# Prevendo o futuro: o método científico

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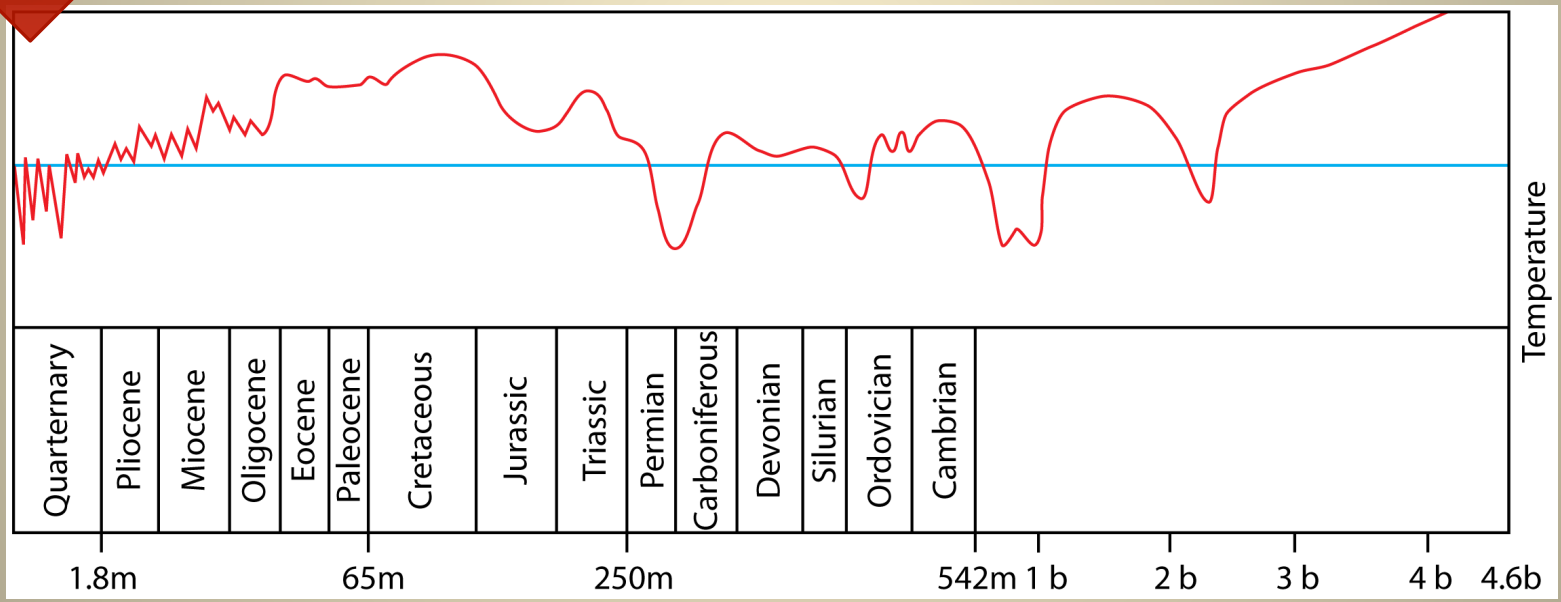
# Temperaturas na Terra

Humanos



# Glacial

# Bem Frio

# Fauna

# Homo Habilis

# Tecnologia

# Tecnologia

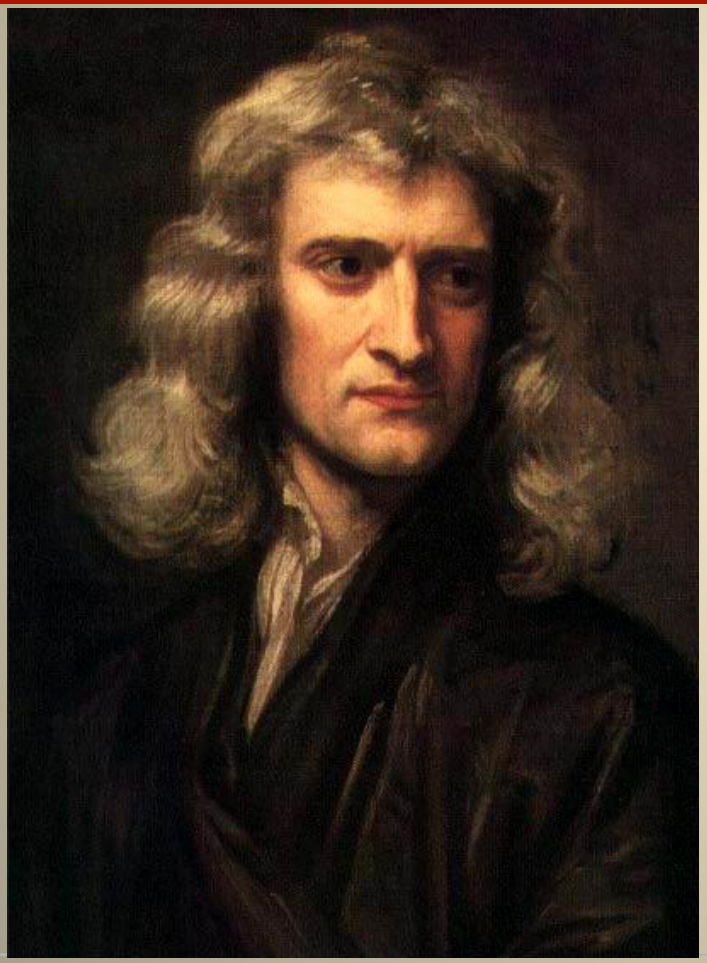
# Milhões de anos depois

# Astrônomos

Hiparco (190 AC)


Ptolomeo (100 AD)

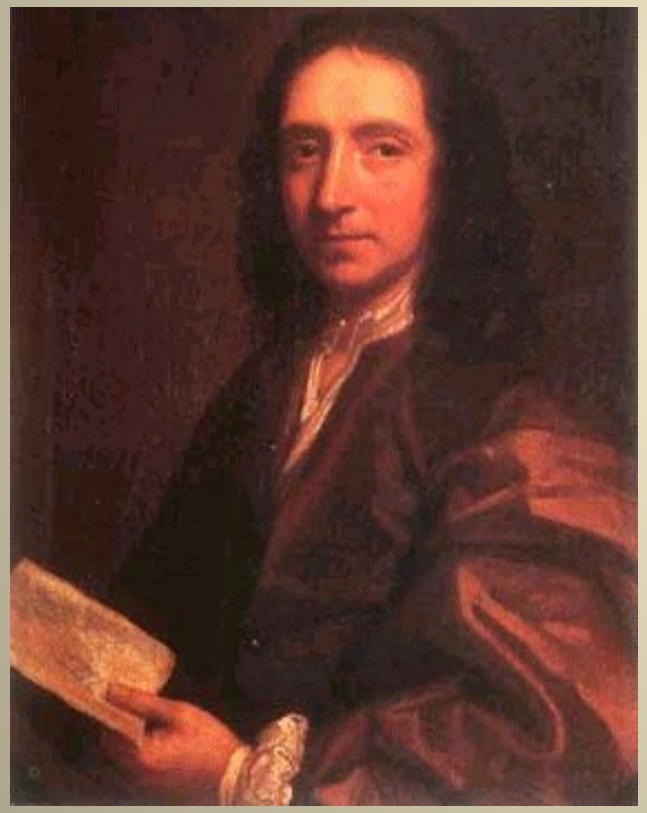
# Newton (1642-1727)



$$F_g = G\frac{Mm}{R^2}$$

Lei da Gravitação Universal

# Halley (1656-1742)



Usando as ideias de Newton estudou a órbita do cometa Halley e PREVIU que ele retornaria em 76 anos.

