Reações nucleares

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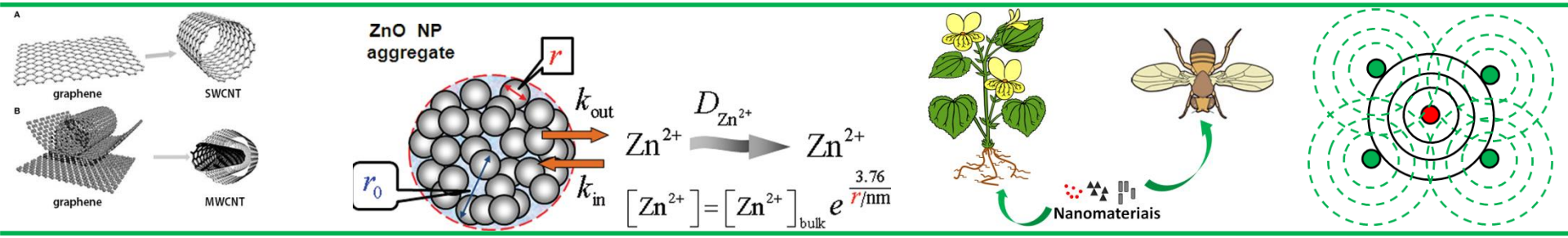
Laboratório de Instrumentação Nuclear



Onde estamos?

Modelos atômicos

Partículas nucleares

Isótopos estáveis e radioativos

Reações nucleares

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Tipos de decaimento nuclear

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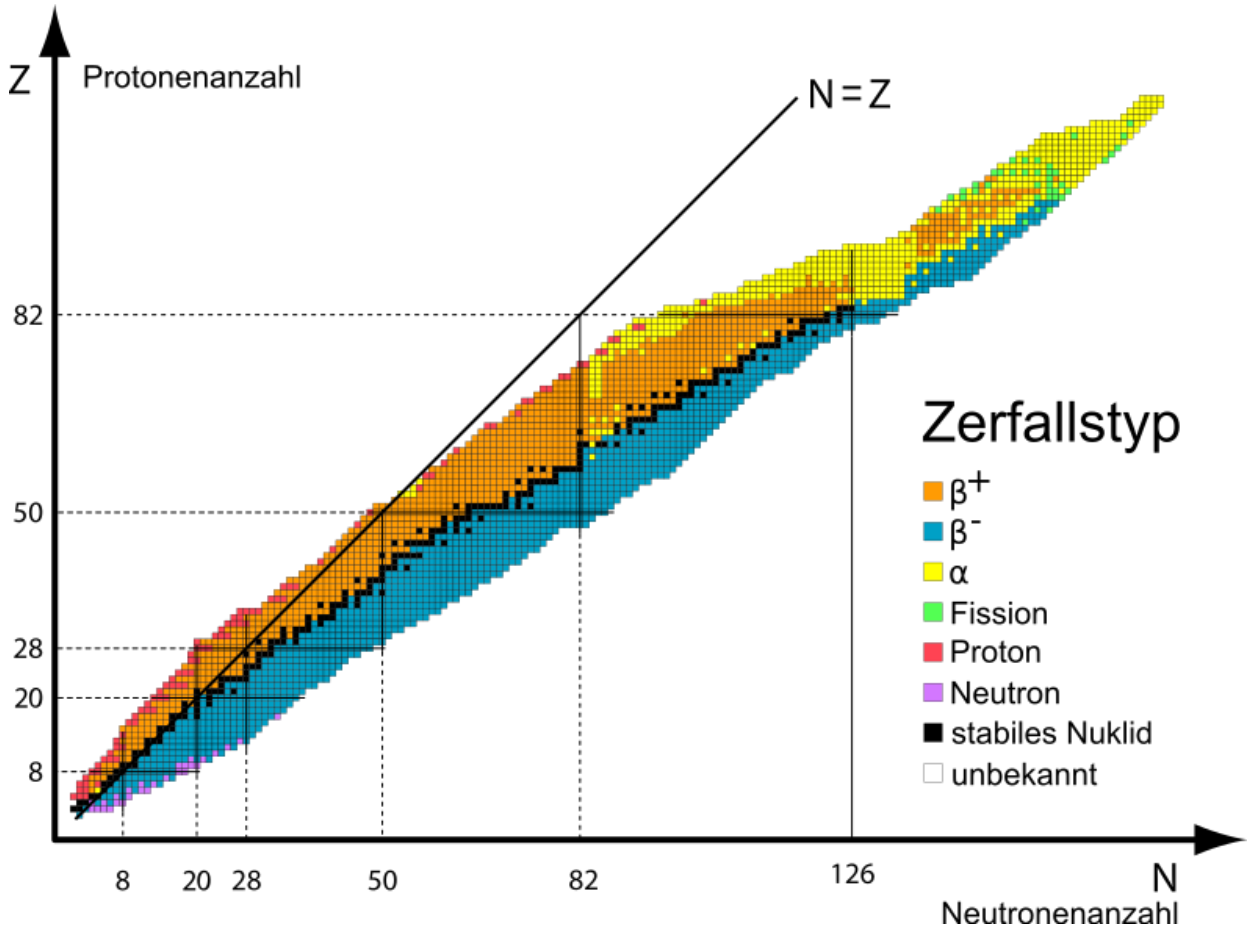
Estabilidade Nuclear

- Qual é razão ideal entre prótons e nêutrons?

