



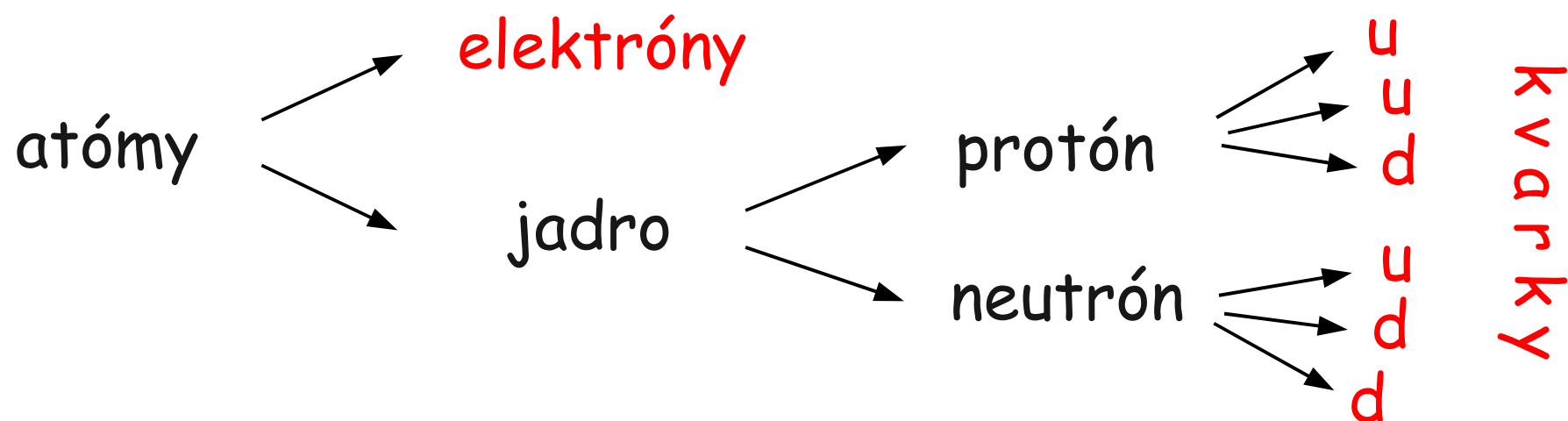
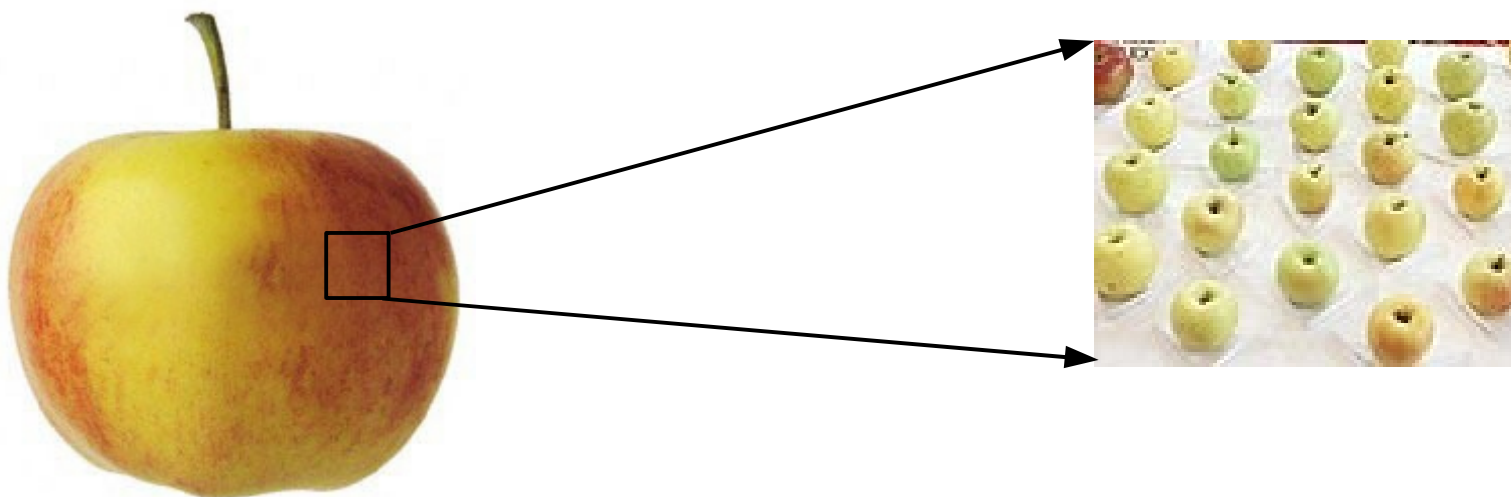
Podivný mikrosvet