Da mesma forma foi o primeiro a PREVER com precisão um eclipse Solar.

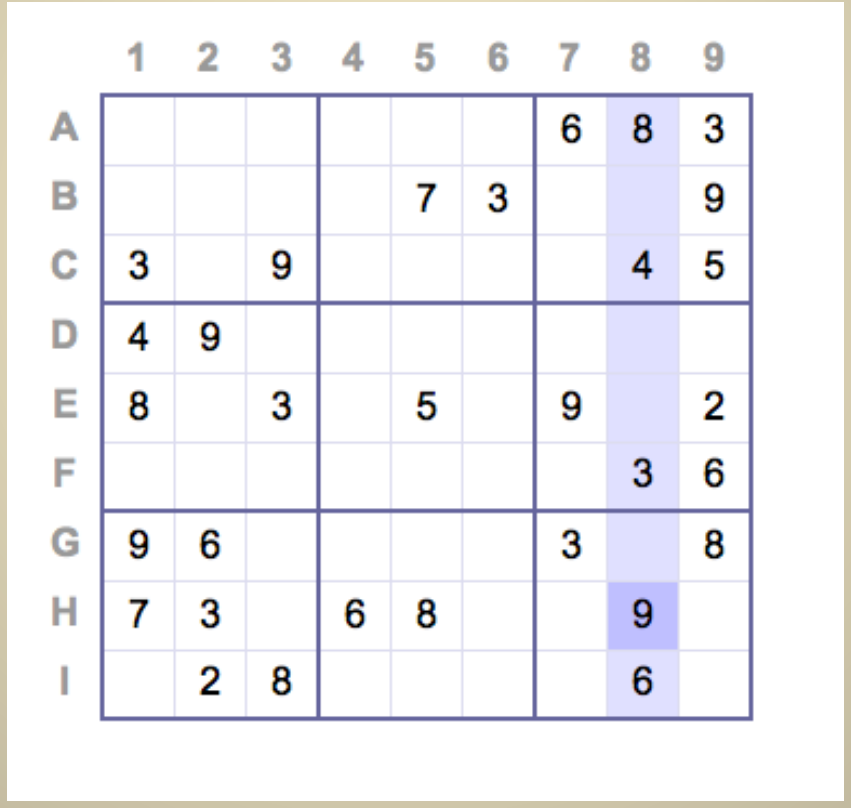
# SUDOKU

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| A | | | | | | | 6 | 8 | |
| B | | | | | 7 | 3 | | | 9 |
| C | 3 | | 9 | | | | | 4 | 5 |
| D | 4 | 9 | | | | | | | |
| E | 8 | | 3 | | 5 | | 9 | | 2 |
| F | | | | | | | | 3 | 6 |
| G | 9 | 6 | | | | | 3 | | 8 |
| H | 7 | | | 6 | 8 | | | | |
| I | | 2 | 8 | | | | | | |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| A | | | | | | | 6 | 8 | 3 |
| B | | | | | 7 | 3 | | | 9 |
| C | 3 | | 9 | | | | | 4 | 5 |
| D | 4 | 9 | | | | | | | |
| E | 8 | | 3 | | 5 | | 9 | | 2 |
| F | | | | | | | | 3 | 6 |
| G | 9 | 6 | | | | | 3 | | 8 |
| H | 7 | | | 6 | 8 | | | | |
| I | | 2 | 8 | | | | | | |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| A | | | | | | | 6 | 8 | 3 |
| B | | | | | 7 | 3 | | | 9 |
| C | 3 | | 9 | | | | | 4 | 5 |
| D | 4 | 9 | | | | | | | |
| E | 8 | | 3 | | 5 | | 9 | | 2 |
| F | | | | | | | | 3 | 6 |
| G | 9 | 6 | | | | | 3 | | 8 |
| H | 7 | | | 6 | 8 | | | | |
| I | | 2 | 8 | | | | | 6 | |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| A | | | | | | | 6 | 8 | 3 |
| B | | | | | 7 | 3 | | | 9 |
| C | 3 | | 9 | | | | | 4 | 5 |
| D | 4 | 9 | | | | | | | |
| E | 8 | | 3 | | 5 | | 9 | | 2 |
| F | | | | | | | | 3 | 6 |
| G | 9 | 6 | | | | | 3 | | 8 |
| H | 7 | 3 | | 6 | 8 | | | | |
| I | | 2 | 8 | | | | | 6 | |


1 2 3 4 5 6 7 8 9
A 6 8 3
B 7 3 9
C 3 9 4 5
D 4 9
E 8 3 5 9 2
F 3 6
G 9 6 3 8
H 7 3 6 8 9
I 2 8 6

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| A | | | | | | | 6 | 8 | 3 |
| B | | | | | 7 | 3 | | | 9 |
| C | 3 | | 9 | | | | 7 | 4 | 5 |
| D | 4 | 9 | | | | | | | |
| E | 8 | | 3 | | 5 | | 9 | | 2 |
| F | | | | | | | | 3 | 6 |
| G | 9 | 6 | | | | | 3 | | 8 |
| H | 7 | 3 | | 6 | 8 | | | 9 | |
| I | | 2 | 8 | | | | | 6 | |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| A | | | | | | | 6 | 8 | 3 |
| B | | | | | 7 | 3 | | | 9 |
| C | 3 | | 9 | | | | 7 | 4 | 5 |
| D | 4 | 9 | | | | | | | |
| E | 8 | | 3 | | 5 | 6 | 9 | | 2 |
| F | | | | | | | | 3 | 6 |
| G | 9 | 6 | | | | | 3 | | 8 |
| H | 7 | 3 | | 6 | 8 | | | 9 | |
| I | | 2 | 8 | | | | | 6 | |

# Método Científico

- OBSERVAÇÃO
- LEIS GERAIS QUE PRODUZEM PREDIÇÕES
- REPETIBILIDADE DOS RESULTADOS EXPERIMENTAIS
- FALSEABILIDADE

# Tabela Periódica de Mendeleev

Listou os elementos de uma linha ou coluna em ordem de peso atômico e iniciou uma nova linha ou coluna quando as características dos elementos começavam a se repetir.
O sucesso da tabela de Mendeleiev surgiu a partir de duas decisões que ele tomou: a primeira foi a de deixar lacunas na tabela quando parecia que o elemento correspondente ainda não tinha sido descoberto. Usando as tendências em sua tabela predisse as propriedades dos elementos em falta, como Gálio e Germanio.

