LA CRISI DELLA FISICA CLASSICA

PROGRAMMA Prof. V.Lubicz

- **I^a Parte:**
  - Comportamento "corpuscolare" della luce
- **II^a Parte:**
  - Il modello atomico
  - Comportamento "ondulatorio" della materia
- **III^a Parte:**
  - Dualità onda-particella: esperimento della doppia fenditura
  - La Meccanica Quantistica

- **IV^a Parte** (12/5/04) Prof. C.Bacci Teoria della relatività

LA FISICA "CLASSICA" (< 1900)

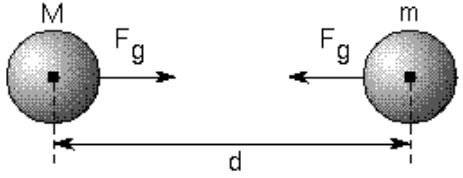
MECCANICA

Newton 1686

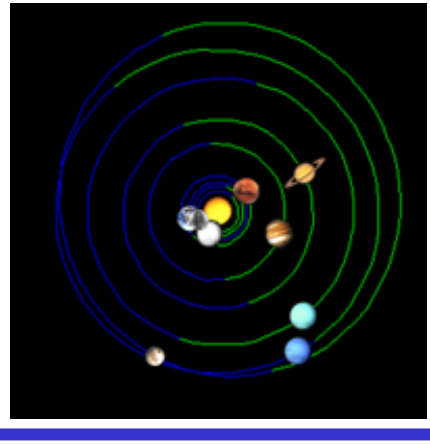
$$F = m\,a$$

Equazione del moto

GRAVITAZIONE UNIVERSALE

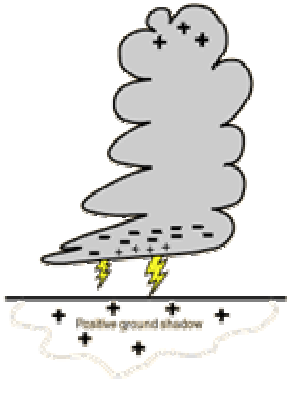


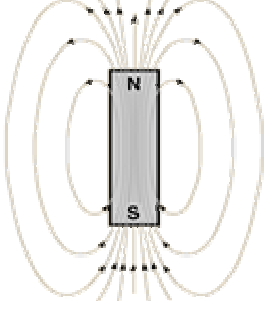
$$F_g = \frac{GMm}{d^2}$$

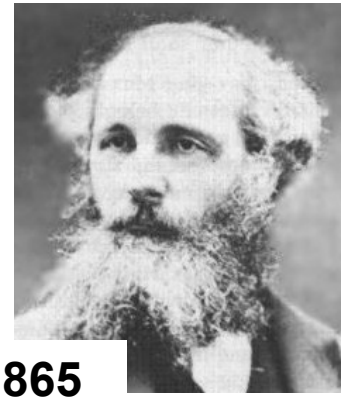


ELETTRO-MAGNETISMO

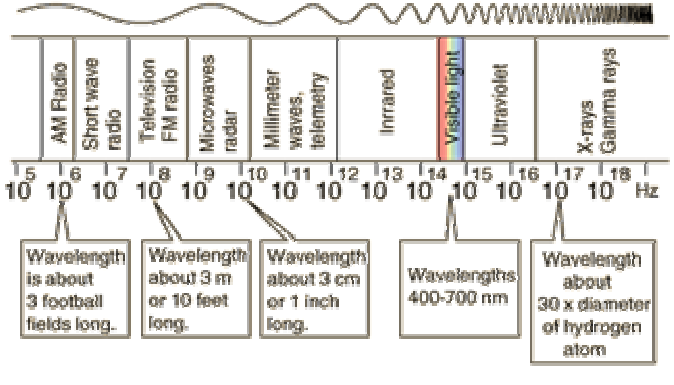
$c = ??$







Maxwell 1865



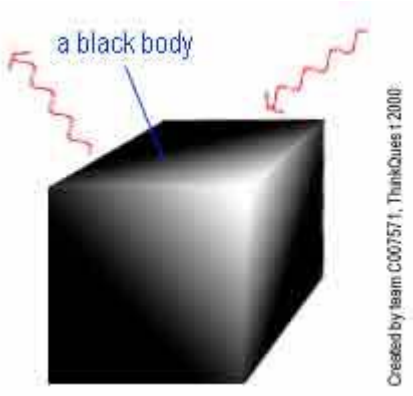
COMPORTAMENTO "CORPUSCOLARE" DELLA LUCE

1. **Lo spettro di corpo nero**
   Planck, 1900

2. **L' effetto fotoelettrico**
   Einstein, 1905

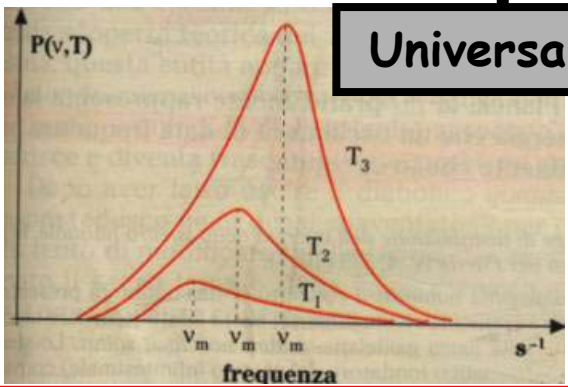
3. **L' effetto Compton**
   Compton, 1922

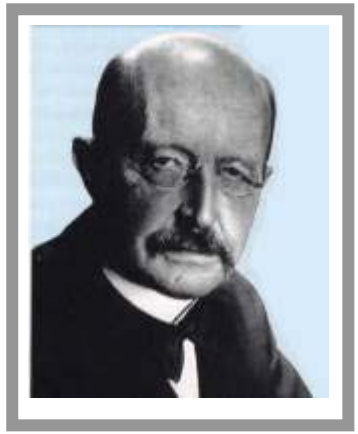
LO SPETTRO DI CORPO NERO



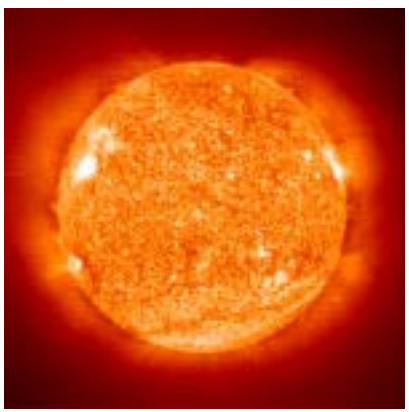
$$\frac{E(\omega,T)}{A(\omega,T)} = u(\omega,T)$$