Mikuláš Gintner

Katedra fyziky
Žilinská univerzita

2011





neutrino elektronové	elektron	u kvark	d kvark
$< 10^{-6}$	1	3 - 6.6	7 - 12

neutrino mionové	mion	c kvark	s kvark
< 0.1	210	2400	200

neutrino tauonové	tauon	t kvark	b kvark
< 20	3500	344000	8400

elektrón	1
protón	1880
t kvark	344000
jadro Au	370000
jablko	1×10^{29}

1.gen.

ν_e
e
u
d

2.gen.

ν_μ
μ
c
s

3.gen.

ν_τ
τ
t
b

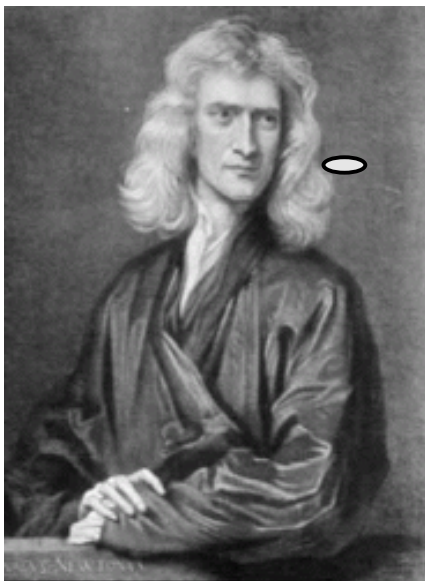
elekt. náboj

0
-1
$+2/3$
$-1/3$



hmotnost'

... + antičástice: rovnaká hmotnost', opačný náboj



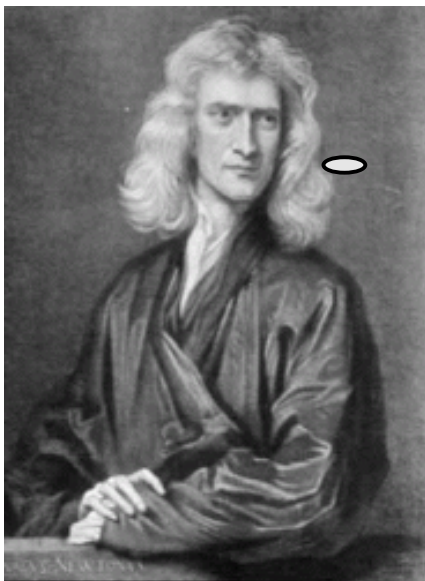
gravitačná

elmag

silná

slabá





gravitačná

elmag

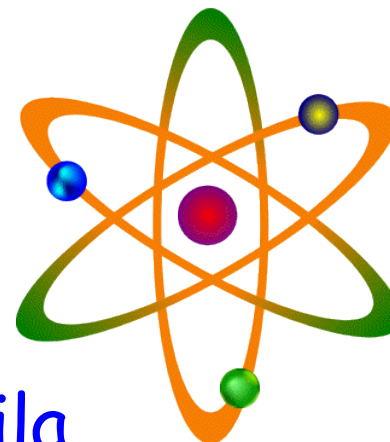
silná

slabá



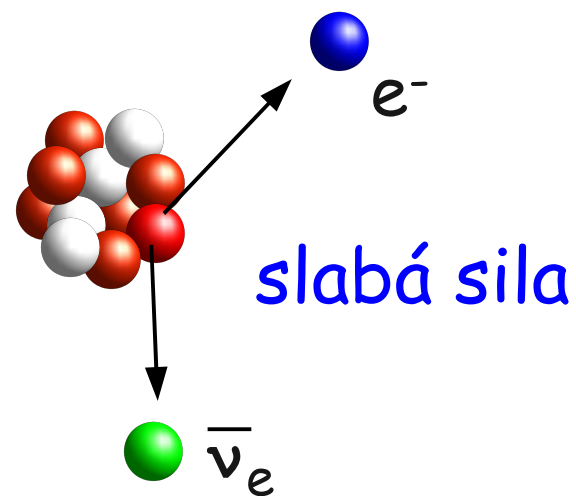
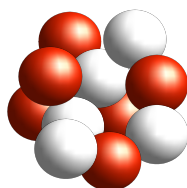


gravitácia



elmag sila

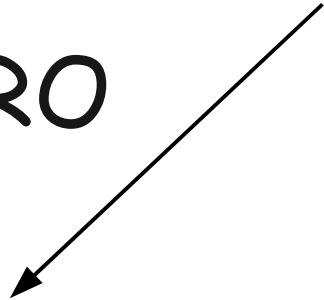
silná sila
(jadrová)