**Mendeleev's Periodic Table of 1869**[1]

| | | | | | |
|---|---|---|---|---|---|
| | | | Ti 50 | Zr 90 | ? 100 |
| | | | V 51 | Nb 94 | Ta 182 |
| | | | Cr 52 | Mo 96 | W 186 |
| | | | Mn 55 | Rh 104.4 | Pt 197.4 |
| | | | Fe 56 | Ru 104.4 | Ir 198 |
| | | | Ni, Co 59 | Pd 106.6 | Os 199 |
| H 1 | | | Cu 63.4 | Ag 108 | Hg 200 |
| | Be 9.4 | Mg 24 | Zn 65.2 | Cd 112 | |
| | B 11 | Al 27.4 | ? 68 | U 116 | Au 197? |
| | C 12 | Si 28 | ? 70 | Sn 118 | |
| | N 14 | P 31 | As 75 | Sb 122 | Bi 210? |
| | O 16 | S 32 | Se 79.4 | Te 128? | |
| | F 19 | Cl 35.5 | Br 80 | I 127 | |
| Li 7 | Na 23 | K 39 | Rb 85.4 | Cs 133 | Tl 204 |
| | | Ca 40 | Sr 87.6 | Ba 137 | Pb 207 |
| | | ? 45 | Ce 92 | | |
| | | Er? 56 | La 94 | | |
| | | Yt? 60 | Di 95 | | |
| | | In 75.6? | Th 118? | | |

# Tabela Periódica

| 1 IA | | | | | | | | | | | | 13 IIIA | 14 IVA | 15 VA | 16 VIA | 17 VIIA | 18 VIIIA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 **H** 1.01 | 2 IIA | | | | | | | | | | | | | | | | 2 **He** 4.00 |
| 3 **Li** 6.94 | 4 **Be** 9.01 | | | | | | | | | | | 5 **B** 10.81 | 6 **C** 12.01 | 7 **N** 14.01 | 8 **O** 16.00 | 9 **F** 19.00 | 10 **Ne** 20.18 |
| 11 **Na** 22.99 | 12 **Mg** 24.31 | 3 IIIB | 4 IVB | 5 VB | 6 VIB | 7 VIIB | 8 | 9 VIIIB | 10 | 11 IB | 12 IIB | 13 **Al** 26.98 | 14 **Si** 28.09 | 15 **P** 30.97 | 16 **S** 32.07 | 17 **Cl** 35.45 | 18 **Ar** 39.95 |
| 19 **K** 39.1 | 20 **Ca** 40.08 | 21 **Sc** 44.96 | 22 **Ti** 47.88 | 23 **V** 50.94 | 24 **Cr** 52.00 | 25 **Mn** 54.94 | 26 **Fe** 55.85 | 27 **Co** 58.93 | 28 **Ni** 58.69 | 29 **Cu** 63.55 | 30 **Zn** 65.39 | 31 **Ga** 69.72 | 32 **Ge** 72.61 | 33 **As** 74.92 | 34 **Se** 78.96 | 35 **Br** 79.90 | 36 **Kr** 83.80 |
| 37 **Rb** 85.47 | 38 **Sr** 87.62 | 39 **Y** 88.91 | 40 **Zr** 91.22 | 41 **Nb** 92.91 | 42 **Mo** 95.94 | 43 **Tc** (98) | 44 **Ru** 101.07 | 45 **Rh** 102.91 | 46 **Pd** 106.42 | 47 **Ag** 107.87 | 48 **Cd** 112.41 | 49 **In** 114.82 | 50 **Sn** 118.71 | 51 **Sb** 121.76 | 52 **Te** 127.6 | 53 **I** 126.9 | 54 **Xe** 131.29 |
| 55 **Cs** 132.9 | 56 **Ba** 137.3 | 57 **La*** 138.9 | 72 **Hf** 178.5 | 73 **Ta** 180.9 | 74 **W** 183.9 | 75 **Re** 186.2 | 76 **Os** 190.2 | 77 **Ir** 192.2 | 78 **Pt** 195.1 | 79 **Au** 197.0 | 80 **Hg** 200.6 | 81 **Tl** 204.4 | 82 **Pb** 207.2 | 83 **Bi** 209 | 84 **Po** (209) | 85 **At** (210) | 86 **Rn** (222) |
| 87 **Fr** (223) | 88 **Ra** (226) | 89 **Ac^** (227) | 104 **Rf** (261) | 105 **Db** (262) | 106 **Sg** (263) | 107 **Bh** (264) | 108 **Hs** (265) | 109 **Mt** (268) | 110 **Ds** (271) | 111 **Rg** (272) | | | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * | 58 **Ce** 140.1 | 59 **Pr** 140.9 | 60 **Nd** 144.2 | 61 **Pm** (145) | 62 **Sm** 150.4 | 63 **Eu** 152.0 | 64 **Gd** 157.3 | 65 **Tb** 158.9 | 66 **Dy** 162.5 | 67 **Ho** 164.9 | 68 **Er** 167.3 | 69 **Tm** 168.9 | 70 **Yb** 173.0 | 71 **Lu** 175.0 |
| ^ | 90 **Th** 232.0 | 91 **Pa** (231) | 92 **U** 238.0 | 93 **Np** (237) | 94 **Pu** (244) | 95 **Am** (243) | 96 **Cm** (247) | 97 **Bk** (247) | 98 **Cf** (251) | 99 **Es** (252) | 100 **Fm** (257) | 101 **Md** (258) | 102 **No** (259) | 103 **Lr** (260) |

# Nova Tecnologia

Em 1879 Edison inventou a Lampâda Elétrica e em 1880 fundou uma companhia de energia elétrica.

# No Brasil

- O uso da energia elétrica no Brasil se iniciou com a instalação da Usina Hidrelétrica Ribeirão do Inferno, em **1883**, destinada ao fornecimento de eletricidade para a mineração em Diamantina, Minas Gerais; outro marco foi a Usina Hidrelétrica da Companhia Fiação e Tecidos São Silvestre, de **1885**, no município de Viçosa e a Usina Hidrelétrica Ribeirão dos Macacos, em **1887**, ambas em Minas Gerais; a Usina Termelétrica Velha Porto Alegre, no mesmo ano, no Rio Grande do Sul; e a Usina Hidrelétrica Marmelos, construída em **1889**, na cidade de Juiz de Fora, Minas Gerais.

- Em **1899**, foi permitido no país o funcionament da companhia São Paulo Railway, Light and Power Company Ltd. - uma empresa canadense que deu origem ao Grupo Light no Brasil.