https://nds.iaea.org/relnsd/vcharthtml/VChartHTML.html



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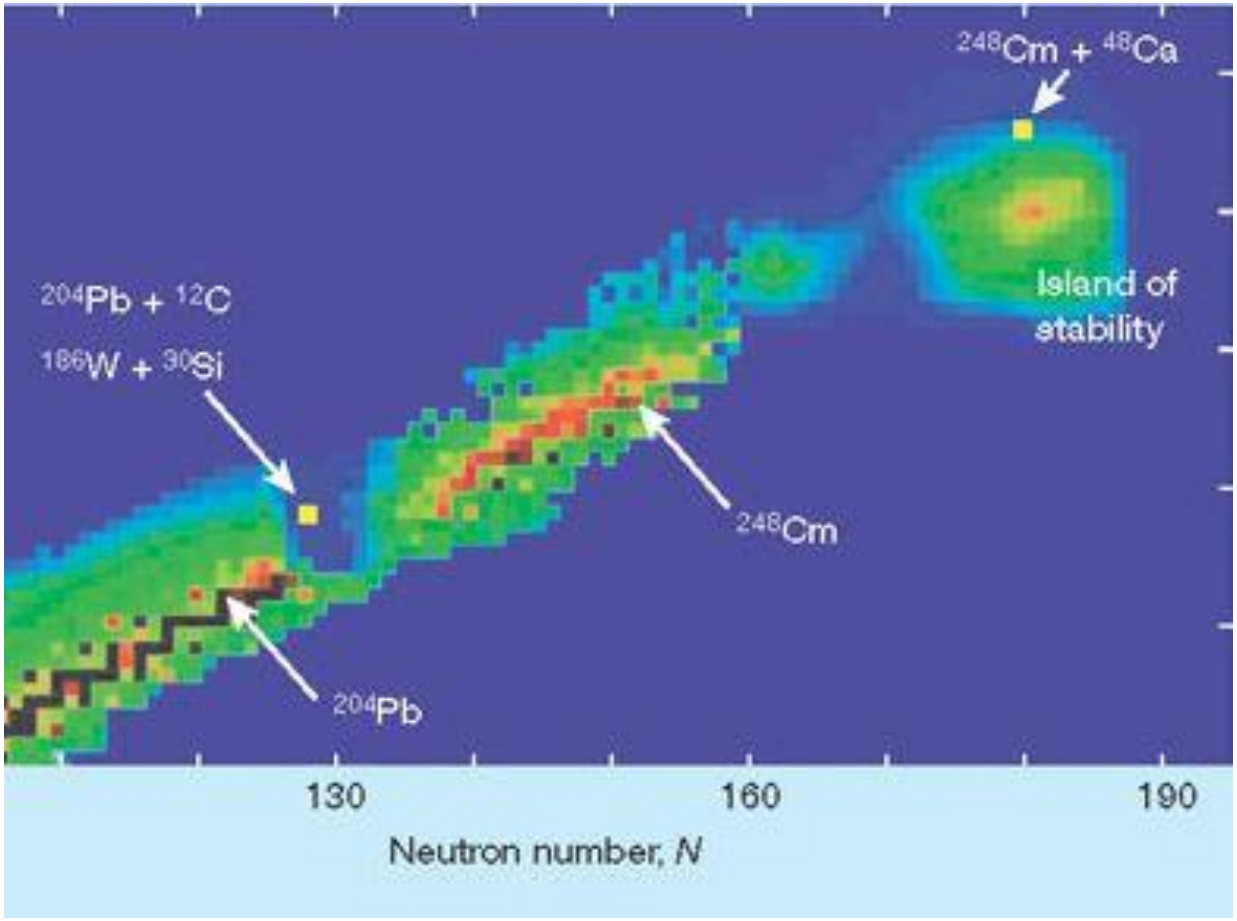
A ilha de estabilidade

https://www.researchgate.net/figure/Chart-of-the-nuclides-the-domain-of-the-heavy-and-superheavy-elements-White-squares_fig1_237662954



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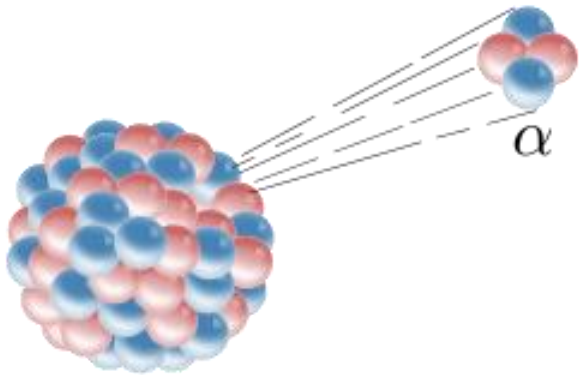
Emissão de partícula alfa

$^{208}_{84}Po \rightarrow {}^{204}_{82}Pb + {}^{4}_{2}\alpha$



https://en.wikipedia.org/wiki/Alpha_decay

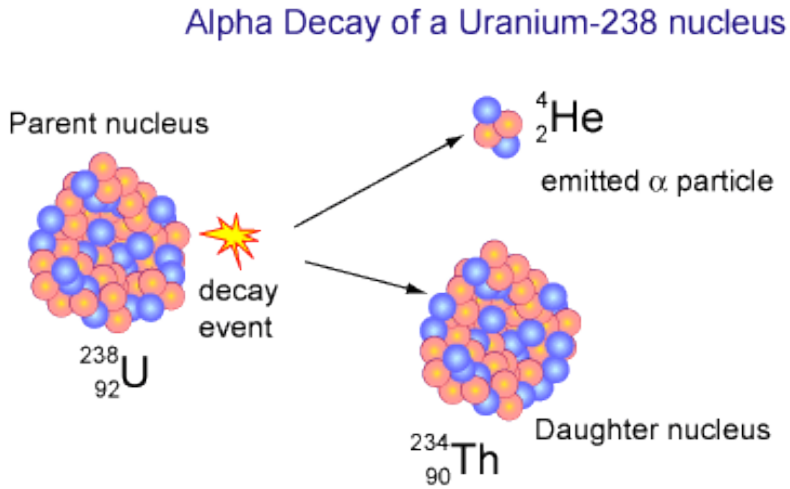
- Exemplo do urânio ^{235}U e ^{238}U
- Qual a proporção numa amostra natural ?

99,3% de ^{238}U e 0,7% de ^{235}U

- Decaimento natural

Via emissão alfa

$^{235}U \rightarrow {}^{231}Th$



https://socratic.org/questions/how-does-the-atomic-number-change-when-it-emits-an-alpha-particle

