FISICA PARA BIOLOGIA F107 A : AULA 9

PROFESSOR Orlando Luis Goulart Peres

Pagina do curso: https://sites.ifi.unicamp.br/orlando/ensino/f-107-fisica-para-biologia/
Moodle: https://www.ggte.unicamp.br/ea/

A NATUREZA ONDULATORIA DA MATERIA

Do experimento Compton e fotoelétrico a luz parece se comportar como uma partícula.

Louis de Broglie propôs por similaridade que partículas poderiam ter comportamento de ondas.

$$\lambda = \frac{h}{p}$$

p=mv onde m massa da partícula e v a velocidade

EXEMPLOS DE COMPRIMENTO DE ONDA DE DE BROGLIE

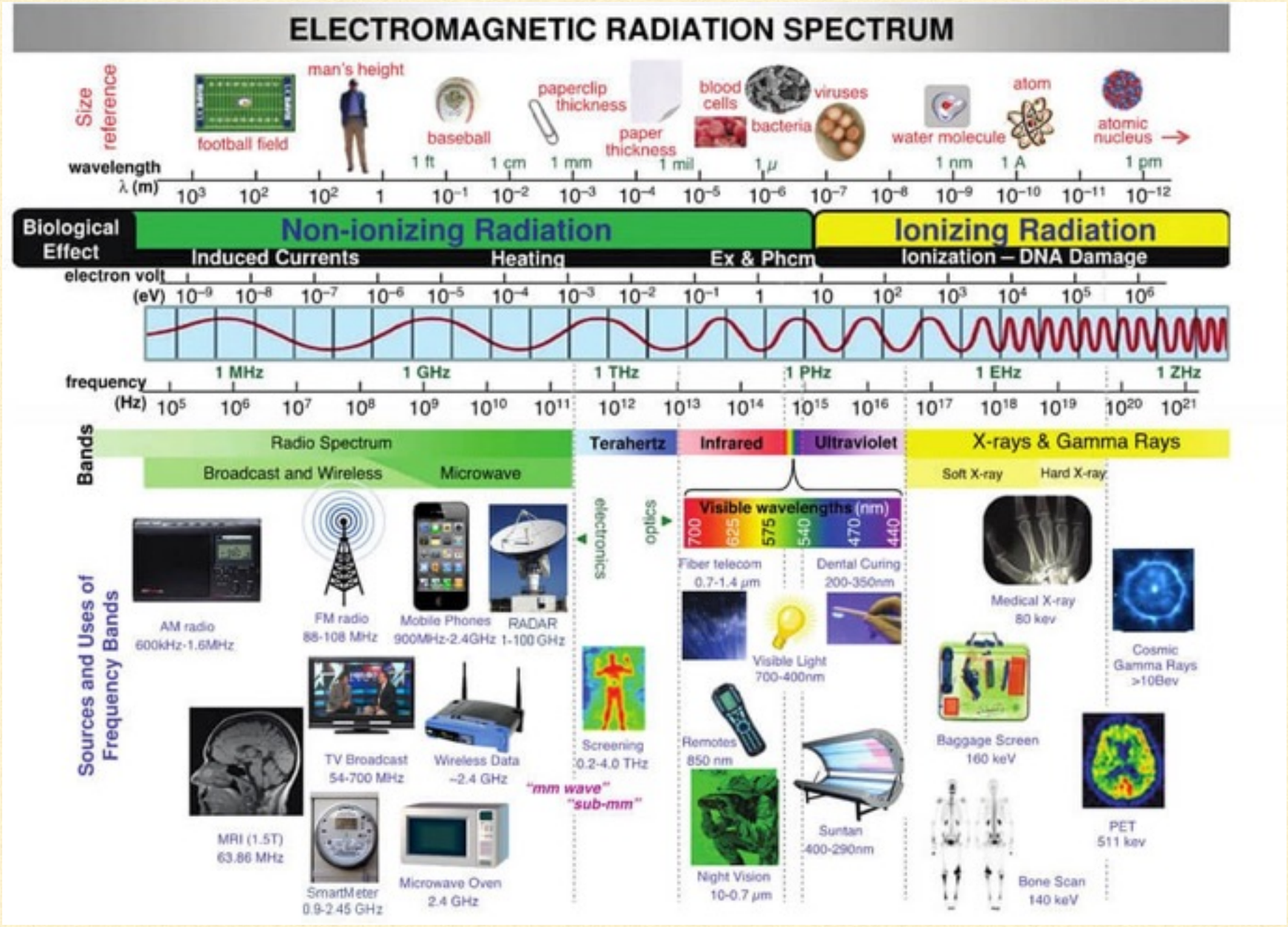
Electron se movimenta com a velocidade $v = 6,0 \times 10^6 \mathrm{m/s}$

$$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{(9,1 \times 10^{-31})(6,0 \times 10^6 \mathrm{m/s}} = 1,2 \times 10^{-10} \mathrm{m}$$

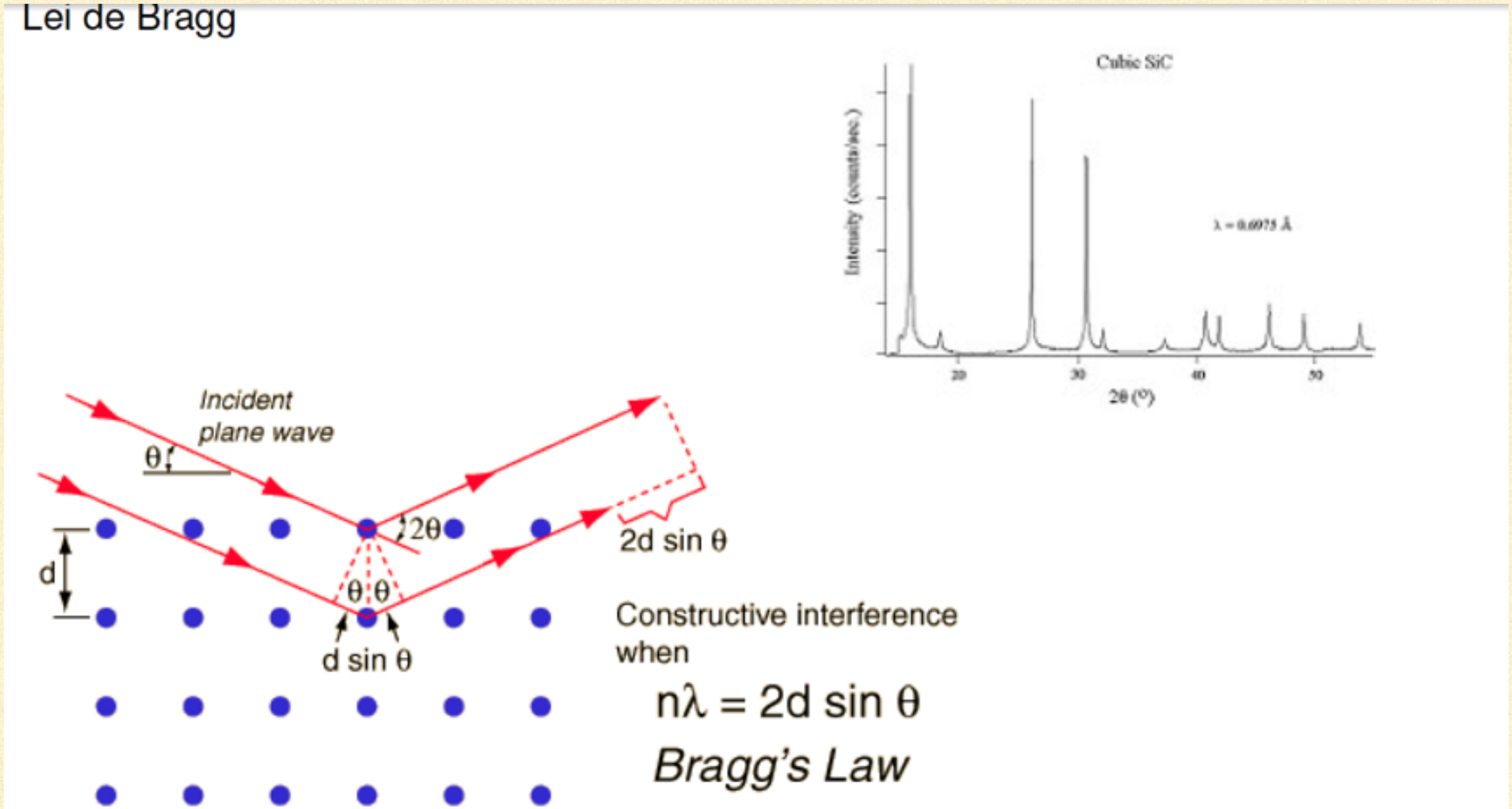
Uma bola de 0,2kg movendo-se a 15 m/s

$$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{(0,2)(15 \mathrm{m/s}} = 2,2 \times 10^{-34} \mathrm{m}$$