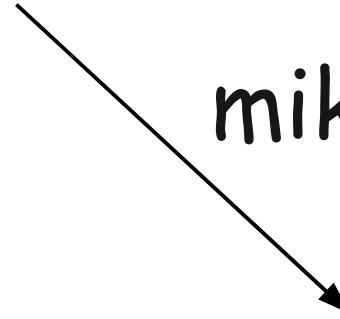
slabá sila

Svet

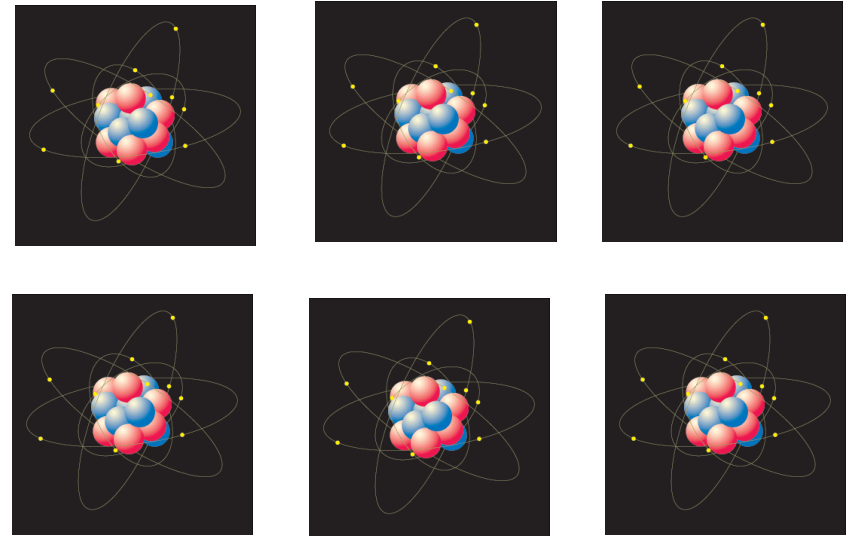
MAKRO



mikro



- klasický

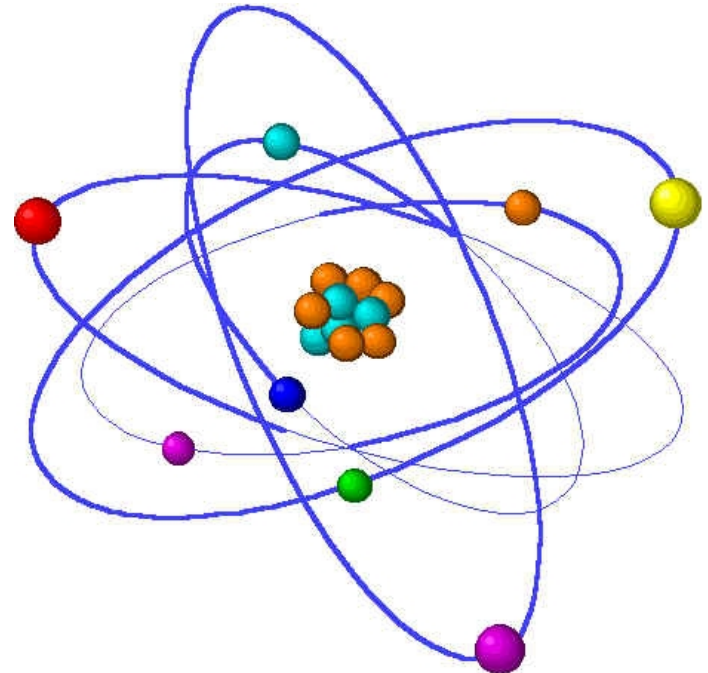
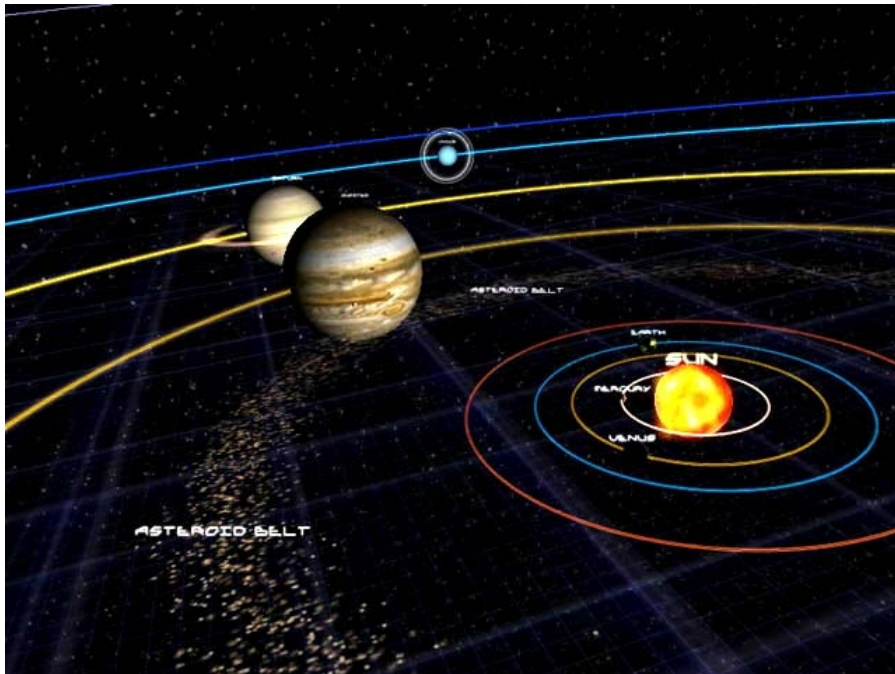


