21/03/2014

Como rango $F_N \sim 2$ fm

$$\Rightarrow mc^2 \simeq \frac{\hbar c}{d_{max}} = 1.6 \times 10^{-11} J = 100 \text{ MeV}$$

12 años después, se halló el mesón-pi en interacciones de rayos cósmicos, con $m \simeq 140 \text{ MeV}/c^2$

Modelos Nucleares

Gota líquida: (von Weizäcker, 1935)

nucleons → moleculas en gota de líquido

↓

Interacc. fuerte/ corto alcance y colisiones frecuentes/ energía de enlace.

(a) efecto de V: $\frac{U}{nucl.} \simeq$ cte (saturación) $\Rightarrow E_V = C_1 A$

(b) Efecto de S: $S \sim r^2 \sim A^{2/3}$ $E_S = -C_2 A^{2/3}$

(c) efecto Coulombiano: $U = ke^2/r$

Para Z protones, $U = \frac{ke^2}{r} \sum_1^{Z-1} j = \frac{ke^2 Z(Z-1)}{2r}$

$$\Rightarrow E_C = -\frac{C_3 Z(Z-1)}{A^{1/3}}$$

(d) simetría: experimental" se observa q' para A fijo, Z=N posee la mayor E. de enlace.

$$\Rightarrow U_{sim} = -\frac{C_4 (N-Z)^2}{A}$$ //

$$\therefore \boxed{E = C_1 A - C_2 A^{2/3} - C_3 \frac{Z(Z-1)}{A^{1/3}} - C_4 \frac{(N-Z)^2}{A}}$$

A > 15:

$C_1 = 15.7$ MeV $C_2 = 17.8$ MeV

$C_3 = 0.71$ MeV $C_4 = 23.6$ MeV

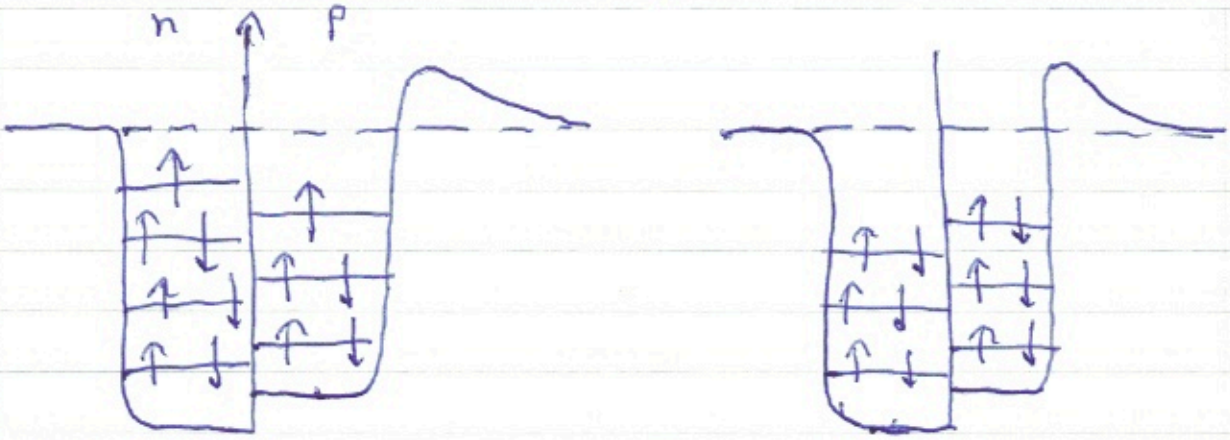
Modelo de Capas (M. Goeppert-Mayer; H. Jensen)

"Cada nucleon se mueve en un estado orbital bien definido en un campo promedio producido por los demás nucleones"

→ similar a los orbitales electrónicos

potencial esférico.

Ejemplo: $^{12}_{5}B$ vs $^{12}_{6}C$



$^{12}_{5}B$ tiene mayor E q' $^{12}_{6}C$ → menos estable

Se favorece $Z = N$ (núcleos ligeros)

Spín-orbital nuclear → debido a FN

Pot. esférico + spin-orbit → ∃ números mágicos

→ 8, 20, 28, 50, 82 y 126 nucleones very stable

P. de exclusión impide colisiones entre nucleones a bajas energías.

Radioactividad

1896: H. Becquerel

Curie: Polonio y radio

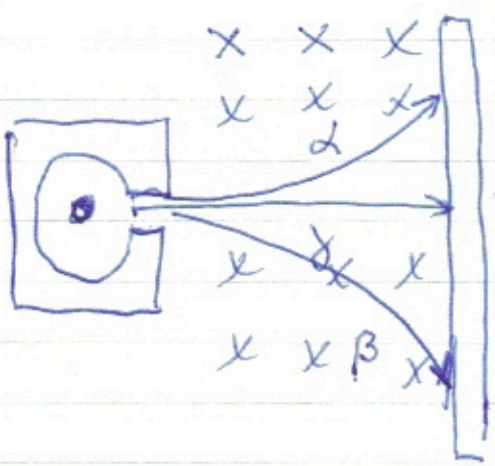
Radioactividad: decaimiento de núcleos inestables