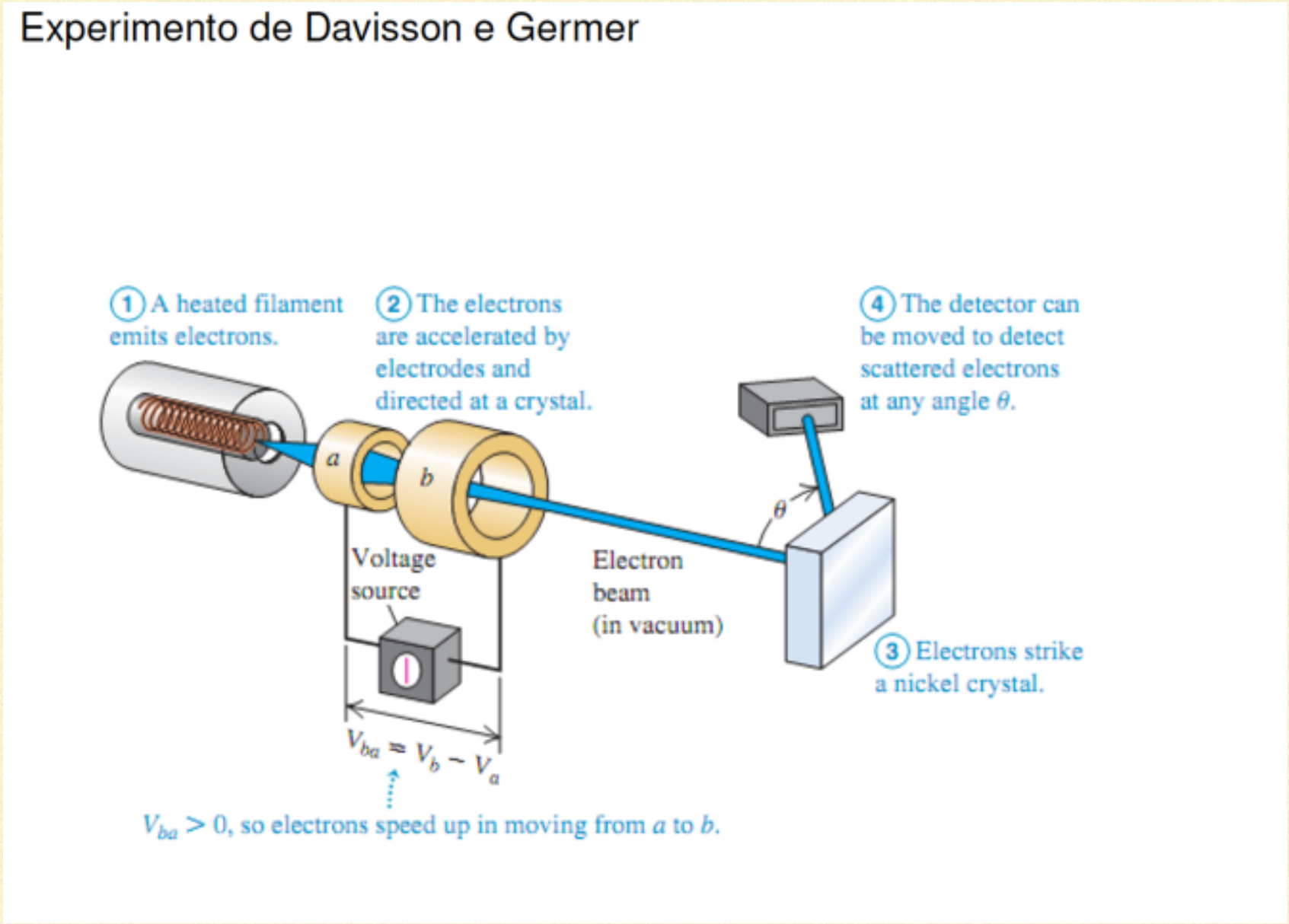
COMPRIMENTO DE ONDA ELETTROMAGNETICA



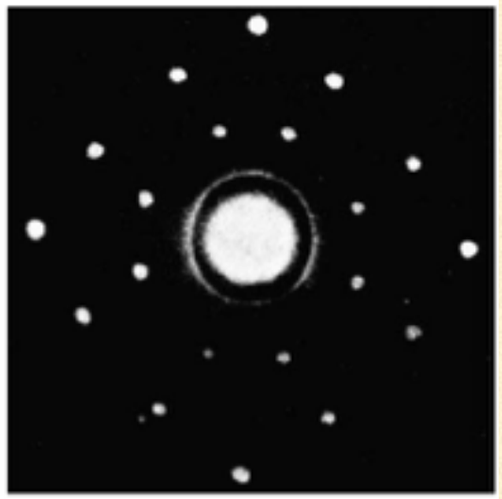
EXPERIMENTO DE DAVISSON-GERMER



EXPERIMENTO DE DAVISSON-GERMER



EXPERIMENTO DE DAVISSON-GERMER



(*a*)

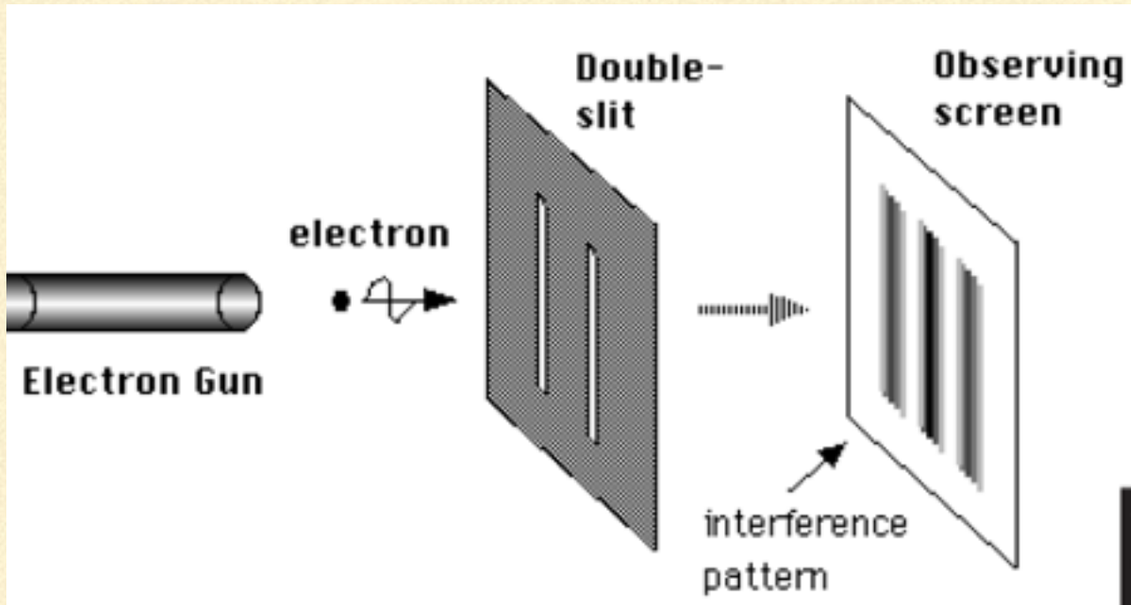
(*b*)

Figure 29.12 (*a*) The neutron diffraction pattern and (*b*) the X-ray diffraction pattern for a crystal of sodium chloride (NaCl). (*a*. From *Phys. Rev.* 73 (5): 527 (1948), by Wollan, Shull, and Marney. © 1948 by

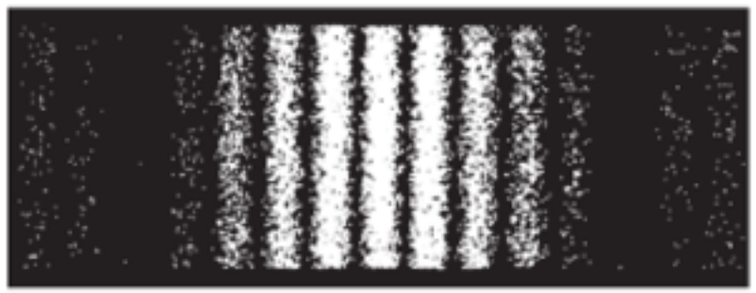
Quando um elétron colide num cristal ele faz uma padrão de difração

Electron difrata-> carater ondulatorio

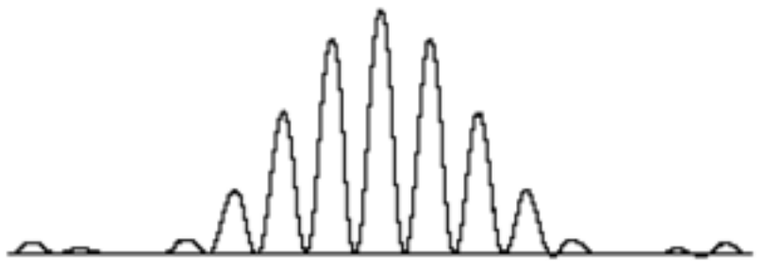
EXPERIMENTO DE JOHNSSON (1961)