Universale

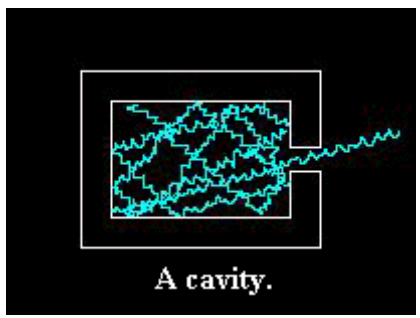




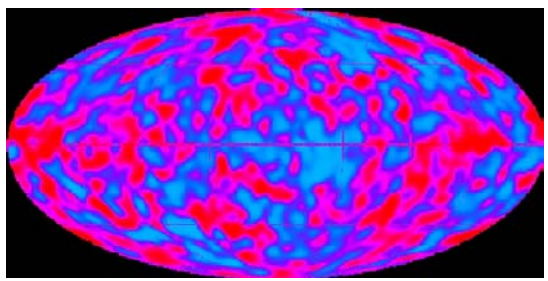
Planck 1900



Sole

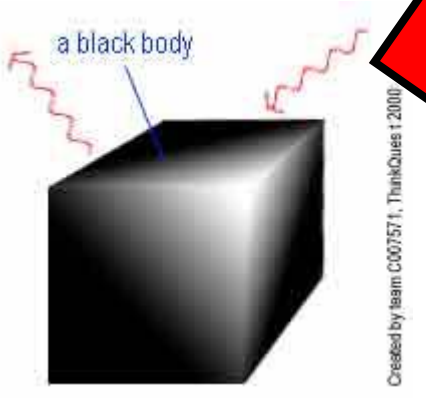


Cavità



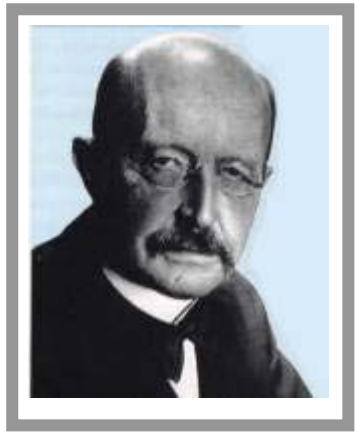
Radiazione cosmica di fondo

LO SPETTRO DI CORPO NERO



$$\frac{E(\omega,T)}{A(\omega,T)} = u(\omega,T)$$

Universale



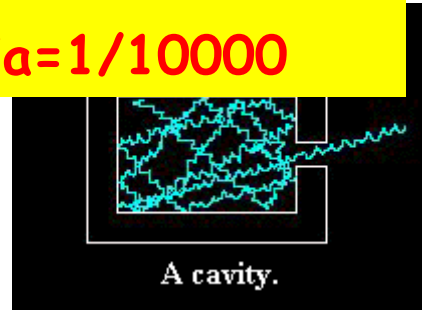
Planck 1900

Scoperta: Penzias e Wilson, 1964

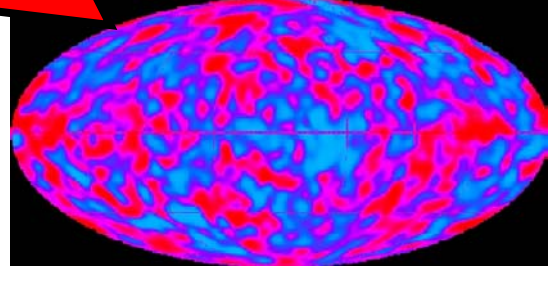
Previsione teorica: Gamow et al., 1948

T=2.73 K, Anisotropia=1/10000

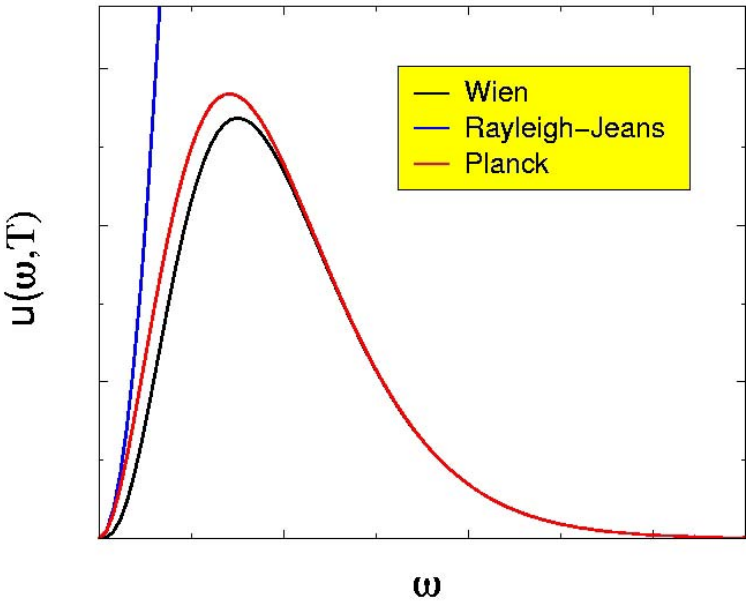
Sole



Cavità