- Combustível nuclear

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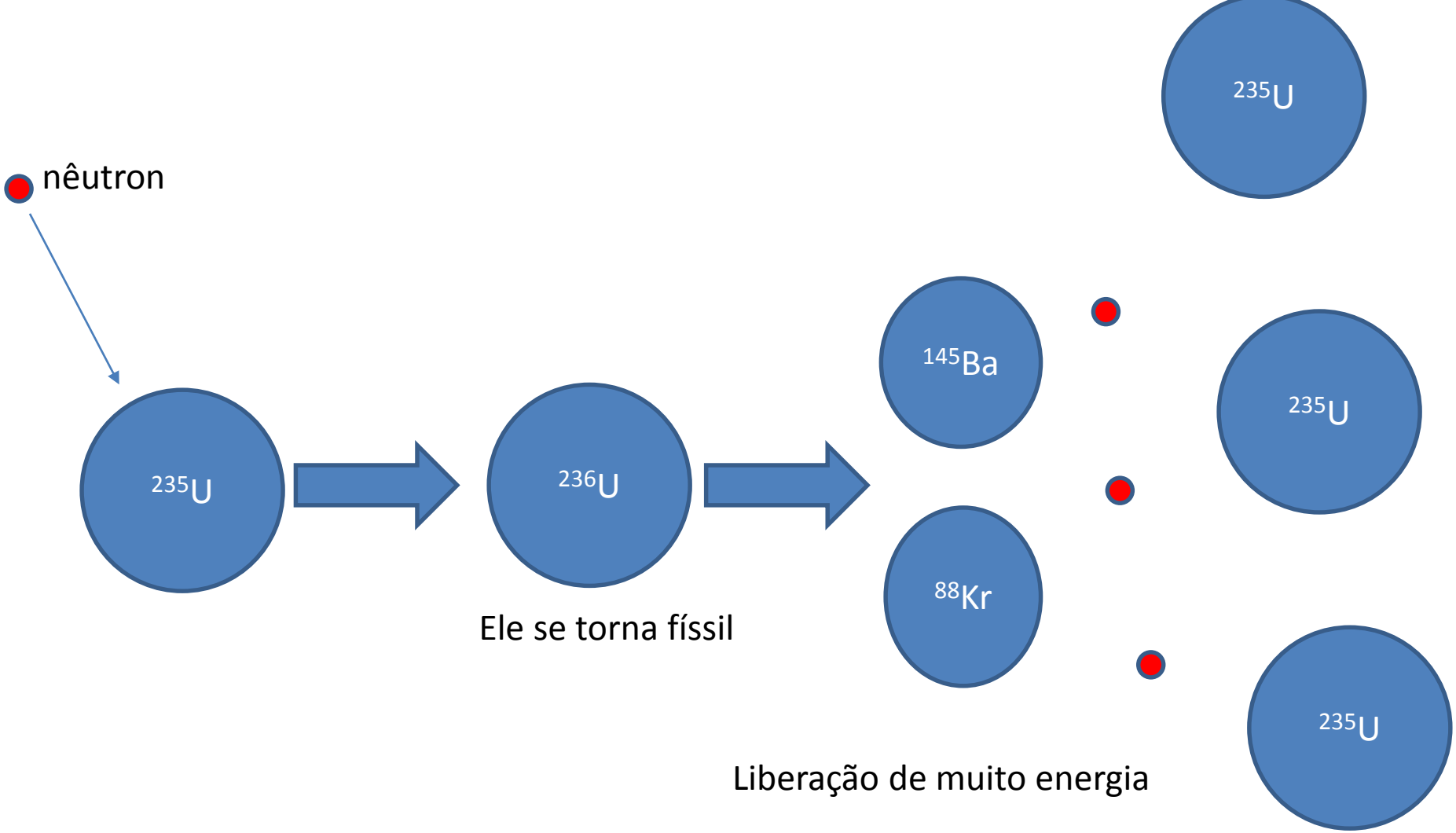


1 kg tem energia equivalente a 25 toneladas de carvão
Em 1 kg de urânio cerca de 1 g de ^{235}U

- Urânio de baixo enriquecimento, ele contém cerca 3-5% de ^{235}U. É usado na produção de energia

- Urânio de alto enriquecimento, que contém quase 100% de ^{235}U. Ele é usado para finalidade bélica.

Emissão de partícula beta negativa

prótons

nêutrons

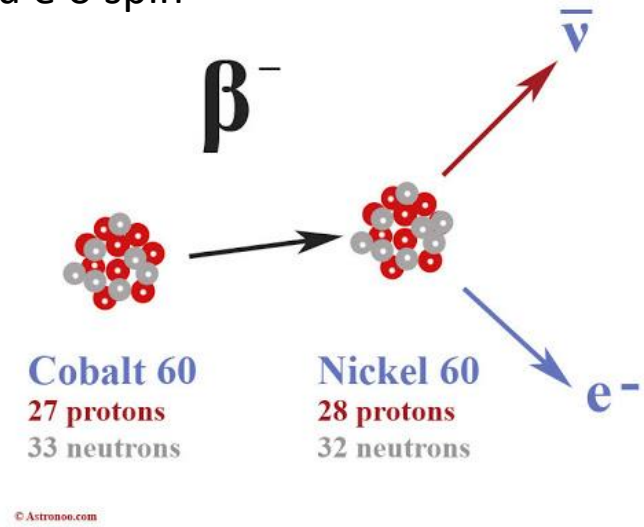
Neutrino e antineutrino
-neutra
-muito mais leve do que o elétron
-diferença é o spin