Resultado do experimento de Jonsson



$$\lambda = \frac{12.3\ \text{Å}}{(V/(\text{Volt})^{1/2})}$$

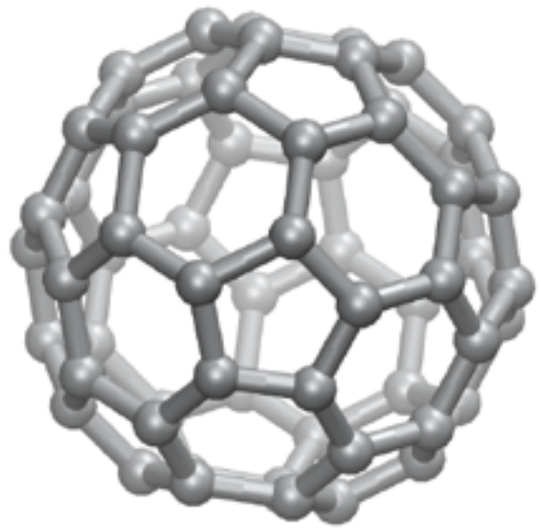


Predicted pattern

Elétrons tem interferência constrtutiva e destrutiva

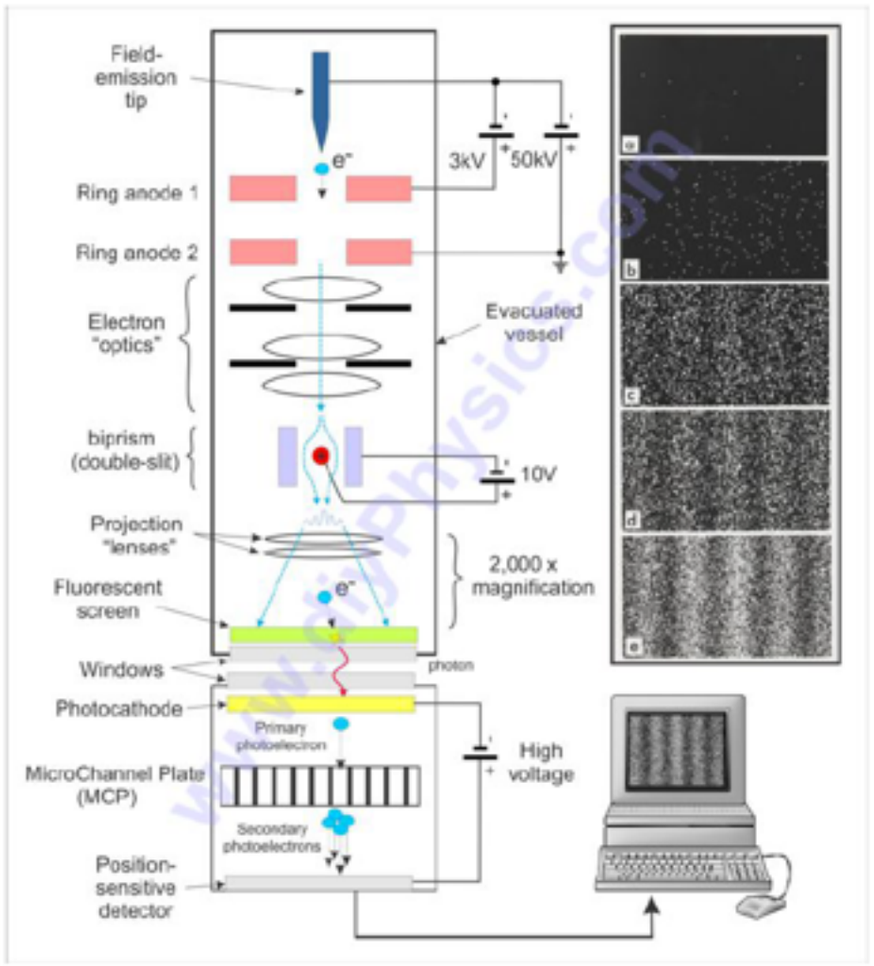
DIFRACAO DE FULLERENO

Fullereno: C_{60} : $m_{\text{fullereno}} = 10^6 m_e$ V=220m/s $\lambda = 2.5 \times 10^{-12}$m



DIFRACAO DE UM ELETRON

Se fizessemos o experimento com muitos poucos elétrons o que aconteceria?



Tonomura 1989

/Desktop/doubleslite-n.wmv

Pier Giorgio Merli, Gian Franco Missiroli and Giulio Pozzi in Bologna in 1974

MODELOS DO ATOMO:

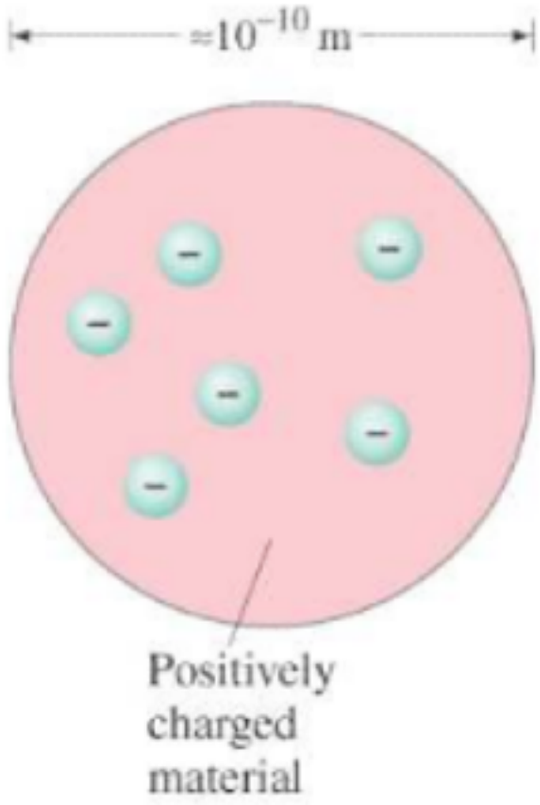


FIGURE 27–17 Plum-pudding model of the atom.

Modelo de Thomson: elétrons são imersos num pudim

MODELOS DO ATOMO: RUTHERFORD

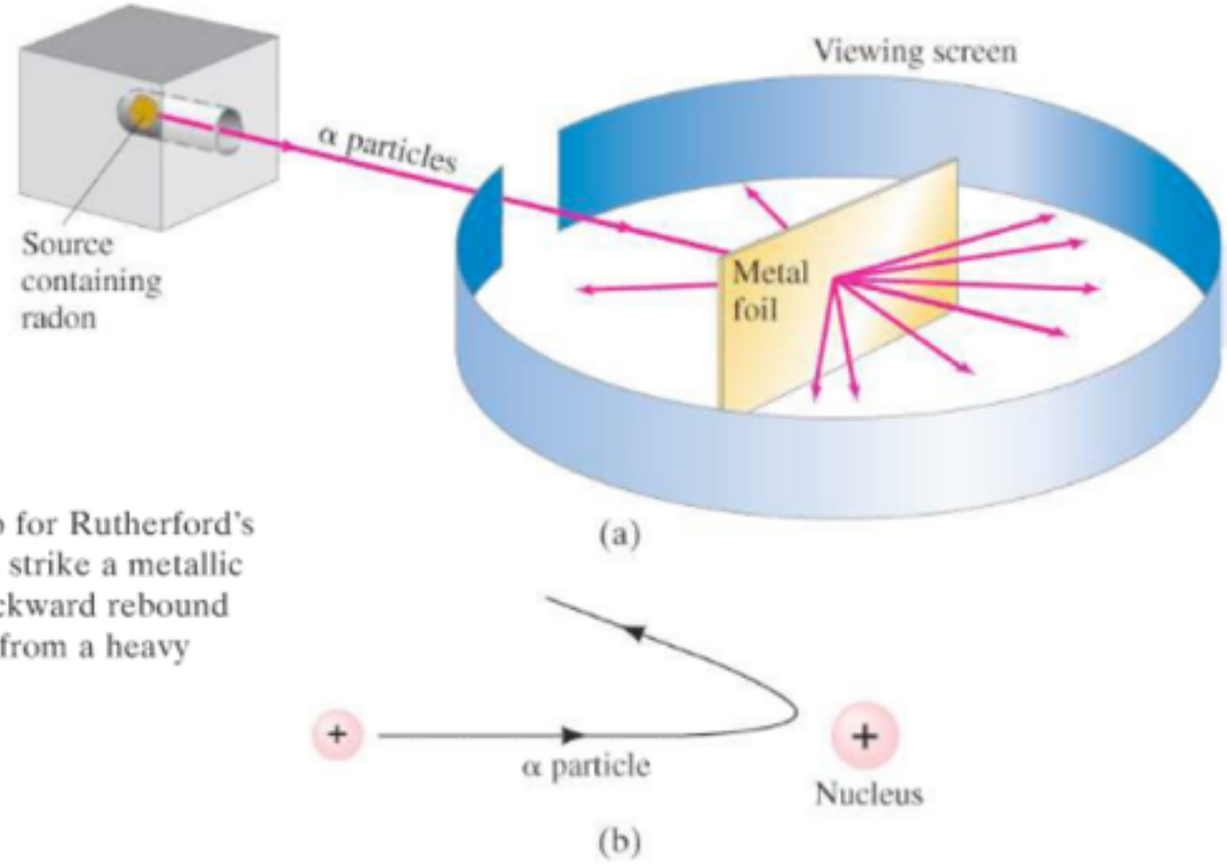
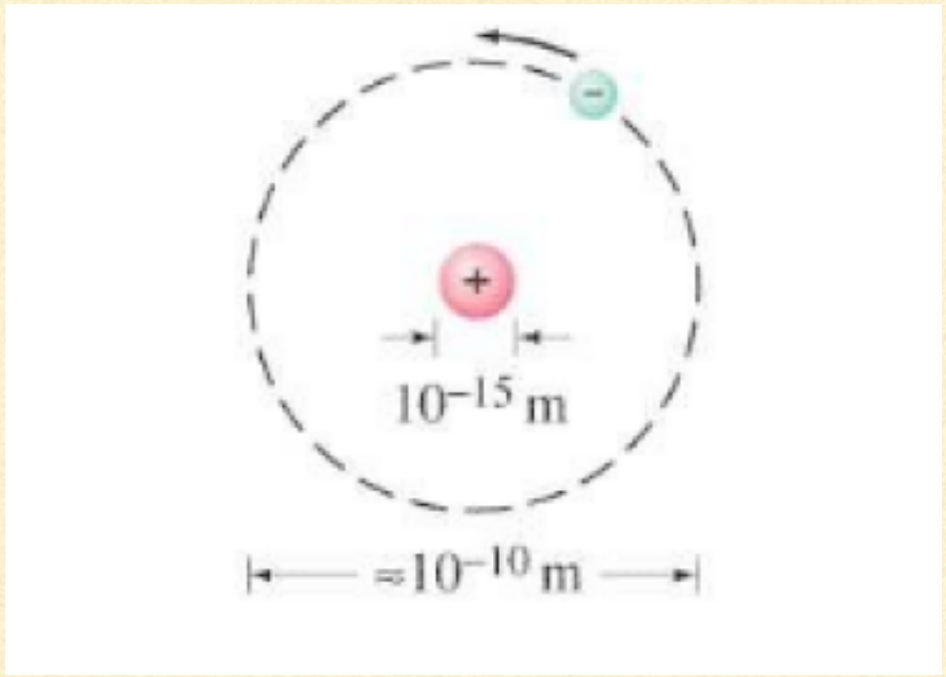


FIGURE 27–18 (a) Experimental setup for Rutherford's experiment: α particles emitted by radon strike a metallic foil and some rebound backward; (b) backward rebound of α particles explained as the repulsion from a heavy positively charged nucleus.