- kvantový
- relativistický

Sila

MAKRO

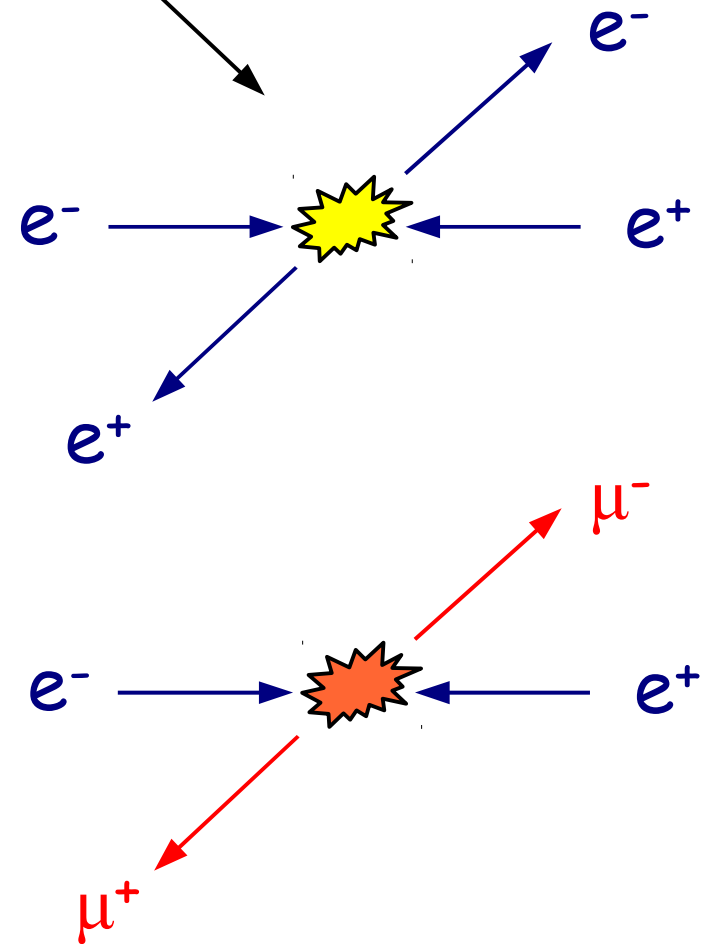
mikro



Sila

MAKRO

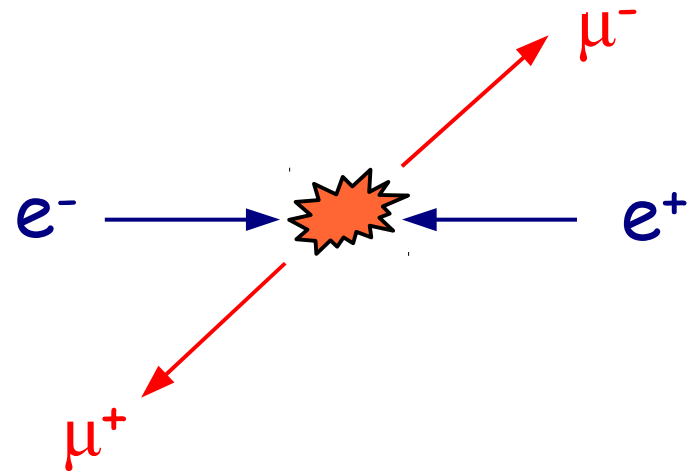
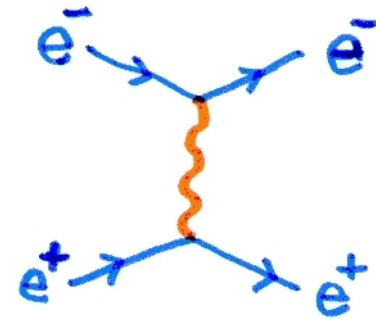
mikro



Sila

MAKRO

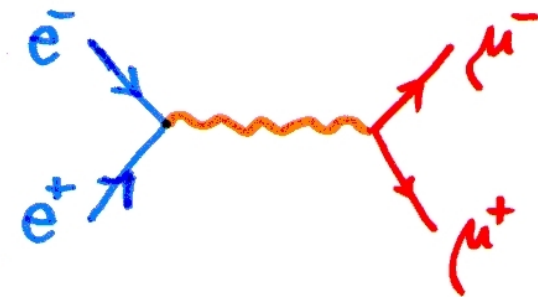
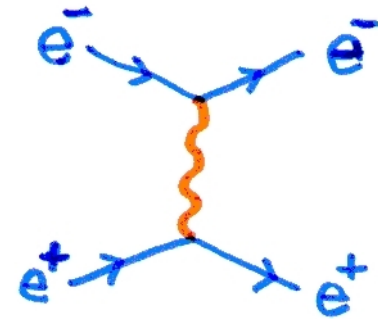
mikro



Sila

MAKRO

mikro



сила:

• **электromagnetická**

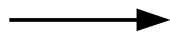
• **silná**

• **slabá**

~~**силонки:**~~



фотон



8 глюонов



W^+ , W^- , Z (бозоны)

elektrón	1	-1
protón	1880	+1
$W^{\pm}$	160600	± 1
Z	182400	0
t kvark	344000	$+ \frac{2}{3}$
jadro Au	370000	+79

fotón	0	0
gluóny	0	0

Hmotnosť

MAKRO

mikro



nezachováva sa!

$$e_{1}^{+} + e_{1}^{-} \rightarrow \mu_{210}^{+} + \mu_{210}^{-}$$

$$Z_{182400}^{0} \rightarrow \mu_{210}^{+} + \mu_{210}^{-}$$

Hmotnosť

MAKRO

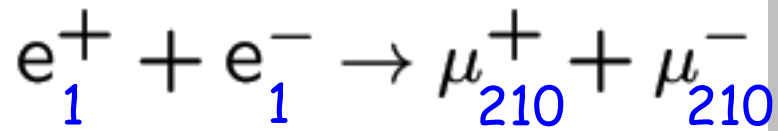
mikro



nezachováva sa!