^{3}H- trítio

+ beta negativa

$^{3}_{1}H \rightarrow {}^{3}_{2}H$

$^{32}_{15}P \rightarrow {}^{32}_{16}S$



http://www.astronoo.com/en/articles/neutrino.html

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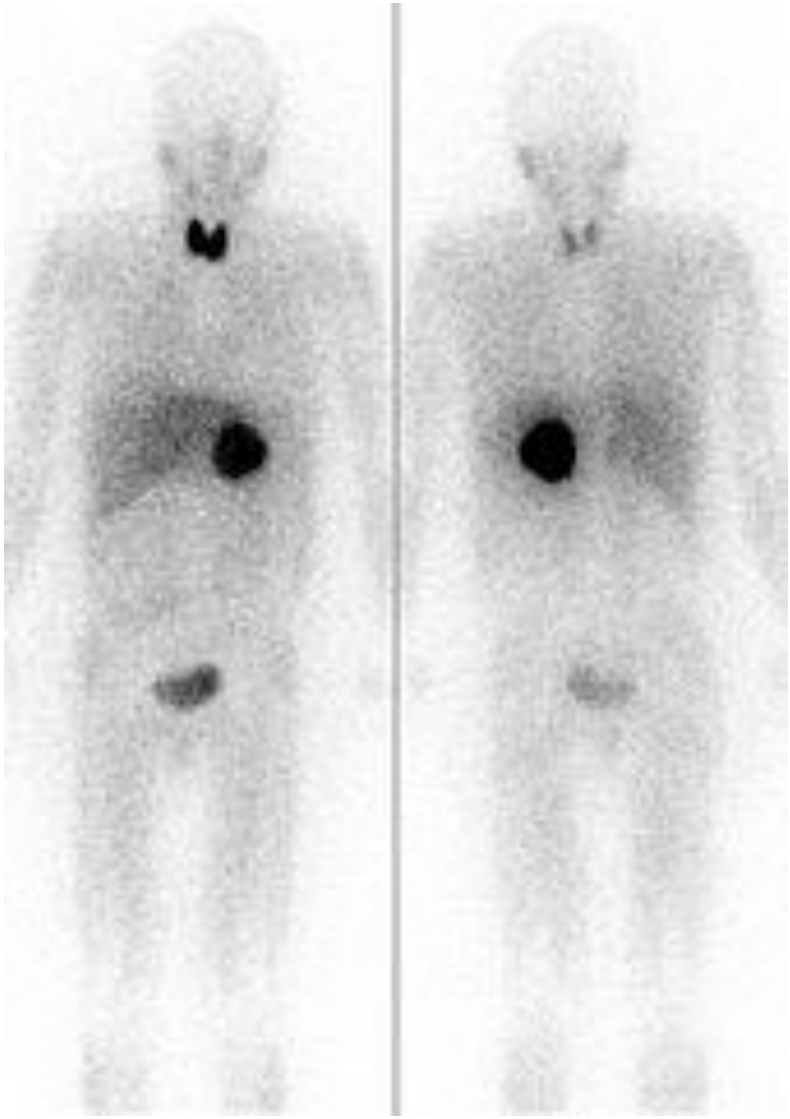
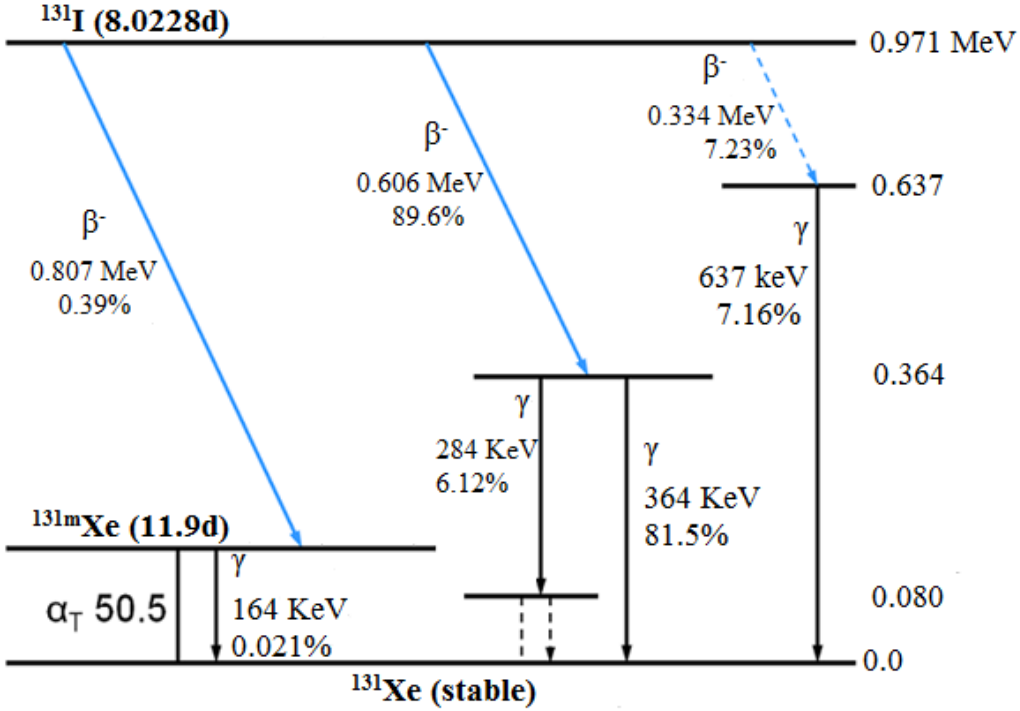
Cintilografia