3 tipos de radiación:

(α): ^4He

(β): electrones o positrones

(γ): fotones de alta energía



(α) hoja de papel

(β) pocos mm de Al

(γ) varios cm de Pb

Tasa de desintegraciones

$$\frac{dN}{dt} = -\lambda N$$

$$\Rightarrow \frac{dN}{N} = -\lambda dt \quad / \int \qquad \int_{N_0}^{N} \frac{dN}{N} = -\lambda \int_0^t dt$$

$$\Rightarrow \ln\left(\frac{N}{N_0}\right) = -\lambda t \Rightarrow \boxed{N = N_0 e^{-\lambda t}}$$

Tasa de decaimiento $R = \left|\frac{dN}{dt}\right| = N_0 \lambda e^{-\lambda t} = R_0 e^{-\lambda t}$

o sea $R = \lambda N$. ↳ "actividad"

VIDA MEDIA: t q' toma $\frac{N}{2}$ en decaer ($T_{1/2}$)

$$\frac{N_0}{2} = N_0 e^{-\lambda T_{1/2}} \Rightarrow T_{1/2} = \frac{\ln(2)}{\lambda} = \frac{0.693}{\lambda}$$

$t = T_{1/2} \rightarrow \frac{N_0}{2}$ permanecen

$t = 2T_{1/2} \rightarrow \frac{N_0}{4}$ "

$t = 3T_{1/2} \rightarrow \frac{N_0}{8}$ "

$1\ \text{Curie} = 1\ Ci = 3.7 \times 10^{10} \frac{\text{decai}}{\text{seg}}$

ST units

$1\ Bq = 1 \frac{\text{decaim.}}{\text{seg.}}$

Ej: $^{14}_{6}C$ tiene $T_{1/2} = 5730$ años

If $N_0 = 1000\ ^{14}_{6}C$, cuantos permanecen en $t = 22,920$ y

$N = N_0 e^{-\lambda t} = N_0 e^{-0.693\left(\frac{t}{T_{1/2}}\right)} \simeq 62$

(b) Isótopo ^{131}I con $T_{1/2} = 8.04$ días, con actividad inicial 5 mCi al enviarse. Al llegar a destino, su actividad ha bajado a 4.2 mCi ¿cuánto tiempo ha transcurrido?

$R/R_0 = e^{-\lambda t} \Rightarrow \ln(R/R_0) = -\lambda t$

$\Rightarrow t = -\frac{1}{\lambda} \ln(R/R_0)$, pero $\lambda = \frac{0.693}{T_{1/2}}$

$= \frac{0.693}{8.04}$ =

$t = -\left(\frac{8.04}{0.693}\right) \ln\left(\frac{4.2\ mCi}{5.0\ mCi}\right) \simeq 2.02$ días

Alexander Valterovich Litvinenko (Russian: Алекса́ндр Ва́льтерович Литвине́нко; IPA: [ɐlʲɪˈksandr ˈvaltərəvʲɪtɕ lʲɪtvʲɪˈnʲenkə]; 30 August 1962[2][3] [4 December 1962 by father's account][4] – 23 November 2006) was a fugitive officer of the Russian FSB secret service who specialised in tackling organised crime.[1][5] In November 1998, Litvinenko and several other FSB officers publicly accused their superiors of ordering the assassination of the Russian tycoon and oligarch Boris Berezovsky. Litvinenko was arrested the following March on charges of exceeding the authority of his position. He was acquitted in November 1999 but re-arrested before the charges were again dismissed in 2000. He fled with his family to London and was granted asylum in the United Kingdom, where he worked as a journalist, writer and consultant for the British intelligence services.

During his time in London, Litvinenko wrote two books, *Blowing Up Russia: Terror from Within* and *Lubyanka Criminal Group*, wherein he accused the Russian secret services of staging the Russian apartment bombings and other terrorism acts in an effort to bring Vladimir Putin to power. He also accused Putin of ordering the murder in October 2006 of the Russian journalist Anna Politkovskaya.