# Novas Revoluções Científicas

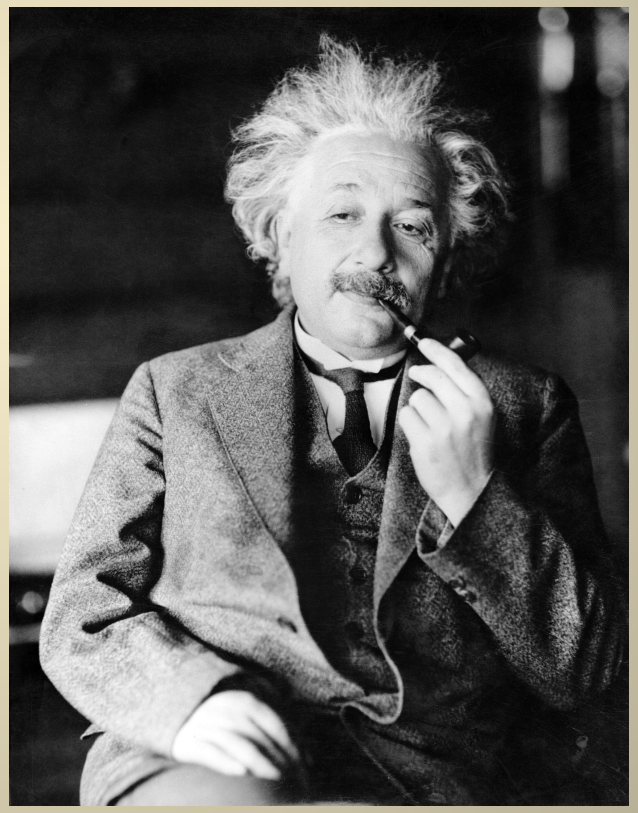
$E=mc^2$

Moeda de 1 centavo de Real

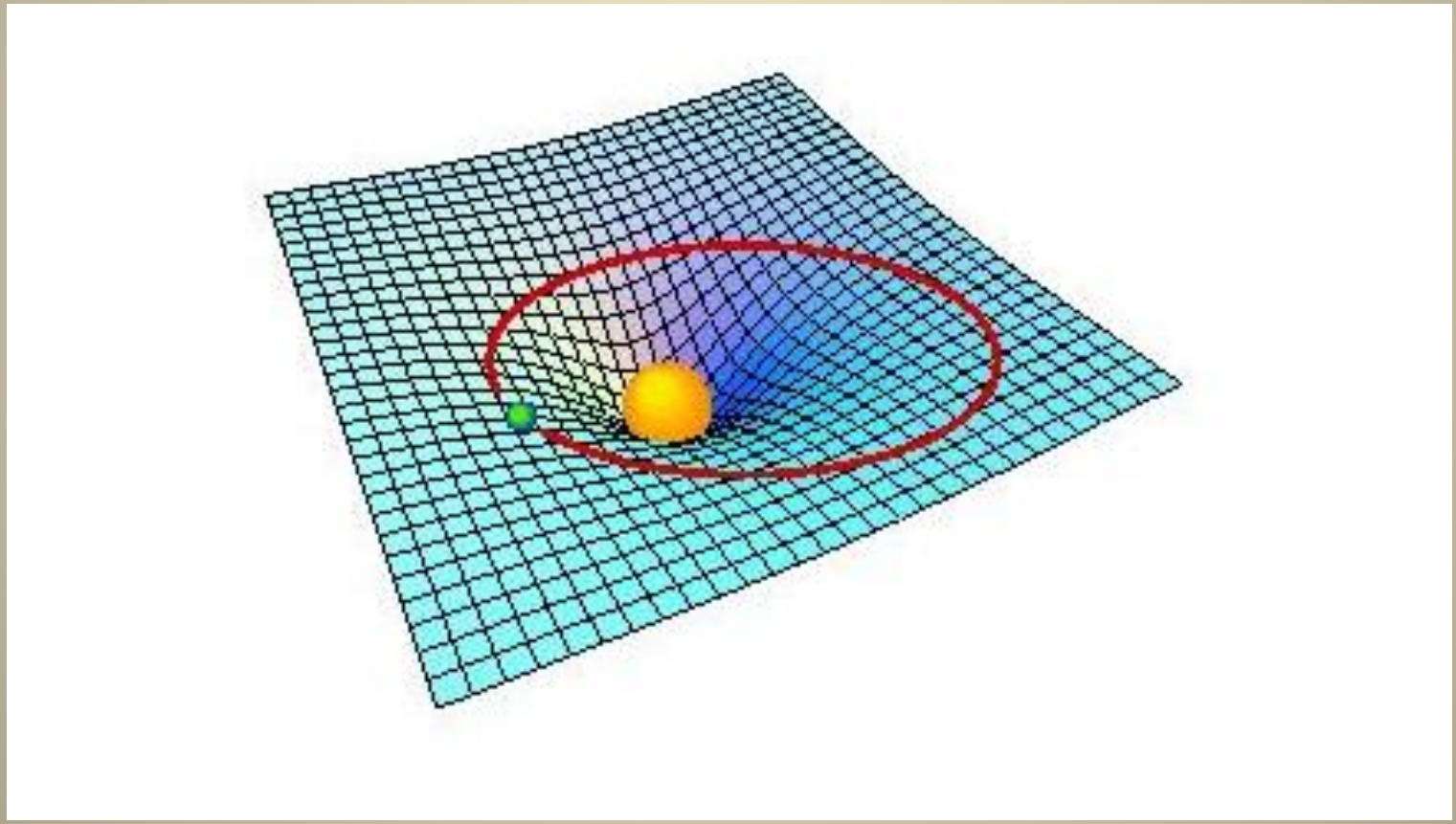
*E = (2,96 g) × (299.792.458 m/s)²*

*= 266.031.532.906.098 Joules*

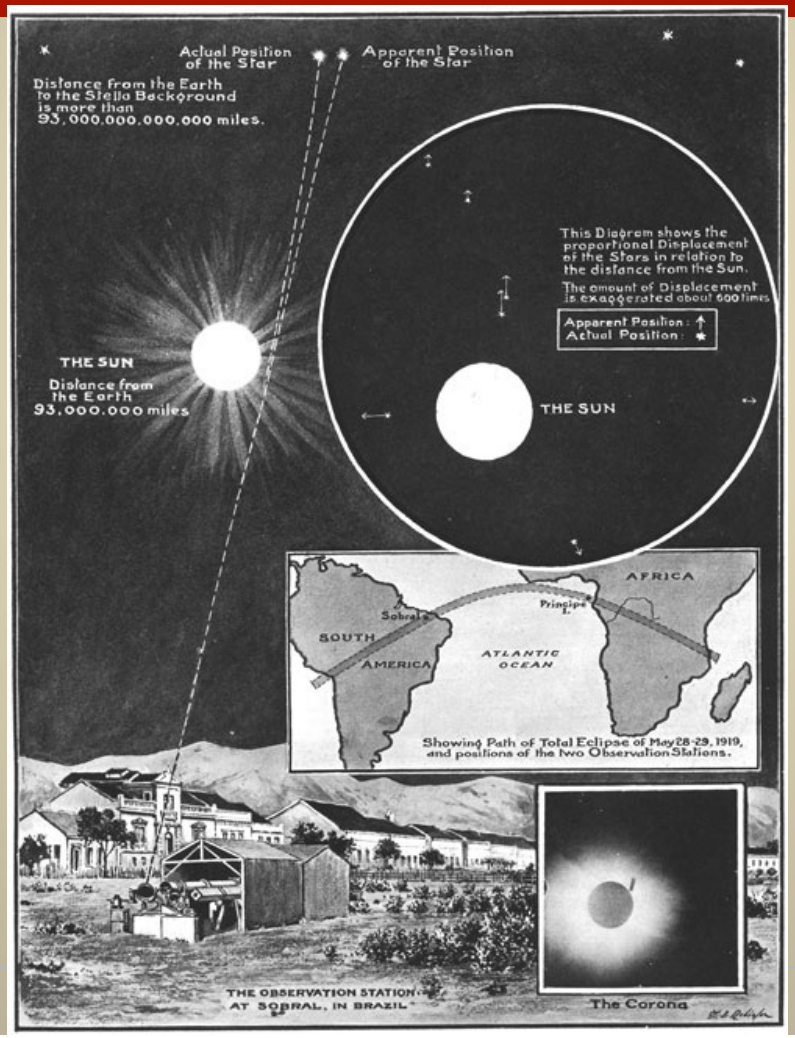