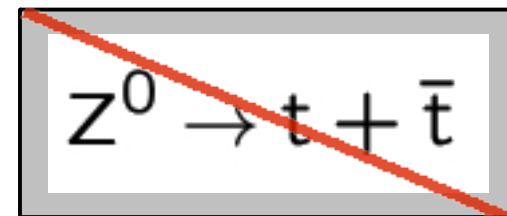
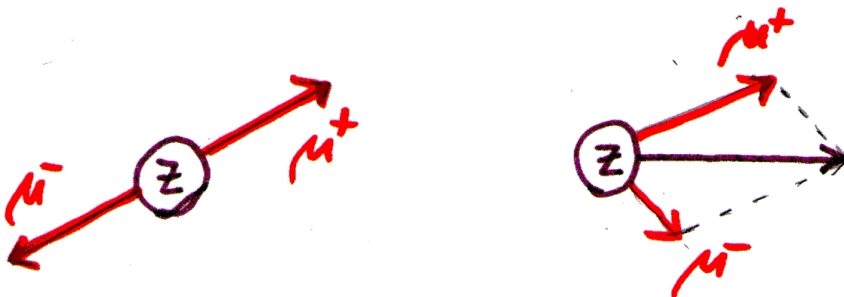
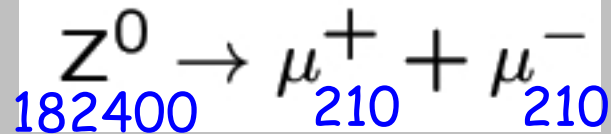
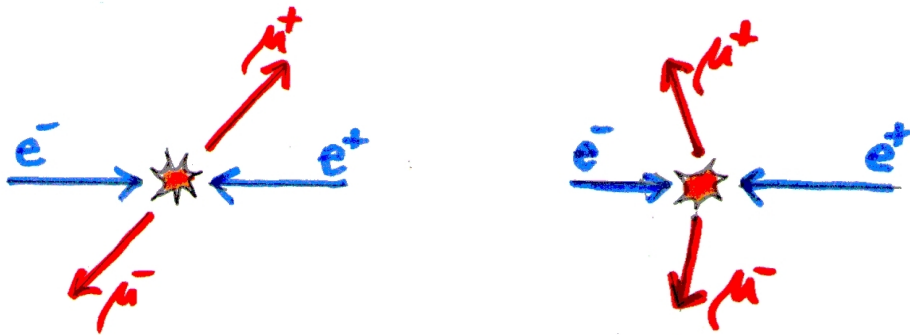
$$E = \sqrt{m^2 c^4 + p^2 c^2}$$