On 1 November 2006, Litvinenko suddenly fell ill and was hospitalised in what was established as a case of poisoning by radioactive polonium-210 which resulted in his death on 23 November. He became the first known victim of lethal Polonium 210-induced acute radiation syndrome.[6] The events leading up to this are a matter of controversy, spawning numerous theories relating to his poisoning and death. A British murder investigation pointed to Andrey Lugovoy, a member of Russia's Federal Protective Service, as the prime suspect. Britain demanded that Lugovoy be extradited, which is against the Constitution of Russia, which directly prohibits[7] extradition of Russian citizens without handing Russia any evidence related to the case. Russia denied the extradition, leading to the cooling of relations between Russia and the United Kingdom.

After Litvinenko's death, his widow, Marina, pursued a vigorous campaign on behalf of her husband through the Litvinenko Justice Foundation. In October 2011, she won the right for an inquest into her husband's death to be conducted by a coroner in London; the inquest was repeatedly set back by issues relating to examinable evidence.[8] A public enquiry began on 27 January 2015.[9]

Alexander Litvinenko
Александр Литвиненко

Allegiance	United Kingdom, Russian Federation
Service	MI6,[1] KGB, FSB (defected)
Birth name	Alexander Valterovich Litvinenko
Born	30 August 1962 Voronezh, Russian SFSR, Soviet Union
Died	23 November 2006 (aged 44) London, United Kingdom
Cause of death	Radiation poisoning
Nationality	Russian, British (2006 – his death)

(a) Profe hace circular un sobre sellado a toda la clase.

(b) Nano la historia de Litvinenko

(c) Abre el sobre y muestra q contiene una fuente de Polonio-210

(d) Los estudiantes se preocupan

(e) se explica q el polonio-210 decae emitiendo partículas - α

$$^{210}_{84}Po \rightarrow {}^{206}_{82}Pb + {}^{4}_{2}He$$

Las partículas α pueden ser detenidas por una hoja de papel. ⇒ puede ser transportado con seguridad, pero también es absorbido por el cuerpo completo ⇒ las células reciben toda la energía.

Actividad : Po-210 → $0.1\,\mu C_i$ de actividad ($1 C_i = 3.7 \times 10^{10} \left(\frac{decay}{sec}\right)$)

[muestra de la sal de clases

⇒ 3700 P. α por segundo

Act. del Po-210 en el cuerpo de L.

se especula q' se usó un microgramo de Po-210

$R = \lambda N$; donde $\lambda = \frac{\ln 2}{T_{1/2}}$

$T_{1/2}(Po\text{-}210) = 138.38$ días $(1.1956 \times 10^7 s)$

$$\Rightarrow R = \lambda N = \left[\frac{\ln 2}{1.1956 \times 10^7}\right]\left[10^{-6} \cdot \frac{6.023 \times 10^{23}}{210}\right]$$

$$= 1.66 \times 10^8 (1/sec) = \boxed{4.49\ m C_i}$$

45.000 ~~mayor~~ más radioactiva q' la fuente usada en la clase

$\Rightarrow$ Alto nivel de envenenamiento en el cuerpo de Litvinenko ; y la pequeña masa requerida.

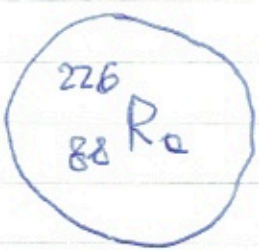
Decaimiento α

$$ {}^{A}_{Z}X \rightarrow {}^{A-4}_{Z-2}X + {}^{4}_{2}He $$

$$ {}^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He \qquad T_{1/2} \sim 10^{9}\ Y $$

$$ {}^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He \qquad T_{1/2} \sim 10^{3}\ Y $$

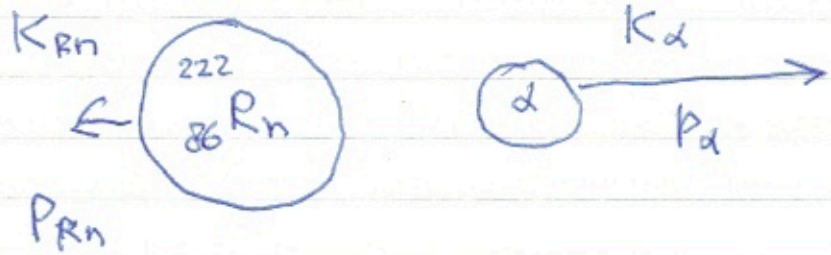
Antes decaimiento



$K_{Ra} = 0$

$P_{Ra} = 0$

Después decaimiento



Energía de desintegración → K. energy of the products

$$ Q = (M_X - M_Y - M_\alpha)c^2 $$

$$ Q = (M_X - M_Y - M_\alpha) \times 931.494 \left(\frac{MeV}{u}\right) $$