*=63.540.540.008,144 Kg de TNT*



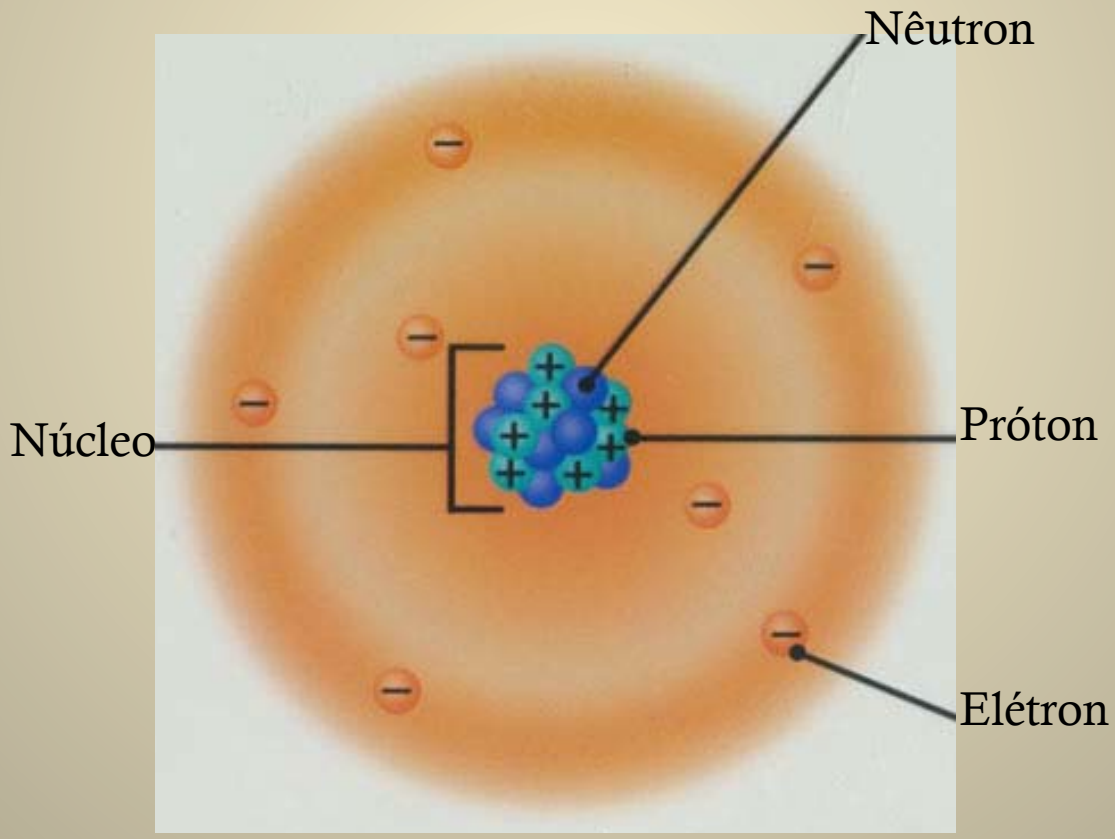
# Teoria Geral da Gravitação



# Sobral – Ceará (1919)



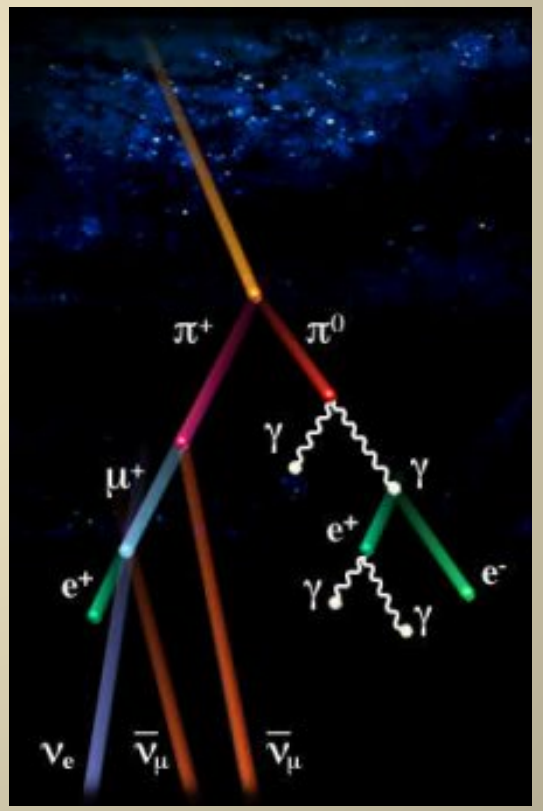
# Átomo



# Raios Cósmicos

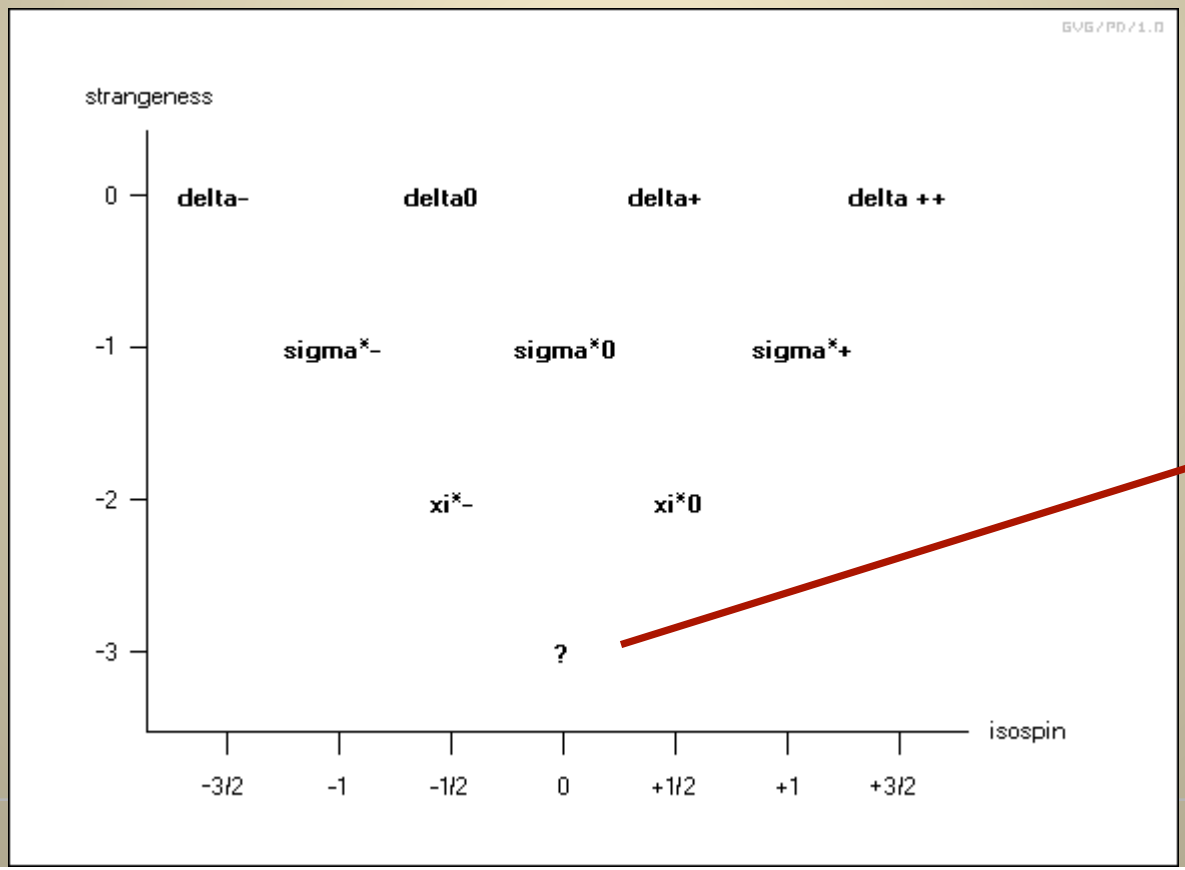
A partir dos anos 30 (século passado).