Radiazione cosmica di fondo



Formula di Wien

$$u(\omega, T) = C\,\omega^3\, e^{-\lambda\omega/T}$$

Formula di Rayleigh - Jeans

$$u(\omega, T) = \frac{\omega^2}{\pi^2 c^3}\, KT$$

$$\hbar = 1.0545716 \times 10^{-34}\, J\, s$$

$$\boldsymbol{\varepsilon = \hbar\omega}$$

Formula di Planck

$$u(\omega, T) = \frac{\omega^2}{\pi^2 c^3}\, \frac{\hbar\omega}{e^{\hbar\omega/KT} - 1}$$

Derivazione della formula di Planck

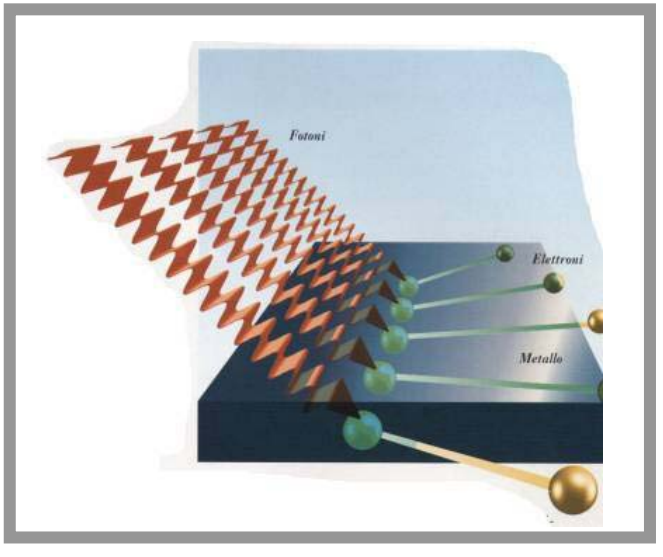
$$p(E_n) = \frac{1}{Z}\, e^{-\beta E_n} \qquad Z = \sum_n e^{-\beta E_n}$$

$$\overline{E} = \sum_n E_n\, p\,(E_n) = \frac{1}{Z} \sum_n E_n\, e^{-\beta E_n}$$