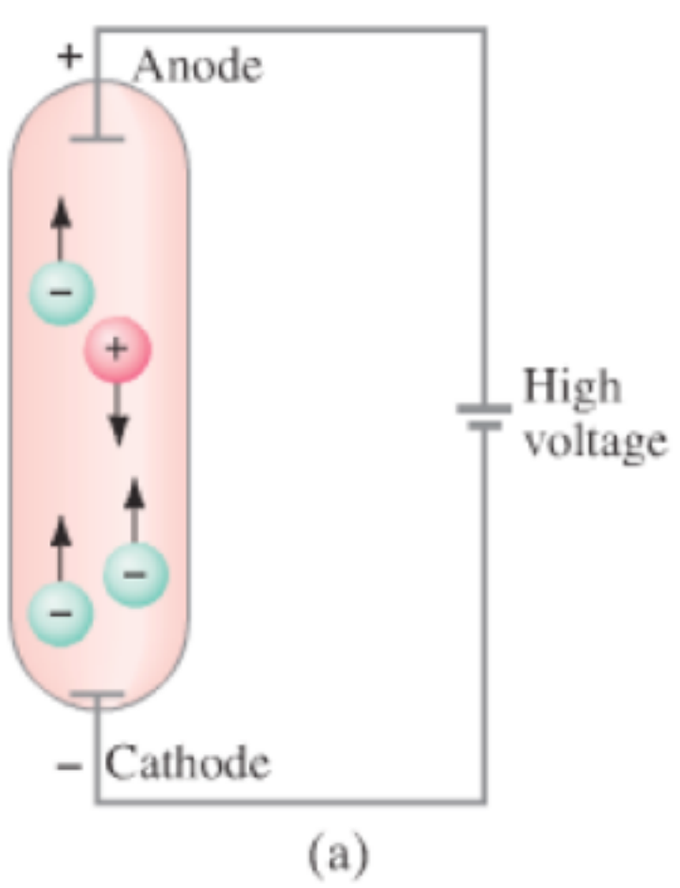
Espalhamento para tras: bola de chumbo e bola de gude

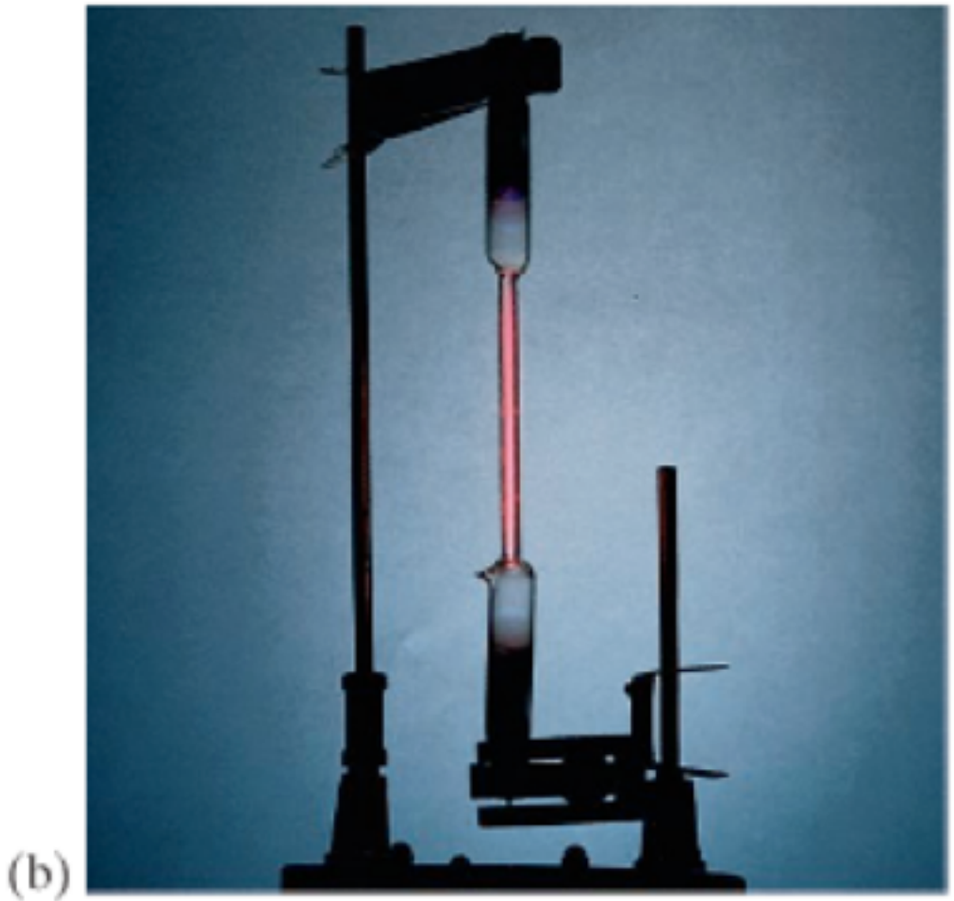
MODELOS DO ATOMO: RUTHERFORD



Rutherford: o átomo não esta espalhado: vazios

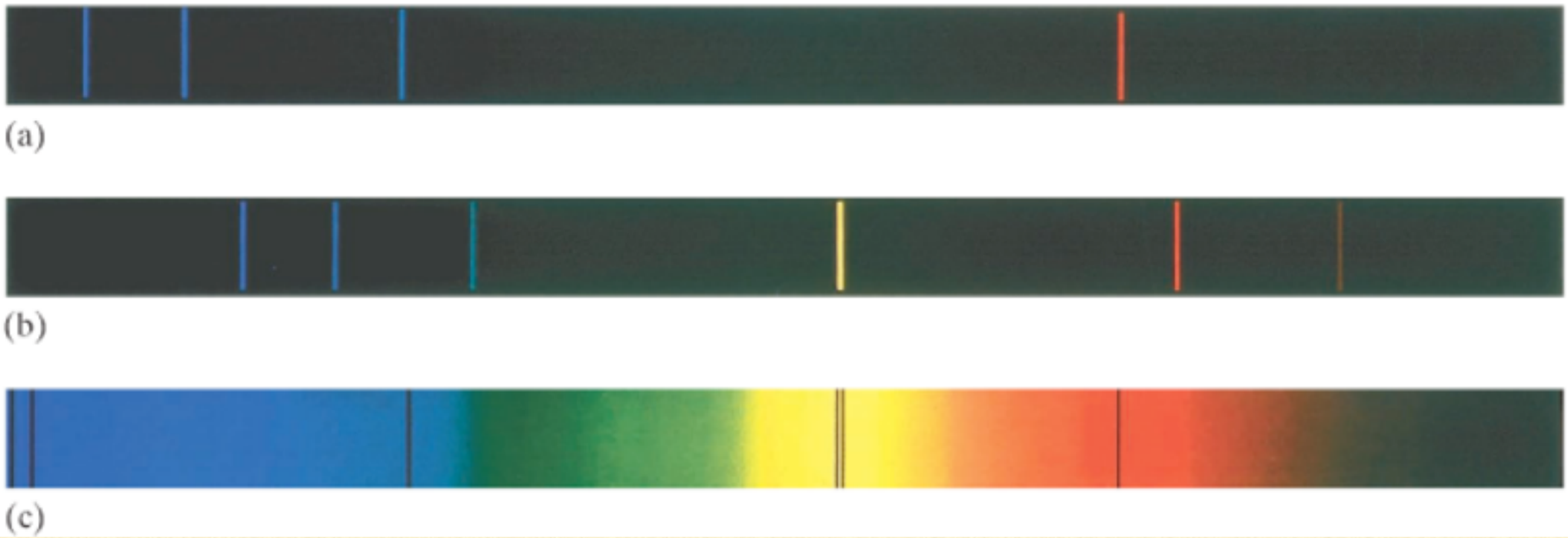
ESPECTRO ATOMICO





Gas rarefeito e aquecido: linhas discretas

ESPECTRO ATOMICO: O QUE VEMOS?



Espectro acima: hidrogênio

Espectro meio: helio

SERIE DE BALMER

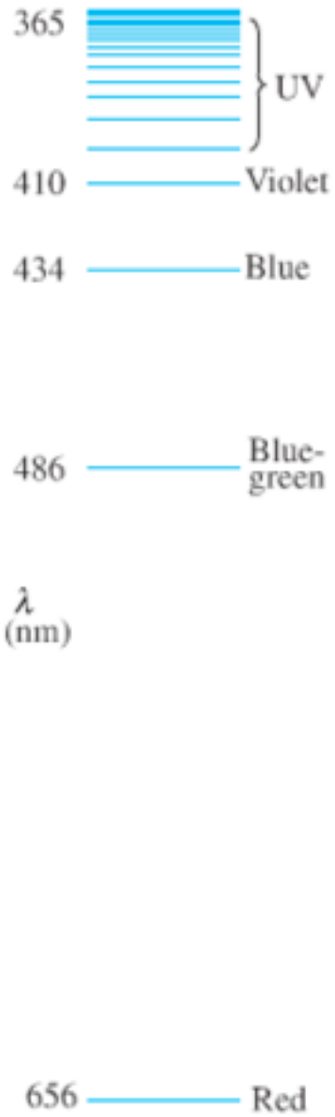


FIGURE 27–22 Balmer series of lines for hydrogen.