Investigando raios cósmicos muitas outras partículas foram encontradas. Esse grande número de partículas descobertas, também em aceleradores, levou cientistas a pensar em como as organizar e que elas poderiam ser compostas por partículas ainda menores.



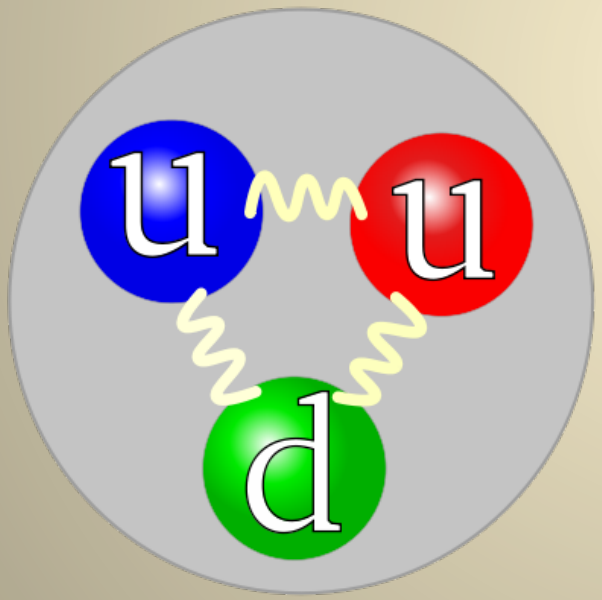
# O Caminho Óctuplo

Gell-Mann e Ne'eman 1960

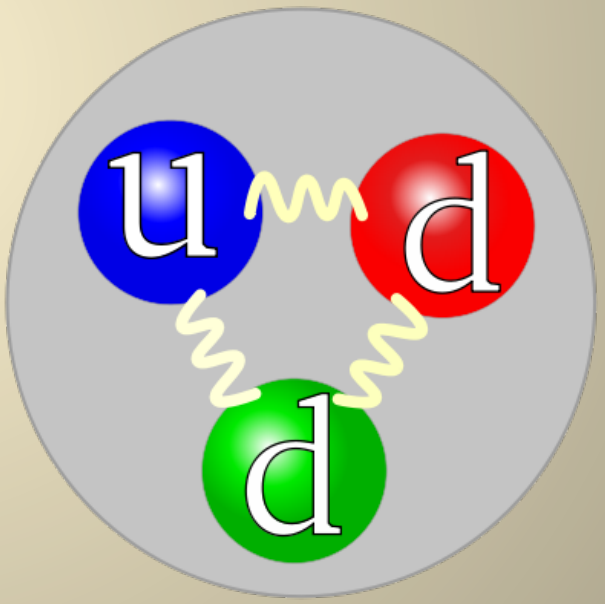


# Estrutura dos Núcleons: Quarks

Próton




Nêutron



# Modelo Padrão

Standard Model of

## FUNDAMENTAL PARTICLES AND INTERACTIONS

The Standard Model summarizes the current knowledge in Particle Physics. It is the quantum theory that includes the theory of strong interactions (quantum chromodynamics or QCD) and the unified theory of weak and electromagnetic interactions (electroweak). Gravity is included on this chart because it is one of the fundamental interactions even though not part of the "Standard Model."

## FERMIONS

matter constituents
spin = 1/2, 3/2, 5/2, ...

**Leptons** spin = 1/2

| Flavor | Mass GeV/c² | Electric charge |
|---|---|---|
| $\nu_e$ electron neutrino | <1×10⁻⁸ | 0 |
| e electron | 0.000511 | –1 |
| $\nu_\mu$ muon neutrino | <0.0002 | 0 |
| $\mu$ muon | 0.106 | –1 |
| $\nu_\tau$ tau neutrino | <0.02 | 0 |
| $\tau$ tau | 1.7771 | –1 |

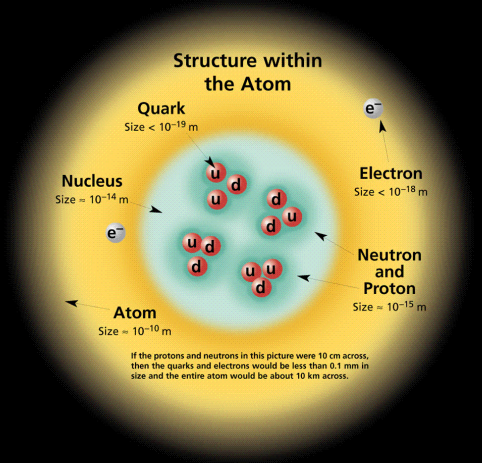
**Quarks** spin = 1/2

| Flavor | Approx. Mass GeV/c² | Electric charge |
|---|---|---|
| u up | 0.003 | 2/3 |
| d down | 0.006 | –1/3 |
| c charm | 1.3 | 2/3 |
| s strange | 0.1 | –1/3 |
| t top | 175 | 2/3 |
| b bottom | 4.3 | –1/3 |

**Spin** is the intrinsic angular momentum of particles. Spin is given in units of ħ, which is the quantum unit of angular momentum, where $\hbar = h/2\pi = 6.58\times10^{-25}$ GeV s = $1.05\times10^{-34}$ J s.

**Electric charges** are given in units of the proton's charge. In SI units the electric charge of the proton is $1.60\times10^{-19}$ coulombs.

The **energy** unit of particle physics is the electronvolt (eV), the energy gained by one electron in crossing a potential difference of one volt. **Masses** are given in GeV/c² (remember $E = mc^2$), where 1 GeV = $10^9$ eV = $1.60\times10^{-10}$ joule. The mass of the proton is 0.938 GeV/c² = $1.67\times10^{-27}$ kg.




## BOSONS

force carriers
spin = 0, 1, 2, ...

