Stimulated emission for balck-body radiation

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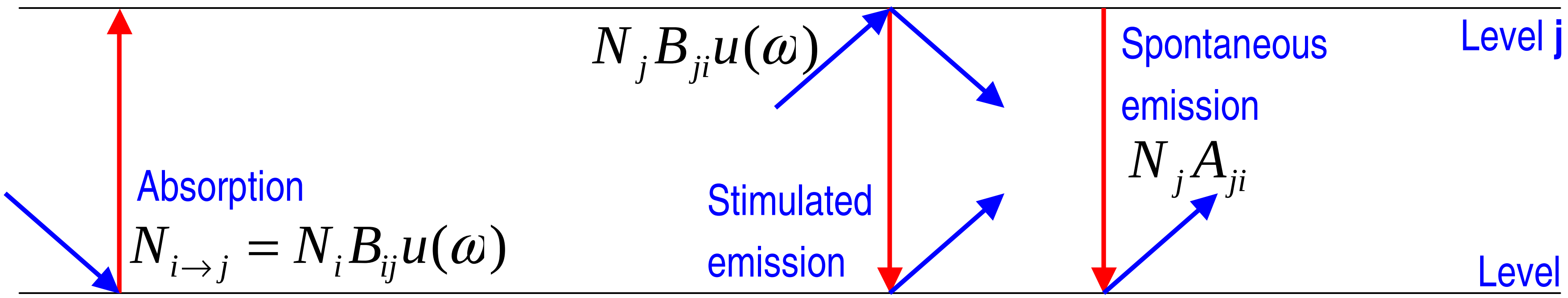
Einstein's explanation from 1917 for the energy density $u(\omega)$ in a black body box.

The light in a black body is emitted by electrons that change their energy level:



Equilibrium:

$$N_{i\to j} = N_{j\to i} \to N_i B_{ij} u(\omega) = N_j [A_{ji} + B_{ji} u(\omega)] \to u(\omega) = \frac{A_{ji}/B_{ji}}{\frac{B_{ij}}{B_{ji}}\frac{N_i}{N_j} - 1}$$

Thermodynamic population of electron energy states:

$$N_i = C\, e^{-\frac{E_i}{kT}}, \quad N_j = C\, e^{-\frac{E_j}{kT}} \to \frac{N_i}{N_j} = e^{\frac{E_j - E_i}{kT}} = e^{\frac{\hbar\omega}{kT}}$$

Assumptions to obtain **Plank's black-body radiation formula**:

- Probability for stimulated emission = probability of absorbtion, $B_{ij} = B_{ji}$
- Probability of spontaneous emission increases with ω^3: $A_{ji} / B_{ji} \propto \omega^3$

$$u(\omega) \propto \frac{\omega^3}{e^{\frac{\hbar\omega}{kT}} - 1}$$

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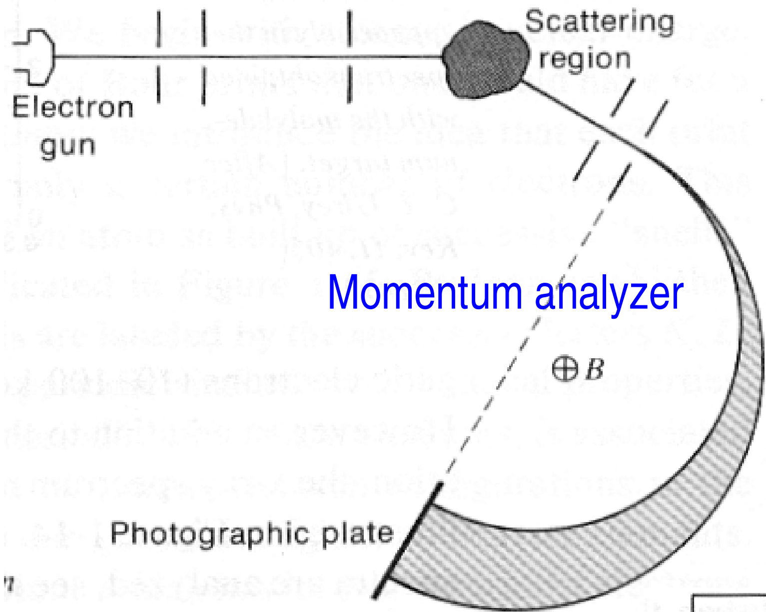
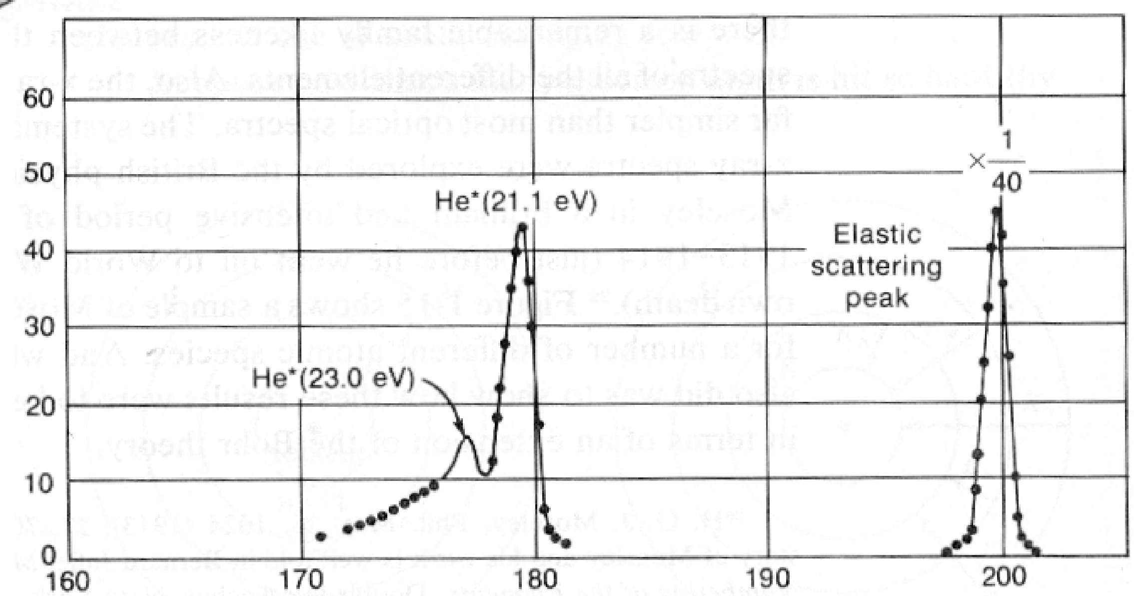
Inelastically scattered electrons



The spectrum of energy losses has peaks at those energies where electrons in the atoms of the probe have been raised to higher energy levels.

This corresponds to the classical Frank-Hertz experiment where the electron energy was measured by a retarding potential.



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