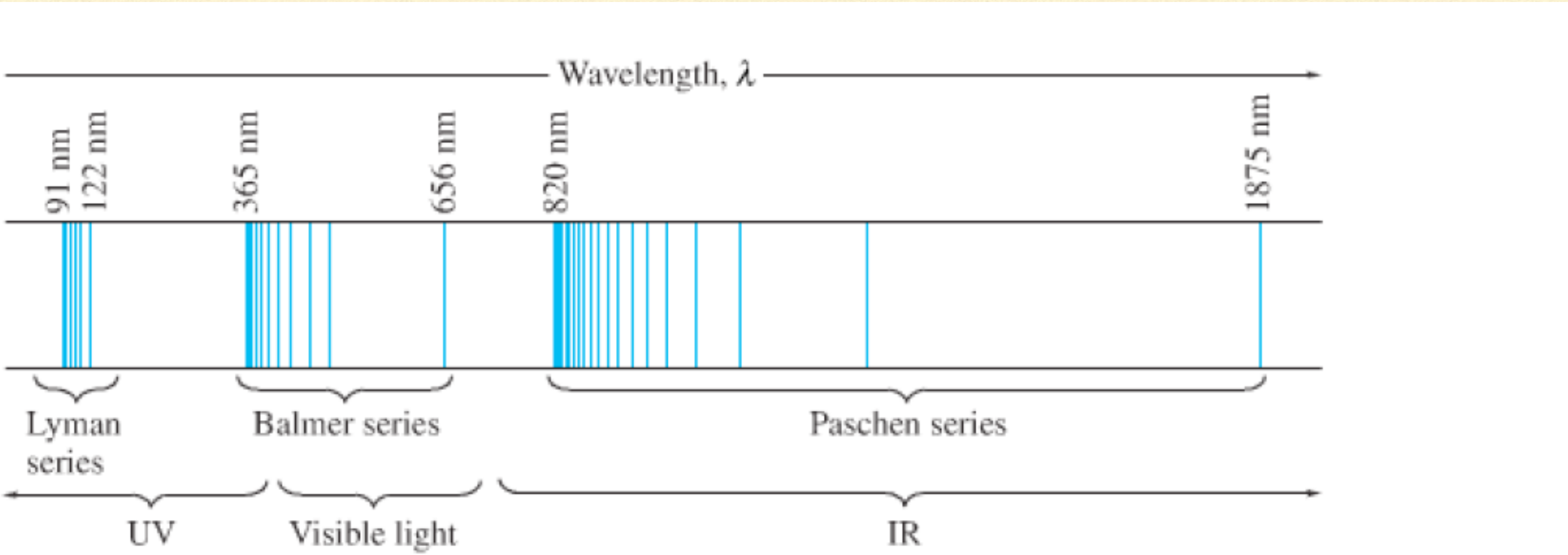
$$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$$

λ comprimento de onda

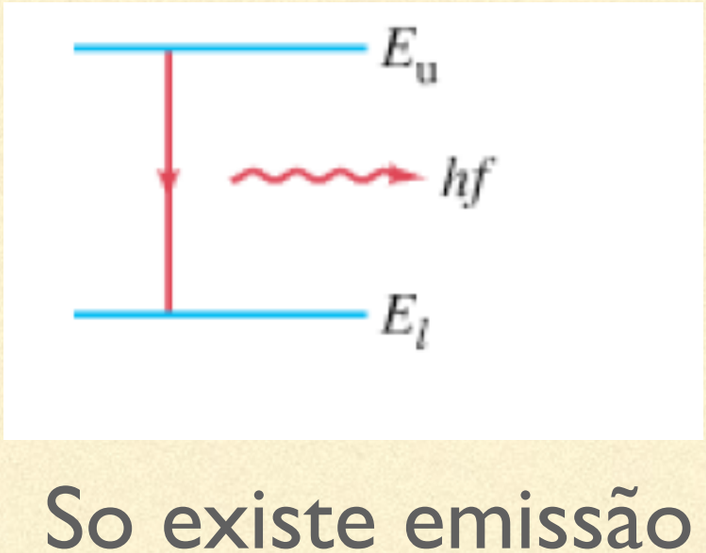
$$\mathrm{R} = 1,0974 \times 10^{7}\mathrm{m}^{-1}$$

n=1,2,3,..

LYMAN SERIES



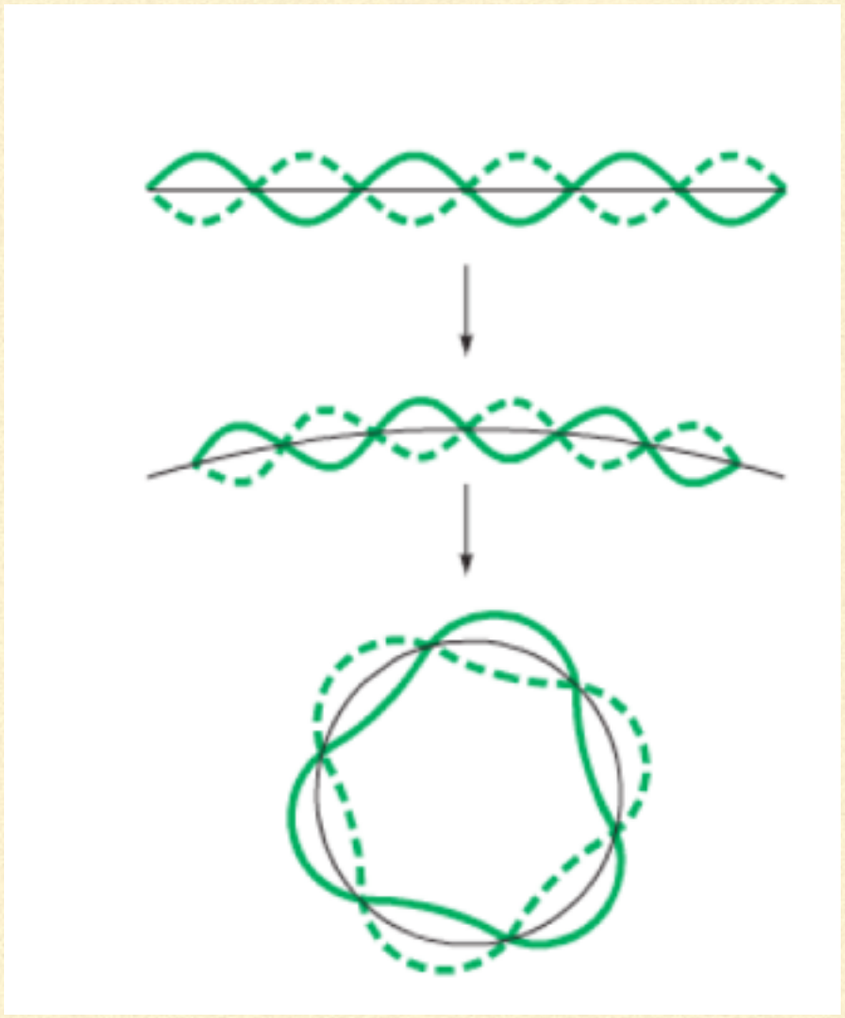
MODELO DE BOHR

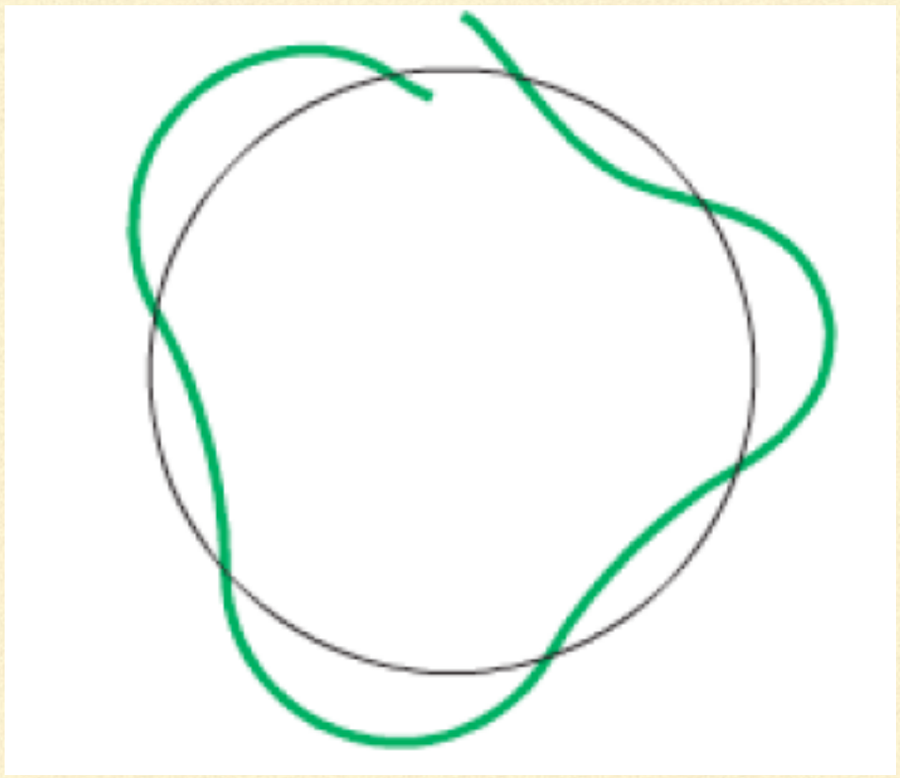


$$hf = E_a - E_l$$

So existe emissão de luz se a tiver a freqüência dada por esta equação.