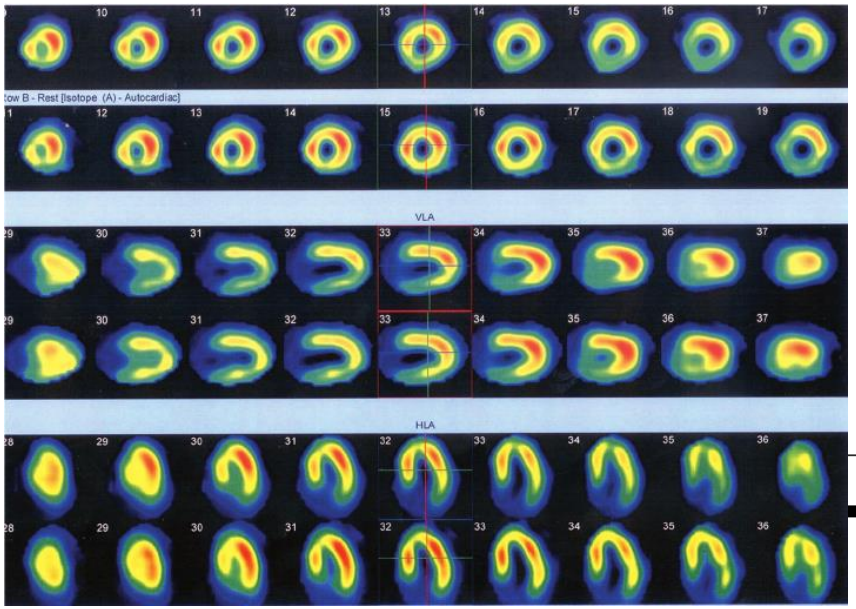


https://en.wikipedia.org/wiki/Iodine-131#/media/File:Pheochromocytoma_Scan.jpg

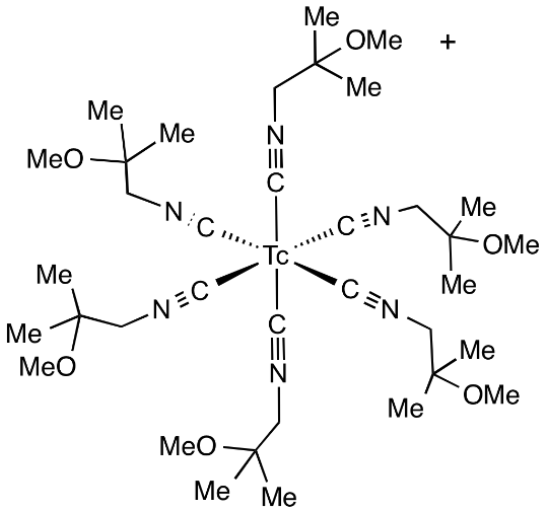


https://www.researchgate.net/figure/I-131-Decay-Scheme_fig1_295919808

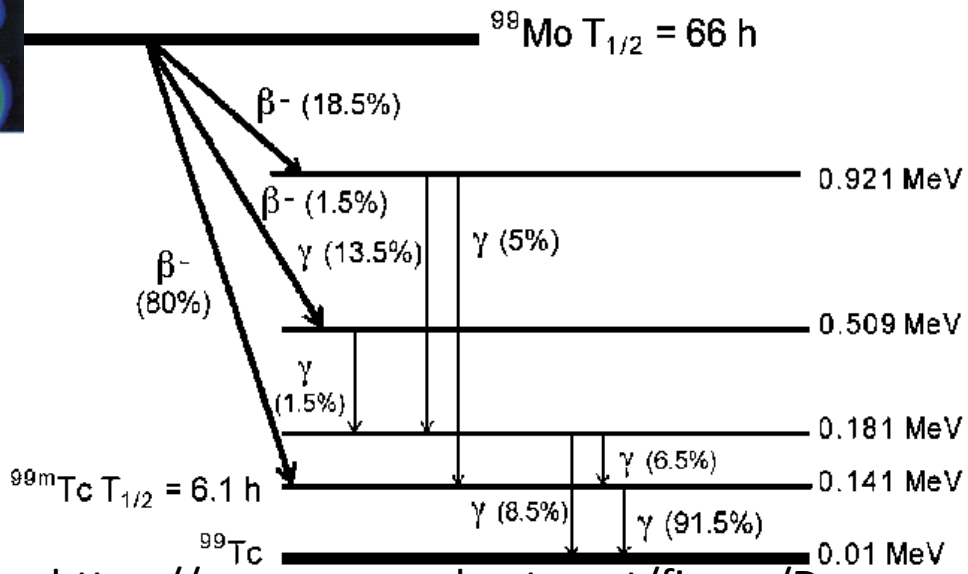
Cintilografia



https://www.researchgate.net/figure/The-exercise-99mTc-MIBI-myocardial-perfusion-SPECT-imaging-revealed-ischemia-in-the_fig1_235644306



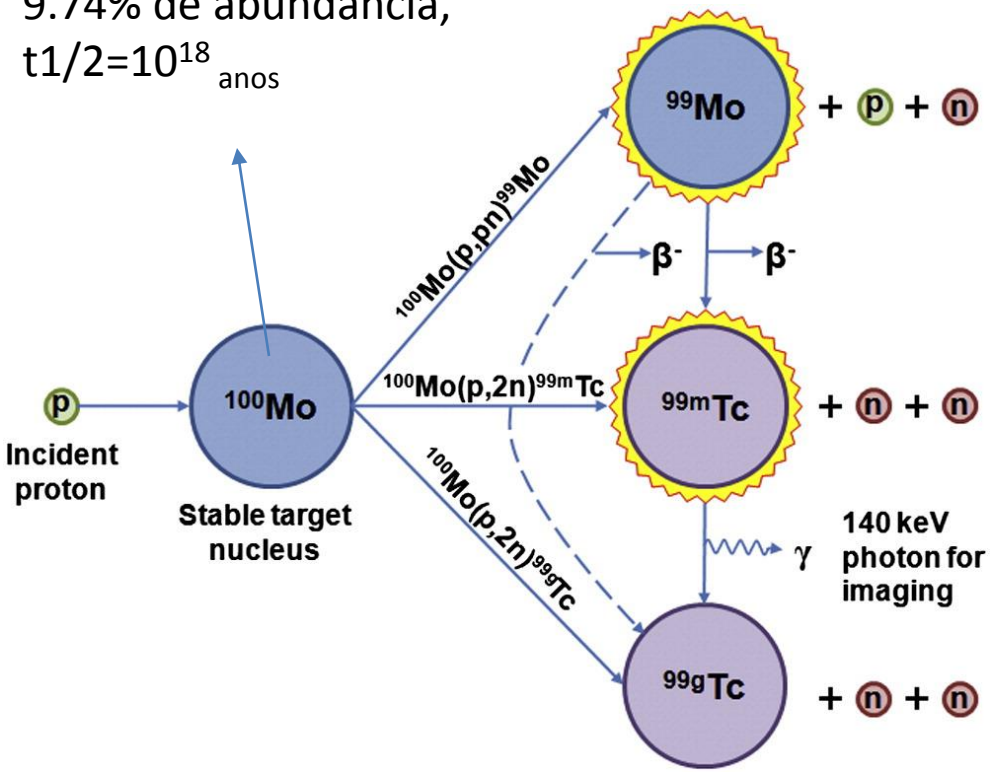
https://en.wikipedia.org/wiki/Technetium_(99mTc)_sestamibi#/media/File:Tc_CNCH2CMe2(OMe)_6Cation.png



https://www.researchgate.net/figure/Decay-scheme-of-99-Mo-and-99m-Tc-T-1-2-5-half-life_fig3_233958932