**Unified Electroweak** spin = 1

| Name | Mass GeV/c² | Electric charge |
|---|---|---|
| $\gamma$ photon | 0 | 0 |
| $W^-$ | 80.4 | –1 |
| $W^+$ | 80.4 | +1 |
| $Z^0$ | 91.187 | 0 |

**Strong (color)** spin = 1

| Name | Mass GeV/c² | Electric charge |
|---|---|---|
| g gluon | 0 | 0 |

**Color Charge**
Each quark carries one of three types of "strong charge," also called "color charge." These charges have nothing to do with the colors of visible light. There are eight possible types of color charge for gluons. Just as electrically-charged particles interact by exchanging photons, in strong interactions color-charged particles interact by exchanging gluons. Leptons, photons, and ***W*** and ***Z*** bosons have no strong interactions and hence no color charge.

**Quarks Confined in Mesons and Baryons**
One cannot isolate quarks and gluons; they are confined in color-neutral particles called **hadrons**. This confinement (binding) results from multiple exchanges of gluons among the color-charged constituents. As color-charged particles (quarks and gluons) move apart, the energy in the color-force field between them increases. This energy eventually is converted into additional quark-antiquark pairs (see figure below). The quarks and antiquarks then combine into hadrons; these are the particles seen to emerge. Two types of hadrons have been observed in nature: **mesons** $q\bar{q}$ and **baryons** $qqq$.

**Residual Strong Interaction**
The strong binding of color-neutral protons and neutrons to form nuclei is due to residual strong interactions between their color-charged constituents. It is similar to the residual electrical interaction that binds electrically neutral atoms to form molecules. It can also be viewed as the exchange of mesons between the hadrons.

## PROPERTIES OF THE INTERACTIONS

| Property \ Interaction | Gravitational | Weak (Electroweak) | Electromagnetic (Electroweak) | Strong: Fundamental | Strong: Residual |
|---|---|---|---|---|---|
| Acts on: | Mass – Energy | Flavor | Electric Charge | Color Charge | See Residual Strong Interaction Note |
| Particles experiencing: | All | Quarks, Leptons | Electrically charged | Quarks, Gluons | Hadrons |
| Particles mediating: | Graviton (not yet observed) | $W^+$ $W^-$ $Z^0$ | $\gamma$ | Gluons | Mesons |
| Strength relative to electromag for two u quarks at: $10^{-18}$ m | $10^{-41}$ | 0.8 | 1 | 25 | Not applicable to quarks |
| Strength relative to electromag for two u quarks at: $3\times10^{-17}$ m | $10^{-41}$ | $10^{-4}$ | 1 | 60 Not applicable to hadrons | |
| for two protons in nucleus | $10^{-36}$ | $10^{-7}$ | 1 | | 20 |

**Baryons qqq and Antibaryons $\bar{q}\bar{q}\bar{q}$**
Baryons are fermionic hadrons.
There are about 120 types of baryons.

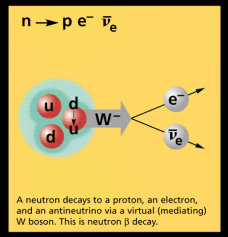
| Symbol | Name | Quark content | Electric charge | Mass GeV/c² | Spin |
|---|---|---|---|---|---|
| p | proton | uud | 1 | 0.938 | 1/2 |
| $\bar{p}$ | anti-proton | $\bar{u}\bar{u}\bar{d}$ | –1 | 0.938 | 1/2 |
| n | neutron | udd | 0 | 0.940 | 1/2 |
| $\Lambda$ | lambda | uds | 0 | 1.116 | 1/2 |
| $\Omega^-$ | omega | sss | –1 | 1.672 | 3/2 |

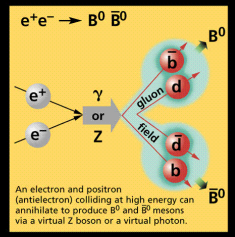
**Mesons $q\bar{q}$**
Mesons are bosonic hadrons.
There are about 140 types of mesons.

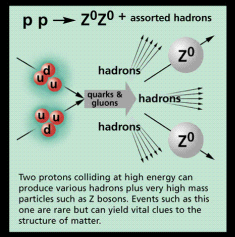
| Symbol | Name | Quark content | Electric charge | Mass GeV/c² | Spin |
|---|---|---|---|---|---|
| $\pi^+$ | pion | $u\bar{d}$ | +1 | 0.140 | 0 |
| $K^-$ | kaon | $s\bar{u}$ | –1 | 0.494 | 0 |
| $\rho^+$ | rho | $u\bar{d}$ | +1 | 0.770 | 1 |
| $B^0$ | B-zero | $d\bar{b}$ | 0 | 5.279 | 0 |
| $\eta_c$ | eta-c | $c\bar{c}$ | 0 | 2.980 | 0 |

**Matter and Antimatter**
For every particle type there is a corresponding antiparticle type, denoted by a bar over the particle symbol (unless + or – charge is shown). Particle and antiparticle have identical mass and spin but opposite charges. Some electrically neutral bosons (e.g., $Z^0$, $\gamma$, and $\eta_c = c\bar{c}$, but not $K^0 = d\bar{s}$) are their own antiparticles.

**Figures**
These diagrams are an artist's conception of physical processes. They are ***not*** exact and have ***no*** meaningful scale. Green shaded areas represent the cloud of gluons or the gluon field, and red lines the quark paths.




**The Particle Adventure**
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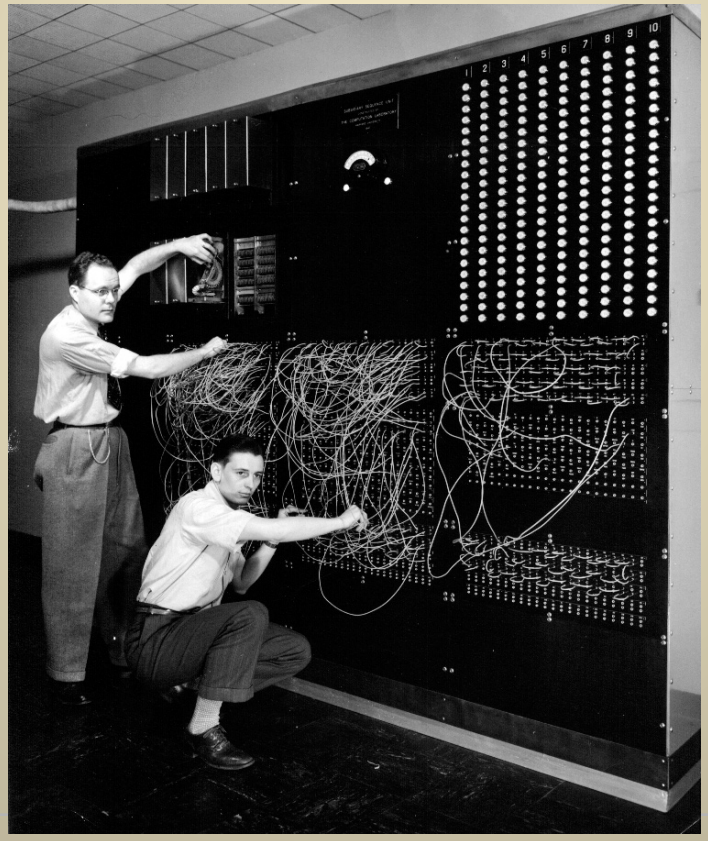
# Novas Tecnologias

Um dos primeiros computadores (1944)