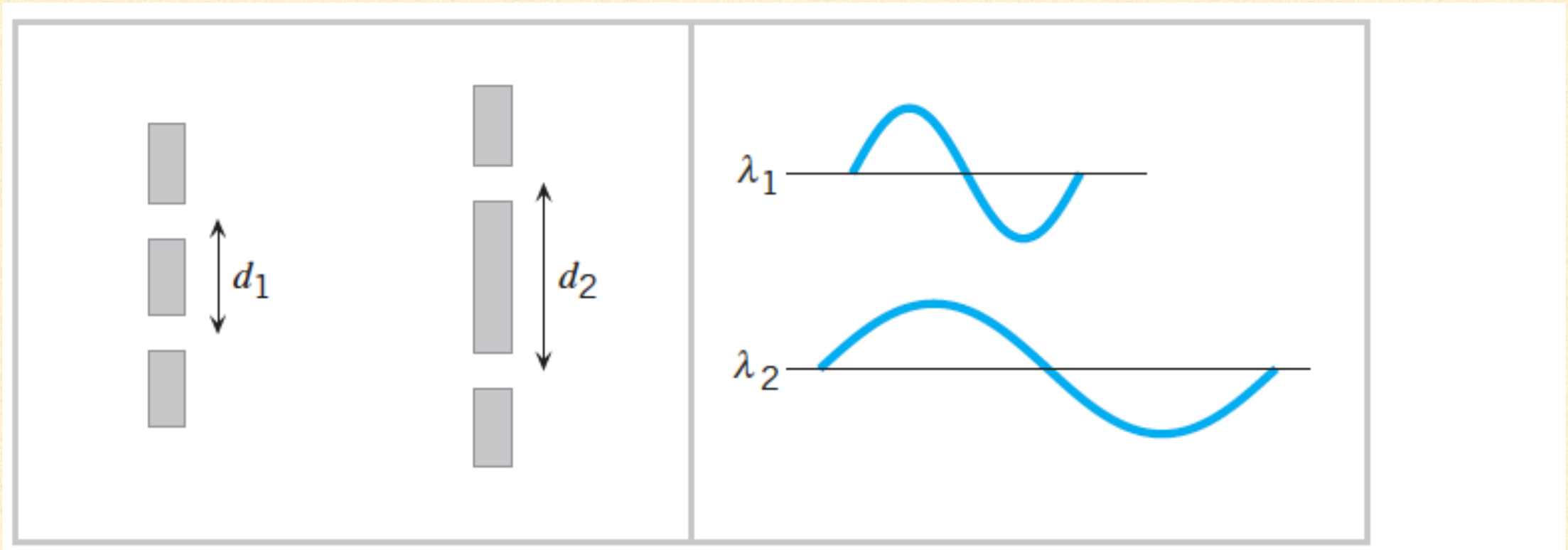
MODELO DE BOHR





$$\lambda = \frac{h}{mv} \quad \text{perimetro} = 2\pi r_a = n\lambda$$

EXEMPLO 11:



Qual destas combinações tera o padrão de máximos e mínimos mais espalhado?

EXEMPLO III:

$$\lambda_{\text{vermelho}} = 660 \text{ nm } \lambda_{\text{verde}} = 550 \text{ nm}$$

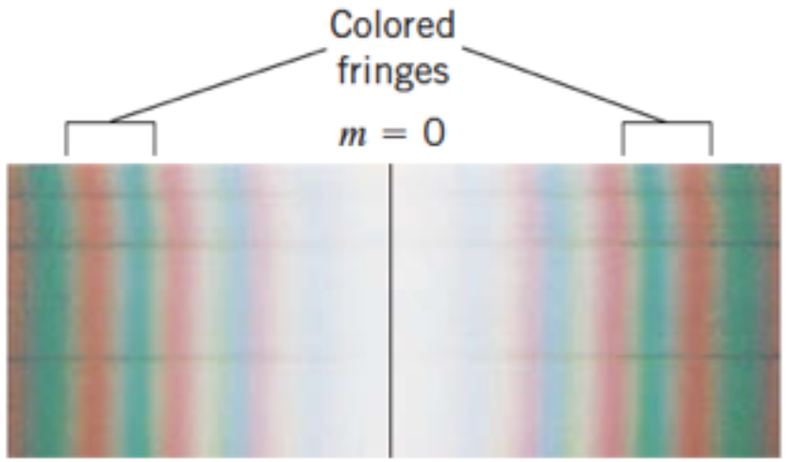


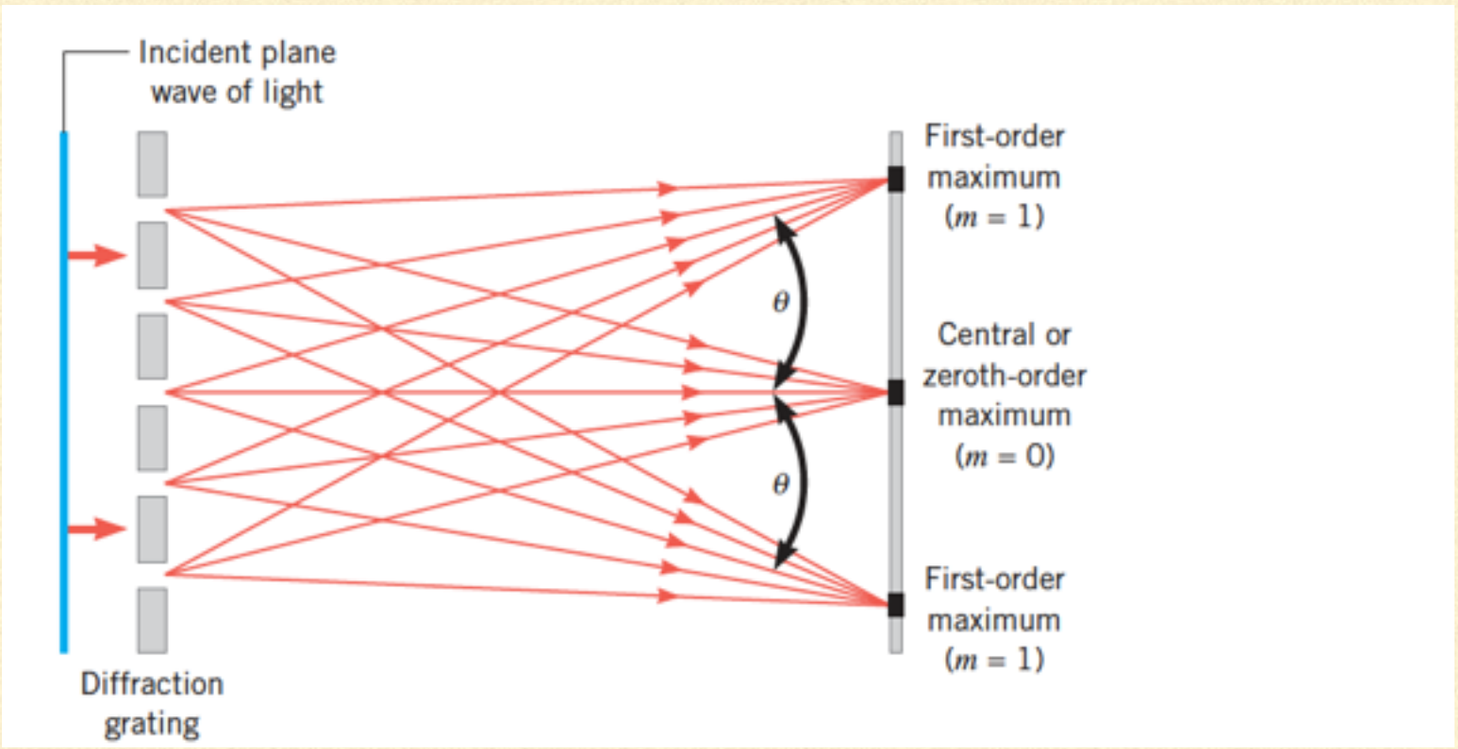
Figure 27.8 This photograph shows the results observed on the screen in one version of Young's experiment in which white light (a mixture of all colors) is used. (© Andy Washnik)

Porque o padrão colorido?

Porque a mancha branca no centro?

GRADE DE DIFRAÇÃO

$$\lambda_{\text{violeta,vermelho}} = 410(660)\ \text{nm grade} = 1,0 \times 10^4\ \text{linhas/cm}$$