Radio fármacos - IPEN

9.74% de abundância,
$t1/2=10^{18}$ anos

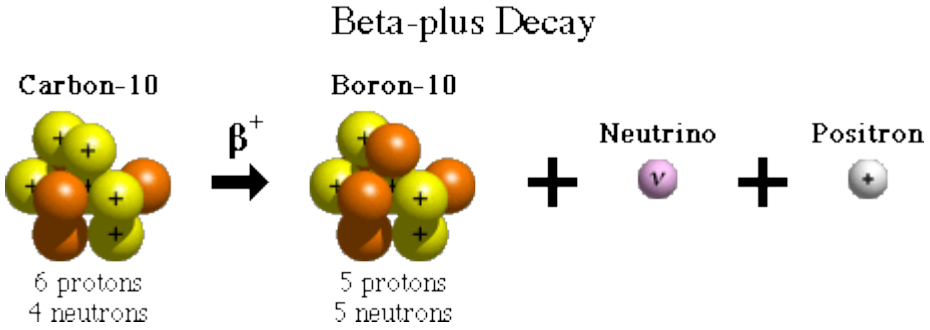


https://www.sciencedirect.com/science/article/pii/S0969805111000473#f0005

Emissão de partícula beta positiva

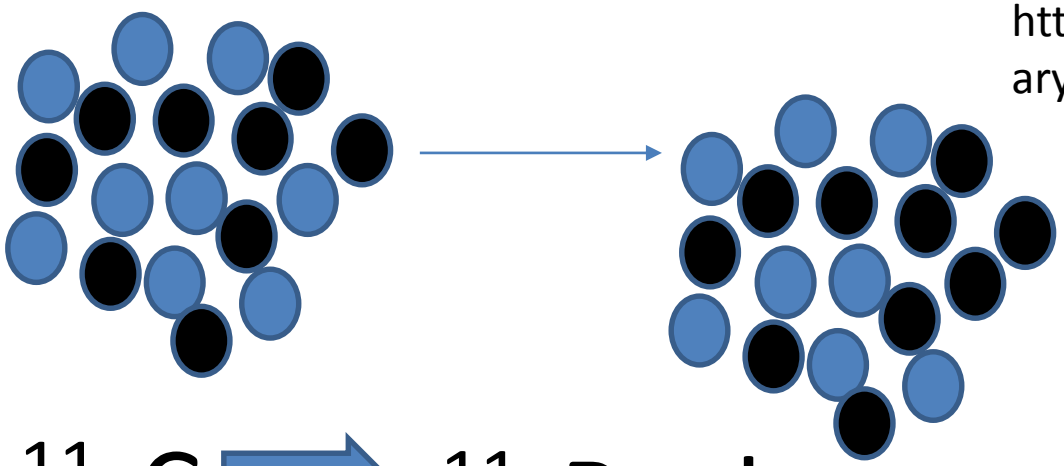
prótons

nêutrons



https://education.jlab.org/glossary/betadecay.html

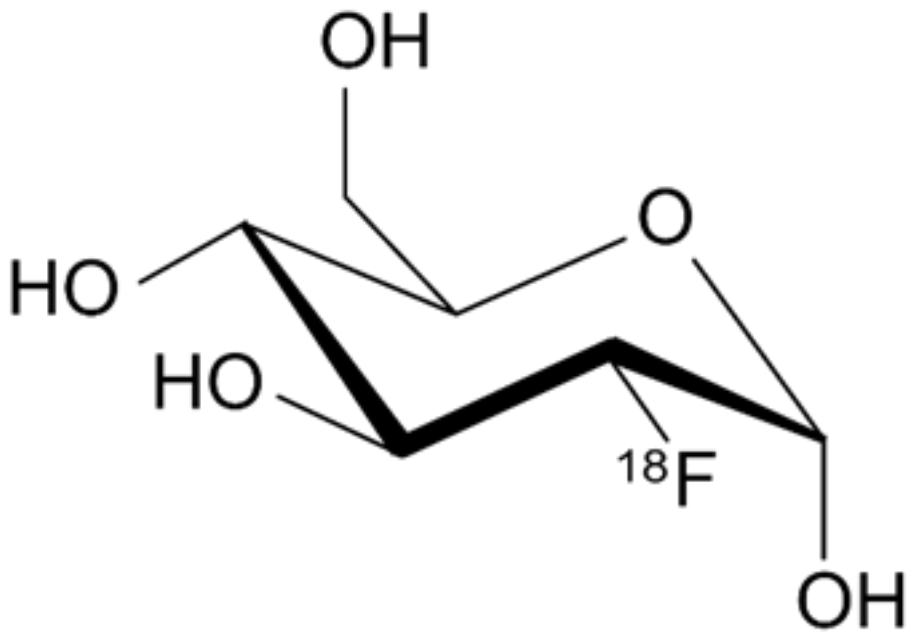
$^{18}_{9}F$



$^{18}_{8}O$ + beta positiva

$^{11}_{6}C \rightarrow {}^{11}_{5}B$ + beta positiva

Emissão de partícula beta positiva



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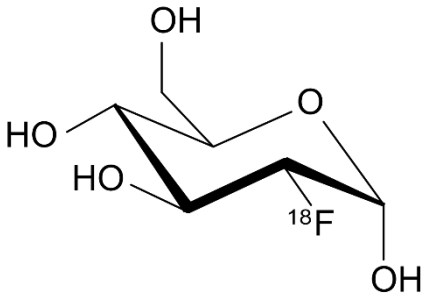
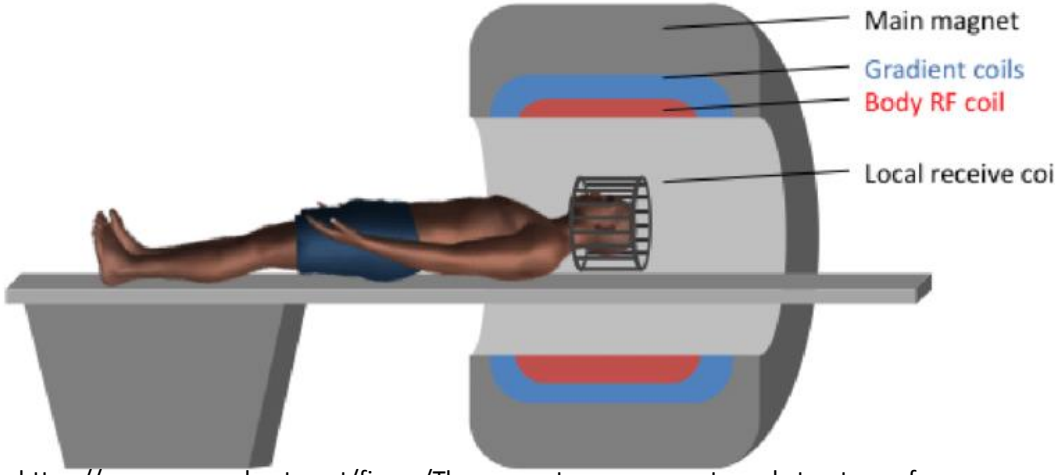
PET (pósitron emission tomography) Scan

^{18}F 109 minutos de tempo de meia vida



$Na^{18}F$



https://www.researchgate.net/figure/The-geometry-components-and-structure-of-a-standard-PET-scanner-top-and-of-a-standard_fig1_272075001

