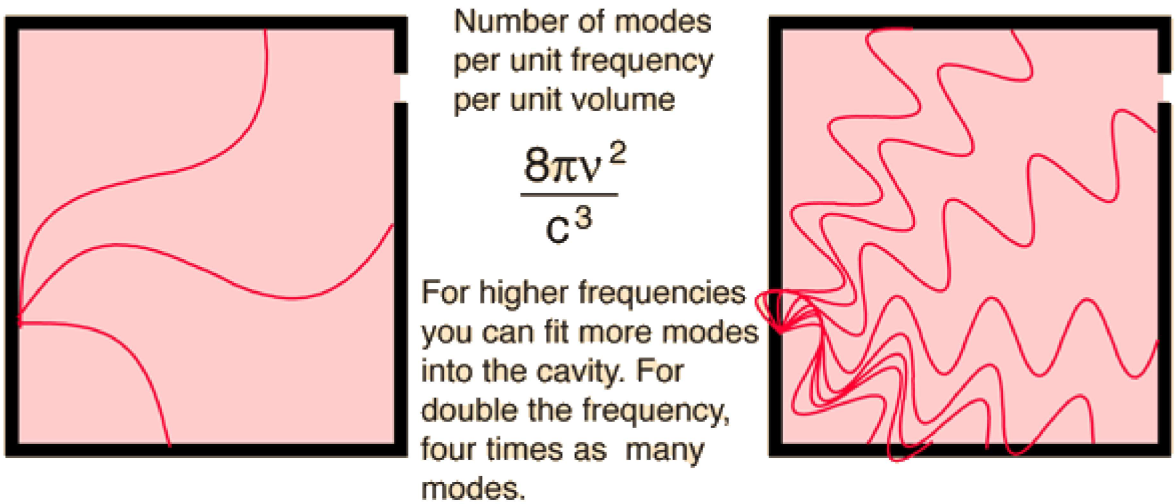
Cavity Modes

A mode for an electromagnetic wave in a cavity must satisfy the condition of zero electric field at the wall. If the mode is of shorter wavelength, there are more ways you can fit it into the cavity to meet that condition. Careful analysis by Rayleigh and Jeans showed that the number of modes was proportional to the frequency squared.



Evaluation of the number of modes

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Planck Radiation Formula

From the assumption that the electromagnetic modes in a cavity were quantized in energy with the quantum energy equal to Planck's constant times the frequency, Planck derived a radiation formula. The average energy per "mode" or "quantum" is the energy of the quantum times the probability that it will be occupied (the Einstein-Bose distribution function):

$$\langle E \rangle = \frac{h\upsilon}{e^{h\upsilon/kT} - 1}$$

This average energy times the density of such states, expressed in terms of either frequency or wavelength

$$\rho(\nu) = \frac{dn_s}{d\nu} = \frac{8\pi}{c^3}\nu^2 \qquad \rho(\lambda) = \frac{dn_s}{d\lambda} = \frac{8\pi}{\lambda^4}$$

gives the energy density, the Planck radiation formula

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