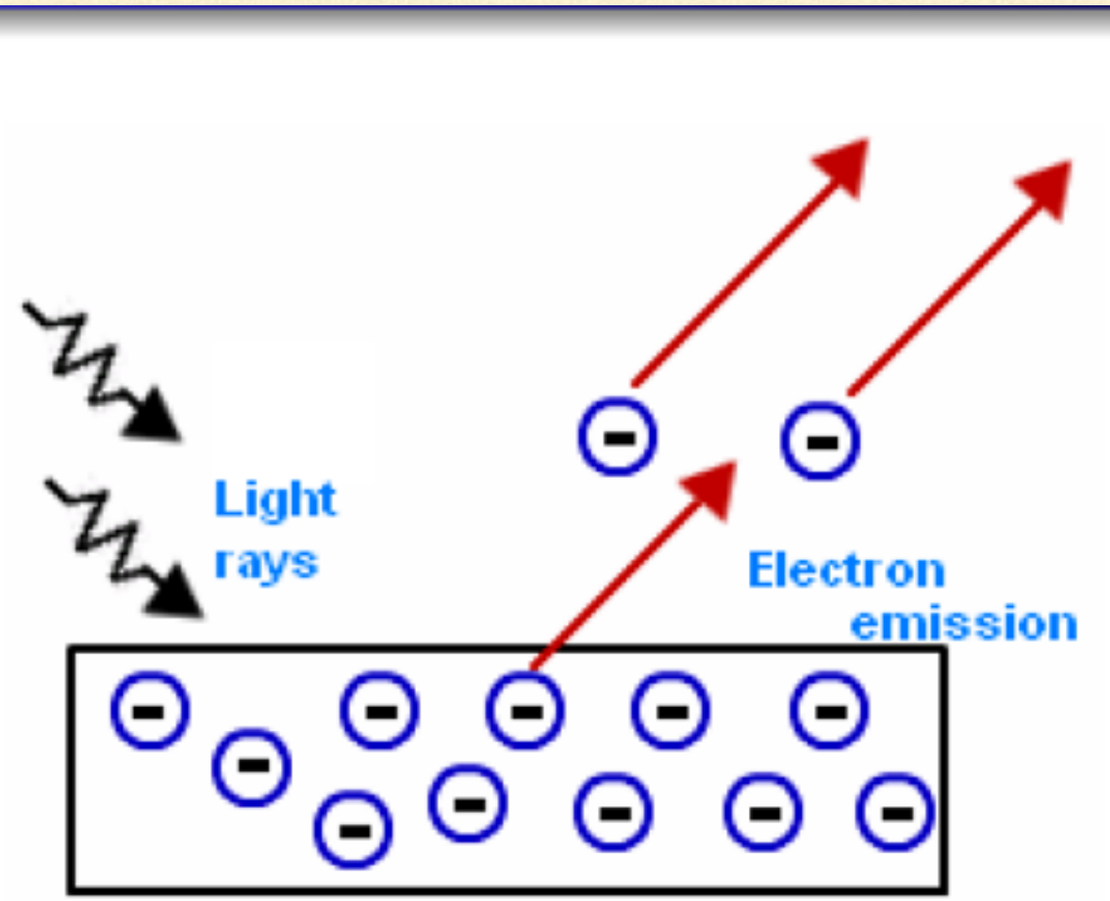
$$\sin\theta = \frac{m\lambda}{d}$$

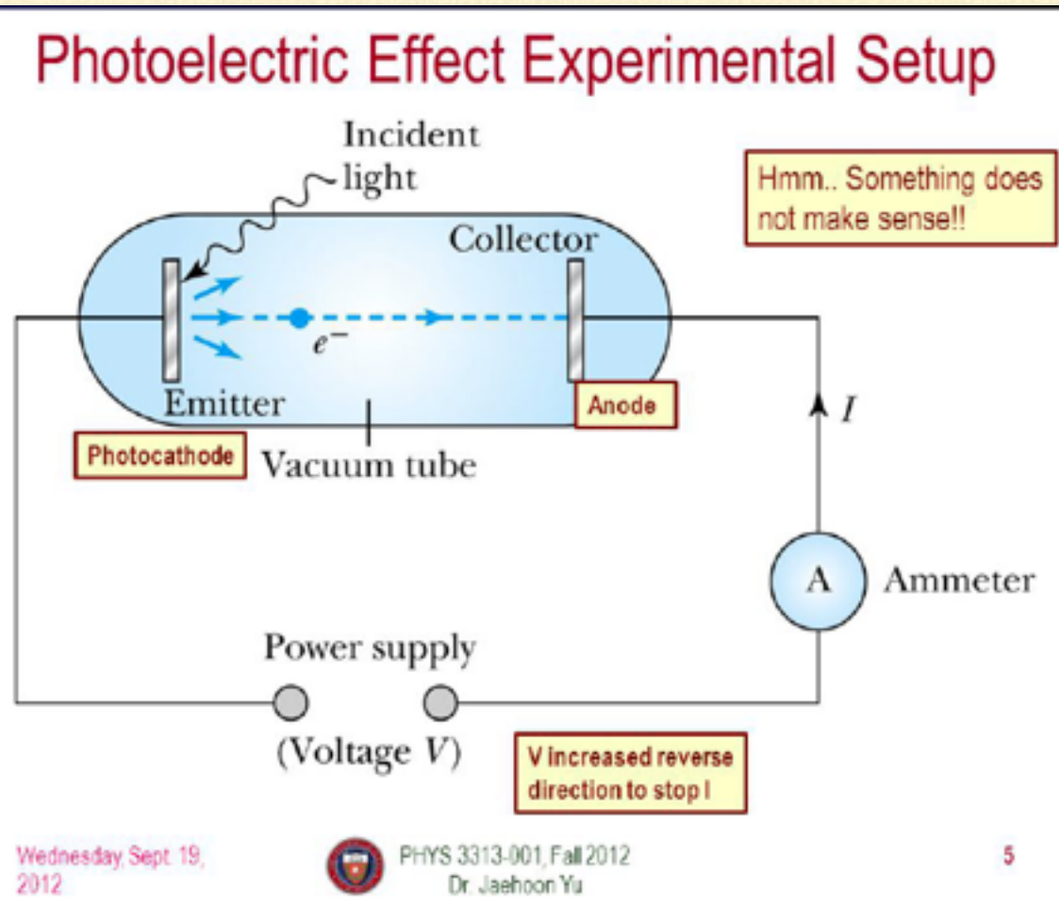
EXEMPLO IV:

Qual eh o angulo do primeiro máximo para a cor violeta?

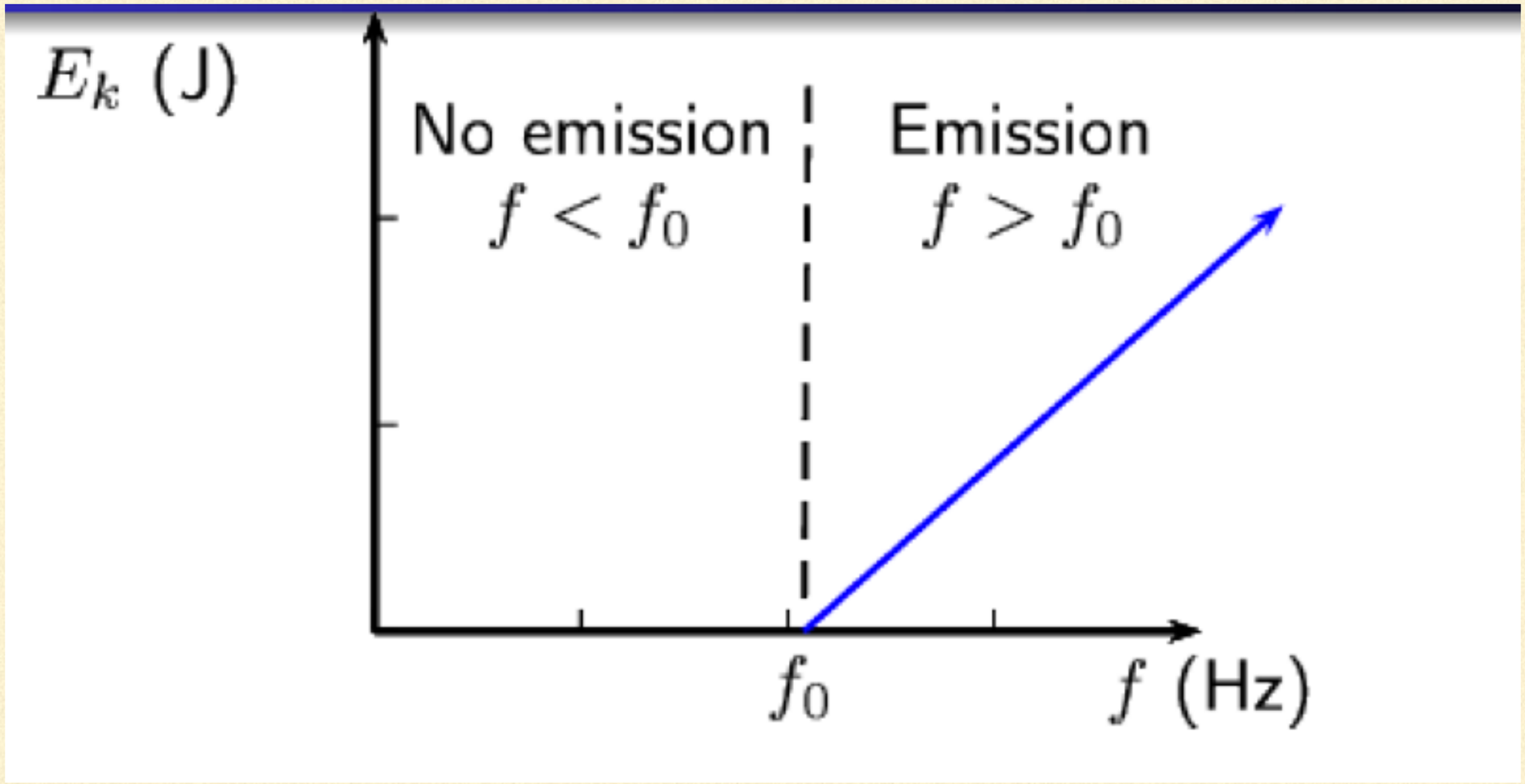
Qual eh o angulo do primeiro máximo para a cor vermelha?