Vamos ver esse vıdeo

https://www.youtube.com/watch?v=GHLBcCv4rqk

Resumo

https://socratic.org/questions/what-is-radioactive-decay

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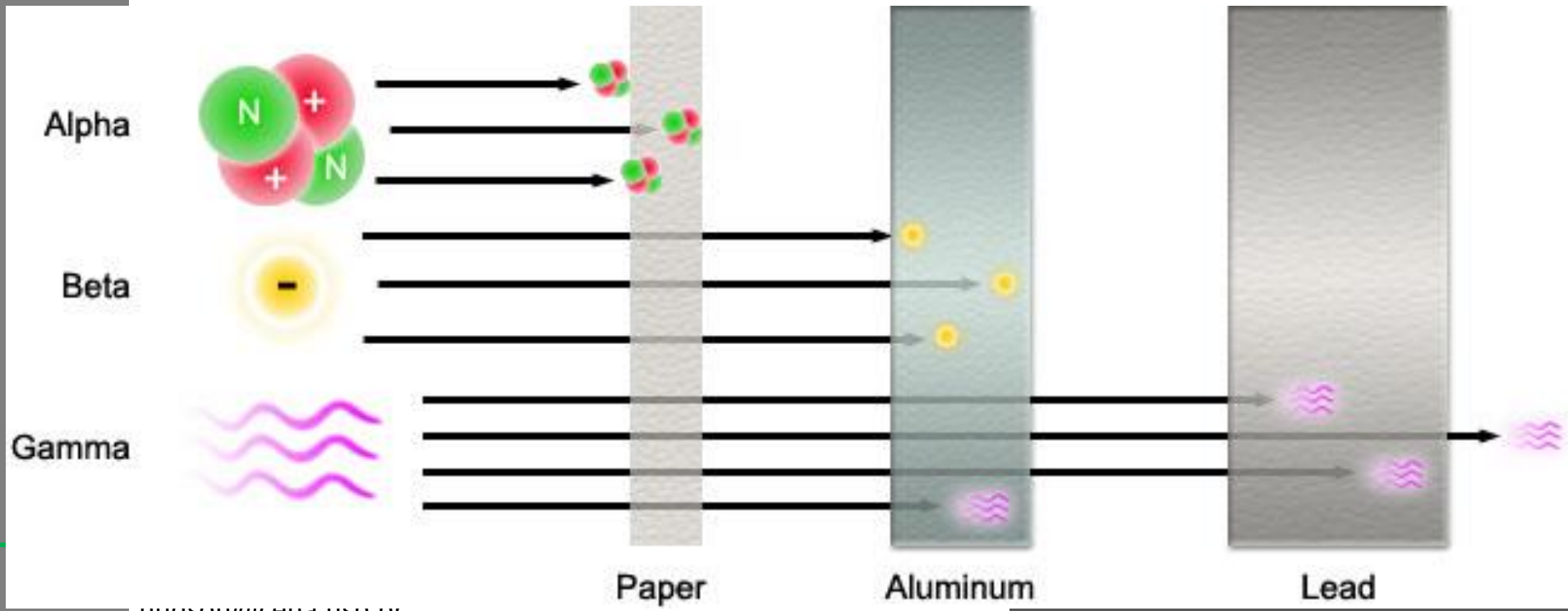
Poder de penetração das partículas

- Notas



De onde vem os radioisótopos?

- O planeta tem cerca de 4,6 bilhões de anos

Isótopos com tempo de meia vida da ordem de 10^9 anos

radioisótopos filhos dos radioisótopos naturais, exemplo $^{234}Th(t_{1/2}$ 24 dias)

radioisótopos que estão sendo sintetizados como ^{14}C

Famílias radioativas

^{232}Th, t1/2= 1,4 x 10^{10} anos

^{235}U, t1/2= 7 x10^8 anos

^{238}U t1/2= 10^9 anos

^{40}K t1/2= 1,2 x 10^9 anos

$$n + {}^{14}_{7}N \rightarrow {}^{14}_{6}C + p$$

- 252 nuclídeos estáveis + 87 radioativos de ocorrência natural
- Naturais + sintéticos (1 h > t1/2)= 905
- Naturais + sintéticos >3300