∃ nulová hmotnosť



zachováva sa:

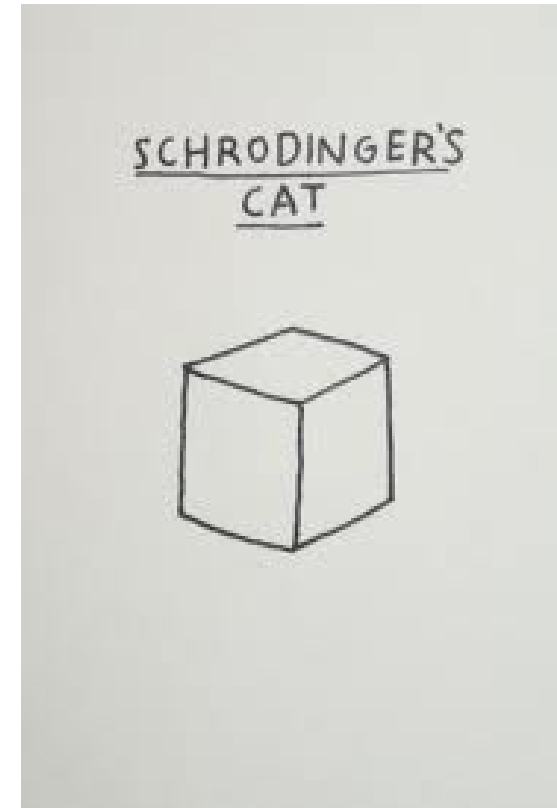
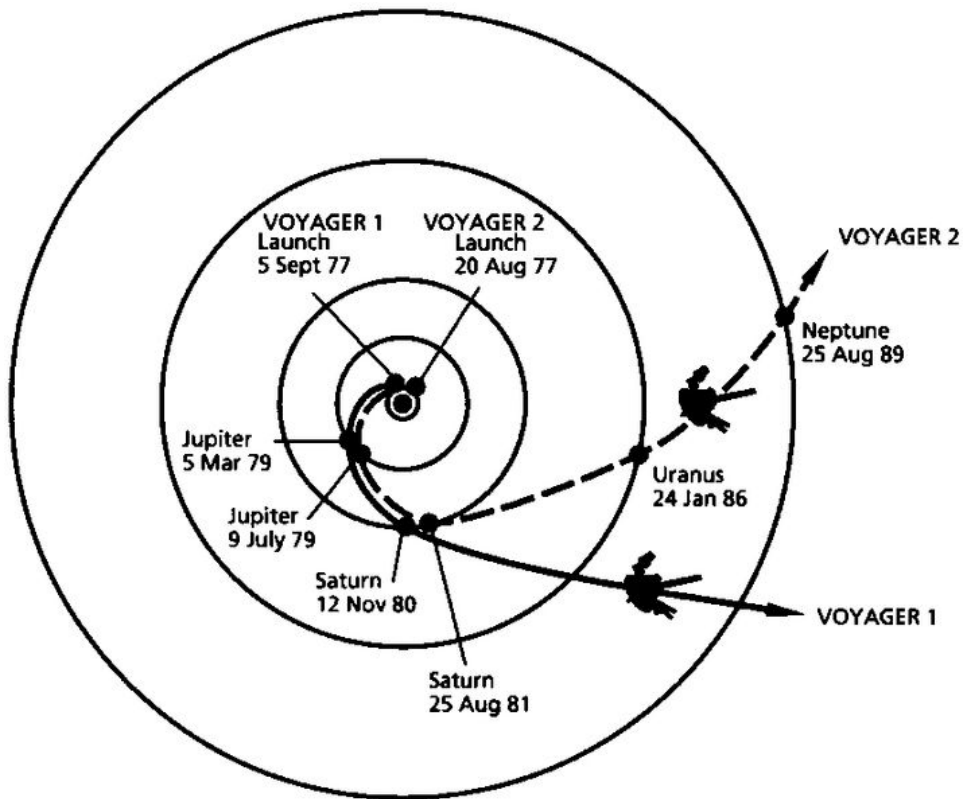
- ✓ elektrický náboj
- ✓ energia
- ✓ hybnosť
- ✓ ...a iné