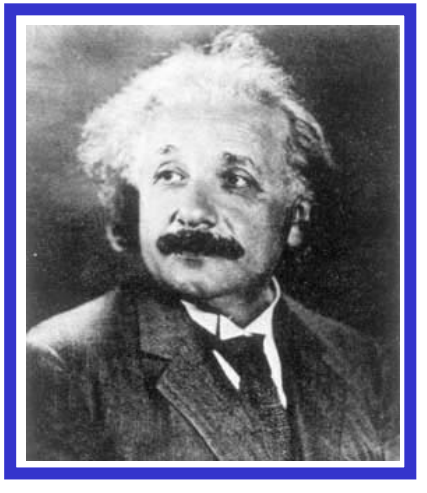
$$E_n = n\,\varepsilon = n\,\hbar\,\omega \qquad n = 0, 1, 2, \ldots$$

$$\overline{E} = \frac{\sum_{n=0}^{\infty} n\varepsilon\, e^{-\beta n\varepsilon}}{\sum_{n=0}^{\infty} e^{-\beta n\varepsilon}} = \frac{\varepsilon}{e^{\beta\varepsilon} - 1}$$

L' EFFETTO FOTOELETTRICO



Scoperta:
Hertz 1887



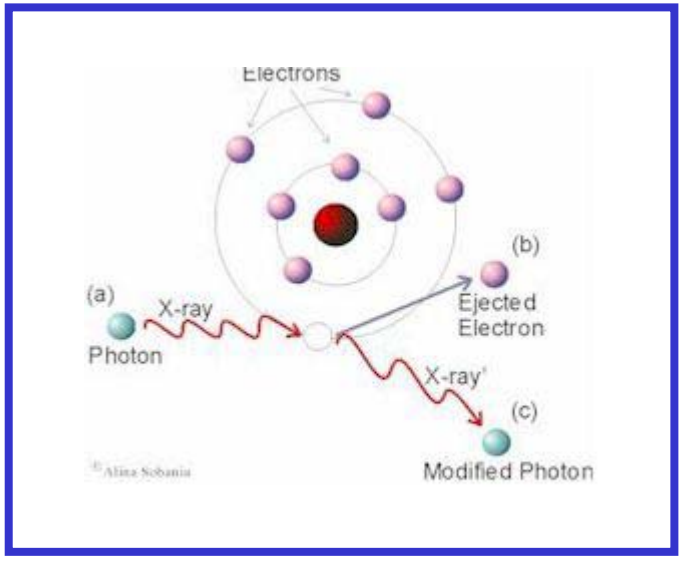
Teoria:
Einstein 1905

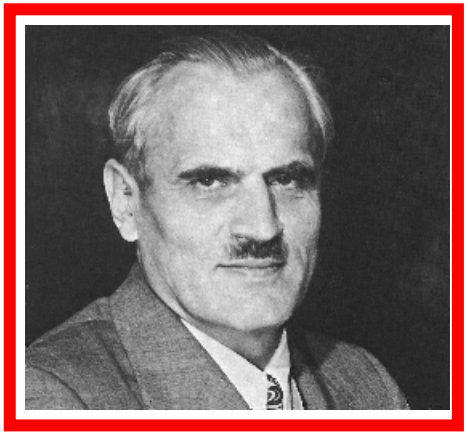
- Effetto a soglia: $\omega > \omega_S$
- $N_{elettr.}$ ~ intensità dell' onda
- $E_{elettr.}$ ~ frequenza ν dell'onda

FOTONI

$$1/2\ mv^2 = \hbar\omega - W$$

L' EFFETTO COMPTON





Compton 1922

$$\Delta\lambda = \lambda - \lambda' = f(\theta) \neq 0$$

Derivazione della formula Compton

$$E = \sqrt{m^2c^4 + c^2p^2}$$

$$p = 0 \rightarrow E = mc^2$$

$$m = 0 \rightarrow E = cp$$

$$\begin{cases} \hbar\omega + mc^2 = \hbar\omega' + \sqrt{m^2c^4 + c^2p'^2} \\ \hbar\vec{k} = \hbar\vec{k}' + \vec{p}' \end{cases}$$

Cons. Energia

Cons. Impulso

$$\omega - \omega' = \frac{\hbar}{mc^2}\,\omega\omega'\,(1 - \cos\theta)$$

$$\Delta\lambda = \lambda - \lambda' = (h/mc)\,(1 - \cos\theta)$$