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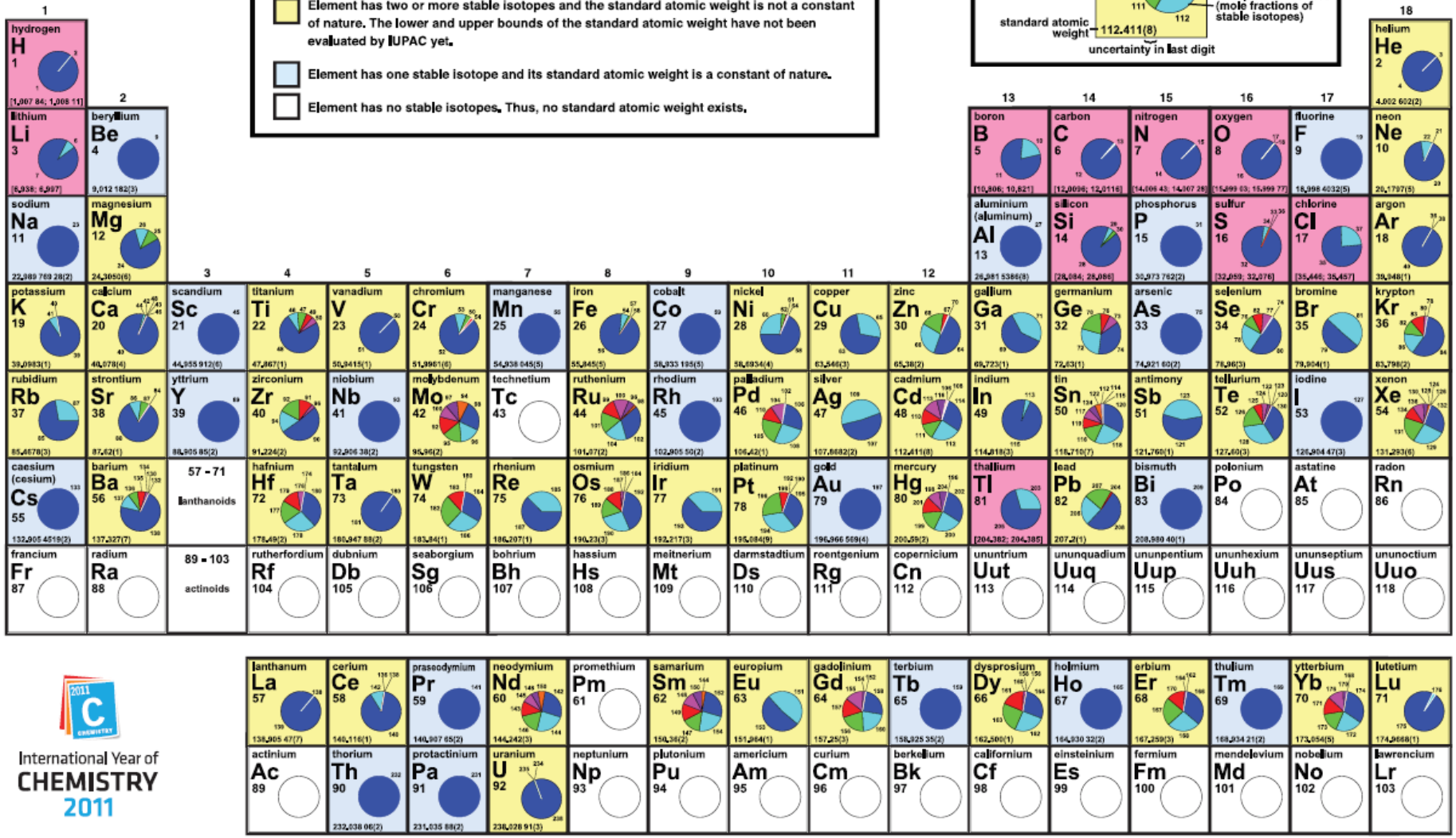
Element has two or more stable isotopes. Atomic weight and isotopic abundances of element vary in naturally occurring materials. The lower and upper bounds of atomic weight have been assessed by IUPAC and are presented as the standard atomic weight within square brackets, [ ].
Element has two or more stable isotopes and the standard atomic weight is not a constant of nature. The lower and upper bounds of the standard atomic weight have not been evaluated by IUPAC yet.
Element has one stable isotope and its standard atomic weight is a constant of nature.
Element has no stable isotopes. Thus, no standard atomic weight exists.
element name
element symbol
atomic number (number of protons)
standard atomic weight
cadmium
Cd
48
112.411(8)
uncertainty in last digit
stable isotope mass numbers (number of protons + neutrons)
isotopic abundances (mole fractions of stable isotopes)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
hydrogen H 1 [1,007 84; 1,008 11]
helium He 2 4,002 602(2)
lithium Li 3 [6,938; 6,997]
beryllium Be 4 9,012 182(3)
boron B 5 [10,806; 10,821]
carbon C 6 [12,0096; 12,0116]
nitrogen N 7 [14,006 43; 14,007 28]
oxygen O 8 [15,999 03; 15,999 77]
fluorine F 9 18,998 4032(5)
neon Ne 10 20,1797(6)
sodium Na 11 22,989 769 28(2)
magnesium Mg 12 24,3050(6)
aluminium (aluminum) Al 13 26,981 5386(8)
silicon Si 14 [28,084; 28,086]
phosphorus P 15 30,973 762(2)
sulfur S 16 [32,059; 32,076]
chlorine Cl 17 [35,446; 35,457]
argon Ar 18 39,948(1)
potassium K 19 39,0983(1)
calcium Ca 20 40,078(4)
scandium Sc 21 44,955 912(6)
titanium Ti 22 47,867(1)
vanadium V 23 50,9415(1)
chromium Cr 24 51,9961(6)
manganese Mn 25 54,938 045(5)
iron Fe 26 55,845(5)
cobalt Co 27 58,933 195(5)
nickel Ni 28 58,6934(4)
copper Cu 29 63,546(3)
zinc Zn 30 65,38(2)
gallium Ga 31 69,723(1)
germanium Ge 32 72,63(1)
arsenic As 33 74,921 60(2)
selenium Se 34 78,96(3)
bromine Br 35 79,904(1)
krypton Kr 36 83,798(2)
rubidium Rb 37 85,4678(3)
strontium Sr 38 87,62(1)
yttrium Y 39 88,905 85(2)
zirconium Zr 40 91,224(2)
niobium Nb 41 92,906 38(2)
molybdenum Mo 42 95,96(2)
technetium Tc 43
ruthenium Ru 44 101,07(2)
rhodium Rh 45 102,905 50(2)
palladium Pd 46 106,42(1)
silver Ag 47 107,8682(2)
cadmium Cd 48 112,411(8)
indium In 49 114,818(3)
tin Sn 50 118,710(7)
antimony Sb 51 121,760(1)
tellurium Te 52 127,60(3)
iodine I 53 126,904 47(3)
xenon Xe 54 131,293(6)
caesium (cesium) Cs 55 132,905 4519(2)
barium Ba 56 137,327(7)
57 - 71 lanthanoids
hafnium Hf 72 178,49(2)
tantalum Ta 73 180,947 88(2)
tungsten W 74 183,84(1)
rhenium Re 75 186,207(1)
osmium Os 76 190,23(3)
iridium Ir 77 192,217(3)
platinum Pt 78 195,084(9)
gold Au 79 196,966 569(4)
mercury Hg 80 200,59(2)
thallium Tl 81 [204,382; 204,385]
lead Pb 82 207,2(1)
bismuth Bi 83 208,980 40(1)
polonium Po 84
astatine At 85
radon Rn 86
francium Fr 87
radium Ra 88
89 - 103 actinoids
rutherfordium Rf 104
dubnium Db 105
seaborgium Sg 106
bohrium Bh 107
hassium Hs 108
meitnerium Mt 109
darmstadtium Ds 110
roentgenium Rg 111
copernicium Cn 112
ununtrium Uut 113
ununquadium Uuq 114
ununpentium Uup 115
ununhexium Uuh 116
ununseptium Uus 117
ununoctium Uuo 118
lanthanum La 57 138,905 47(7)
cerium Ce 58 140,116(1)
praseodymium Pr 59 140,907 65(2)
neodymium Nd 60 144,242(3)
promethium Pm 61
samarium Sm 62 150,36(2)
europium Eu 63 151,964(1)
gadolinium Gd 64 157,25(3)
terbium Tb 65 158,925 35(2)
dysprosium Dy 66 162,500(1)
holmium Ho 67 164,930 32(2)
erbium Er 68 167,259(3)
thulium Tm 69 168,934 21(2)
ytterbium Yb 70 173,054(5)
lutetium Lu 71 174,9668(1)
actinium Ac 89
thorium Th 90 232,038 06(2)
protactinium Pa 91 231,035 88(2)
uranium U 92 238,028 91(3)
neptunium Np 93
plutonium Pu 94
americium Am 95
curium Cm 96
berkelium Bk 97
californium Cf 98
einsteinium Es 99
fermium Fm 100
mendelevium Md 101
nobelium No 102
lawrencium Lr 103
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