Predpoved'

MAKRO

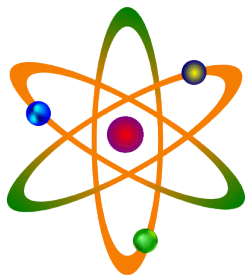
mikro



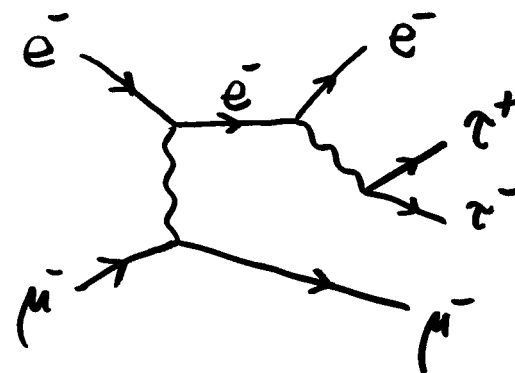
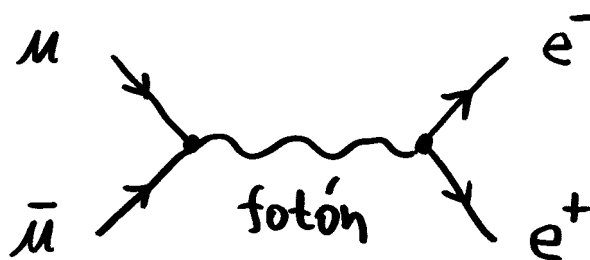
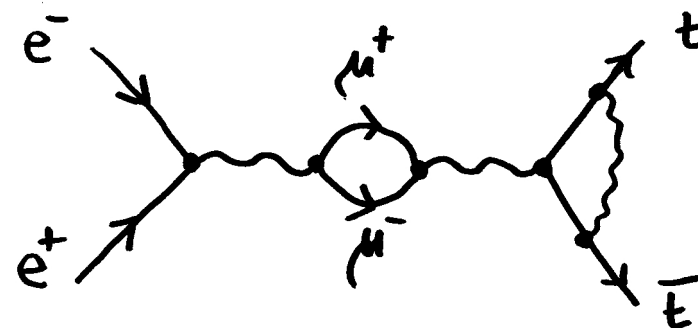
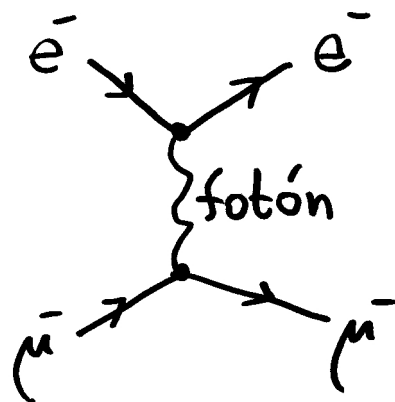
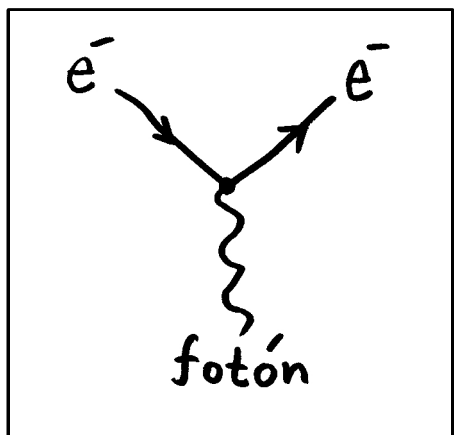
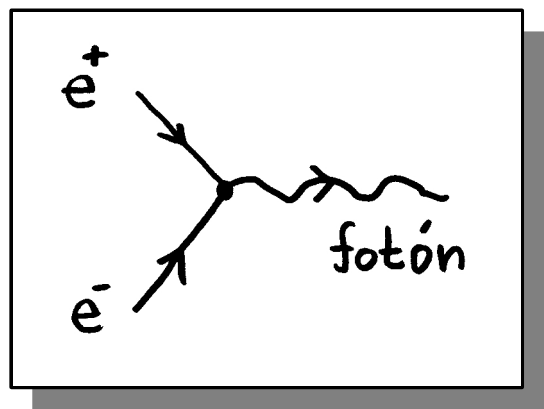
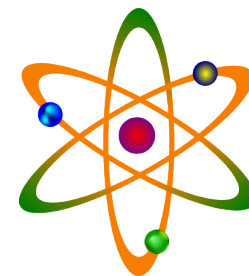
Kvantová teória predpovedá len
pravdepodobnosť výsledku merania.