EFEITO FOTOELÉTRICO E EINSTEIN





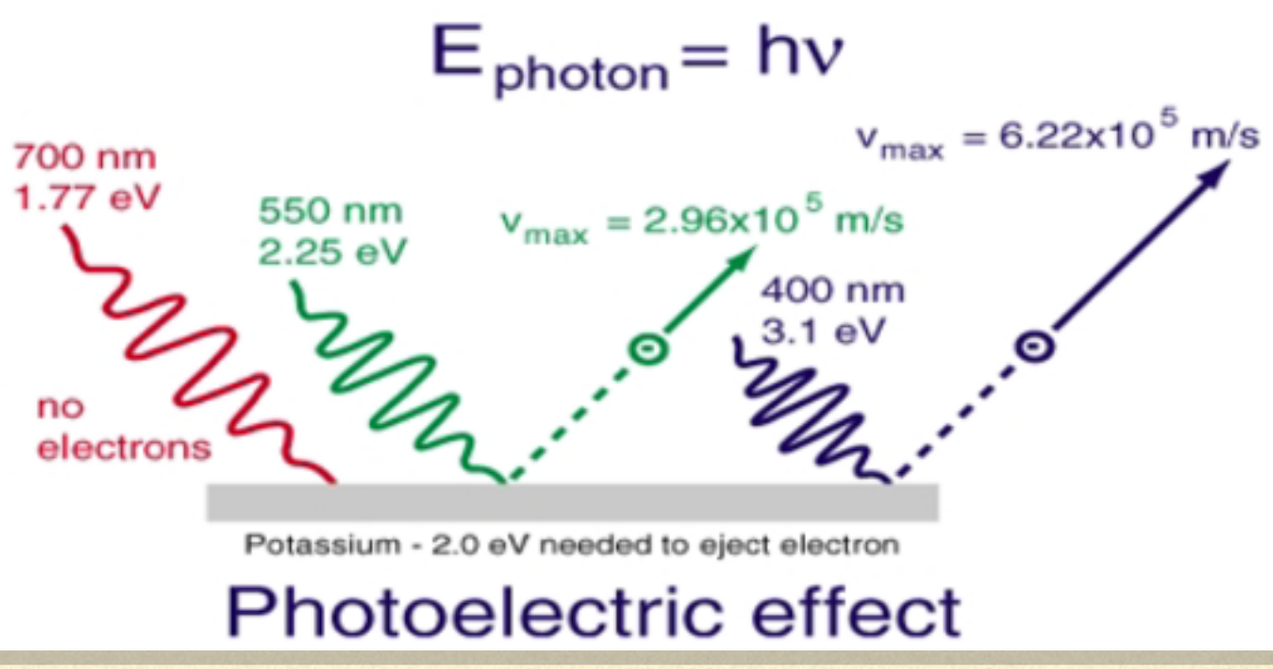
EFEITO FOTOELÉTRICO E EINSTEIN



EFEITO FOTOELÉTRICO E EINSTEIN

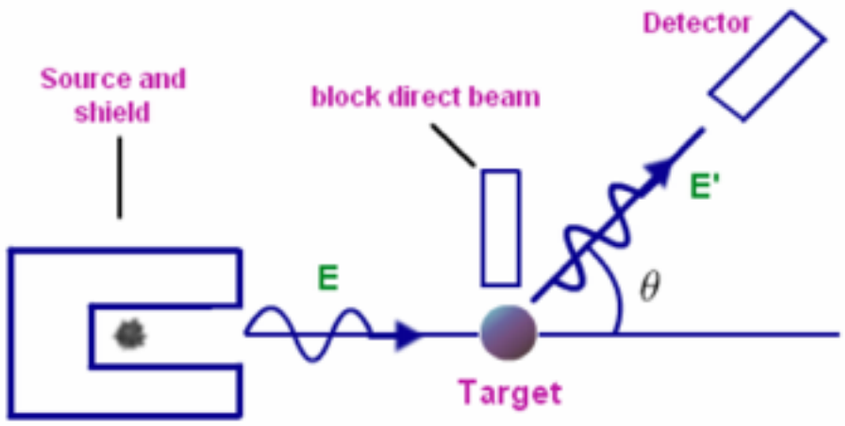
Einstein propós que a luz fosse composta de partículas chamadas fóton

Energia $E = h\nu = \frac{hc}{\lambda}$: $E_e = h\nu - W$



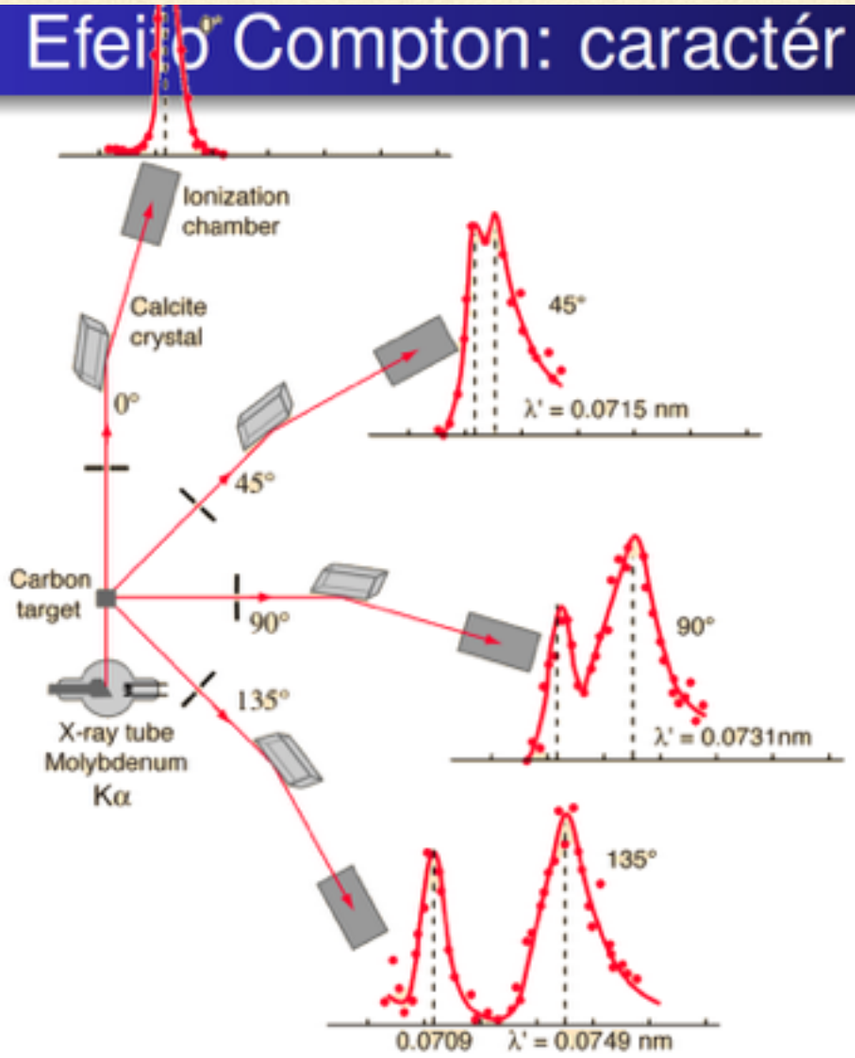
EFEITO COMPTON

Compton fez um experimento em 1923: caracter corspuscular da luz



EFEITO COMPTON II

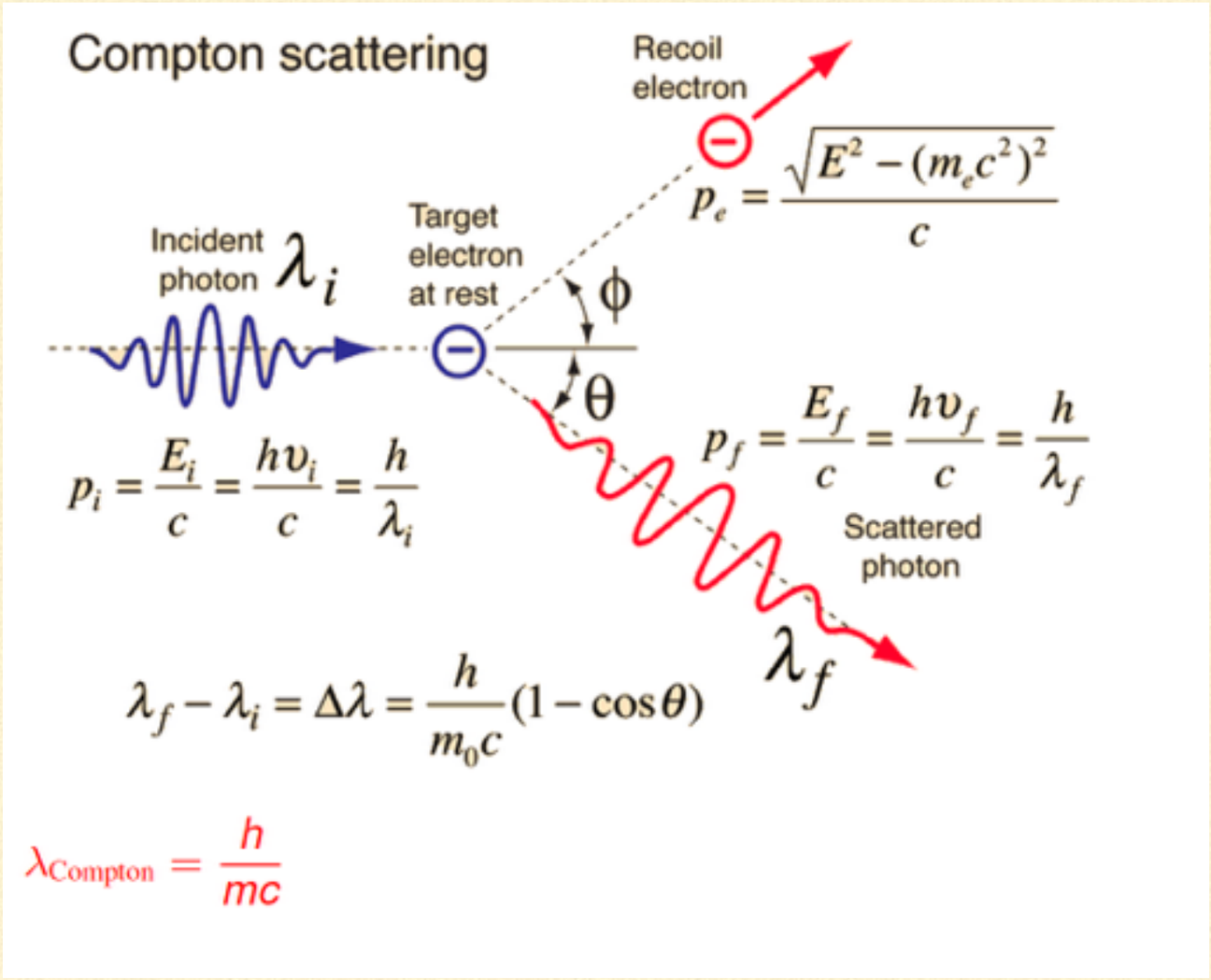
Efeito Compton: caractér corpuscular



Mudança no comprimento de onda:

$$\lambda_{final} > \lambda_{inicial} \rightarrow E_{final} < E_{inicial}$$

EFEITO COMPTON III



Luz se comporta como bolinhas de gude

RESUMO:

- Ondas eletromagnéticas tem interferência e difração.
- Efeito fotoelétrico e compton: luz se comporta como partículas.