MacBook Pro

# Internet


Página inicial do Mozilla Firefox
http://www.google.com.br/firefox?client=firefox-a&rls=org.mozilla:en-US:official
Google Powered Se
Most Visited
Getting Started
Latest Headlines
Apple
Gmail
Google Maps
News
Popular
Wikipedia
Yahoo!
YouTube
Página inicial do Mozilla Firefox
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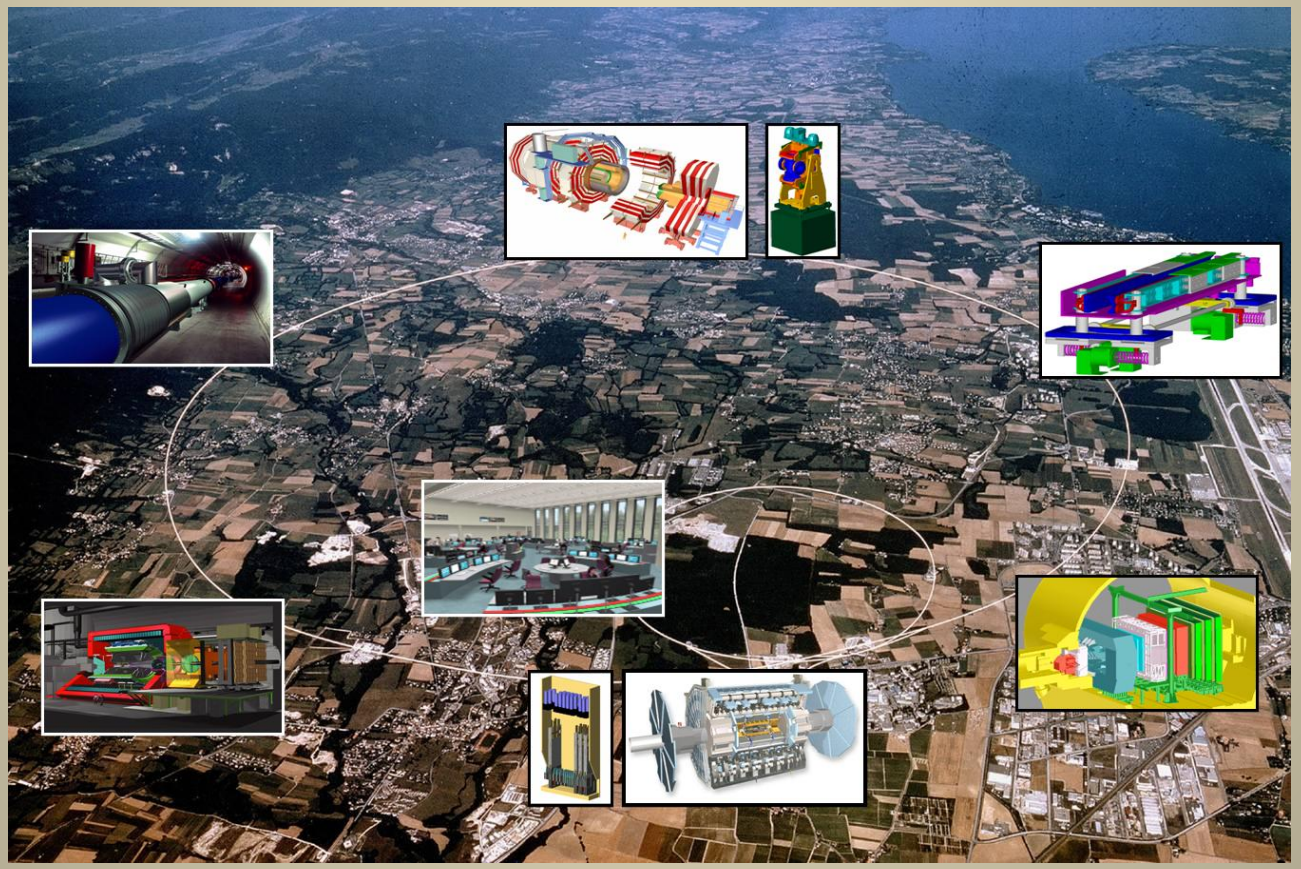
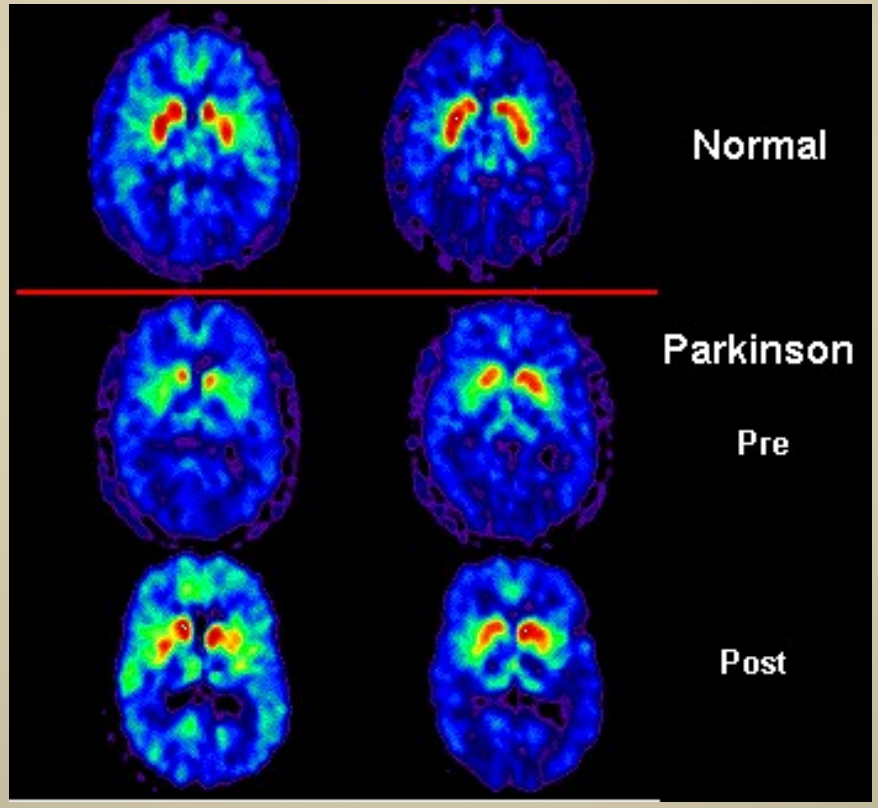
Torne pessoal. Existem milhares de maneiras totalmente gratuitas de personalizar o seu Firefox para que ele se ajuste à sua forma de navegar.
Sobre a Mozilla

# CERN onde nasceu a WWW



# PET Scan

## Tomografia por emissão de Pósitrons



# Pet Scan

- Detectar tumores cancerígenos.
- Determinar se o câncer se espalhou pelo corpo e quanto (metástases).
- Avaliar a eficácia de um determinado tratamento, por exemplo, a terapia contra câncer que um paciente recebe.
- Determinar se o câncer retorna após o tratamento.
- Determinar o fluxo do sangue que chega ao músculo cardíaco.
- Determinar a lesão no coração que provocou um infarto cardíaco.

# Ultrassonografia

# Previsão

O Futuro pertence a vocês!