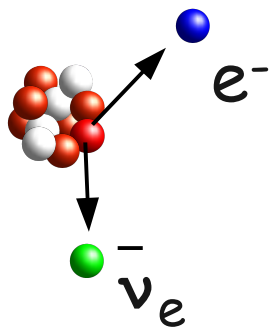
$W^\pm \rightarrow$	$e^\pm \nu$	$\mu^\pm \nu$	$\tau^\pm \nu$	qq'
%	11	11	11	67

energia zrážky		M_Z	$2M_Z$	$3M_Z$	$4M_Z$	$5M_Z$
$e^+e^- \rightarrow$	$\mu^+\mu^-$	20562	37	16	9	6
	W^+W^-	0	190	151	108	81
	$t\bar{t}$	0	0	0	5	6

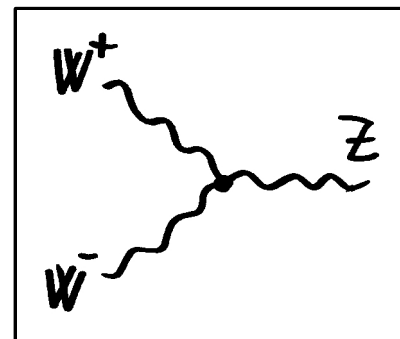
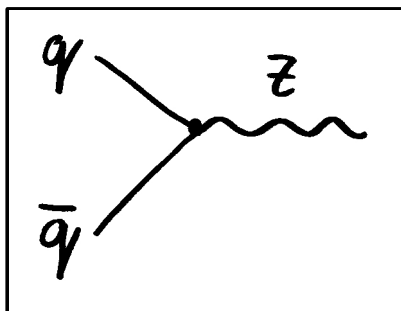
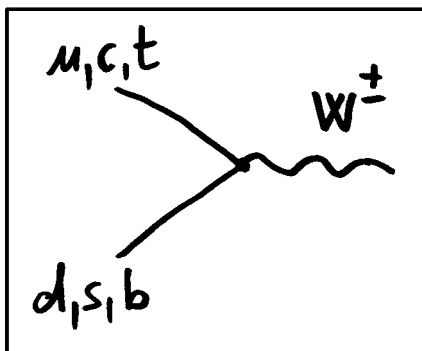
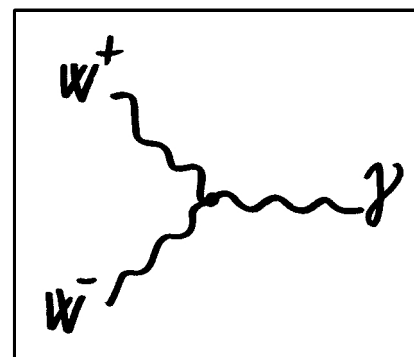
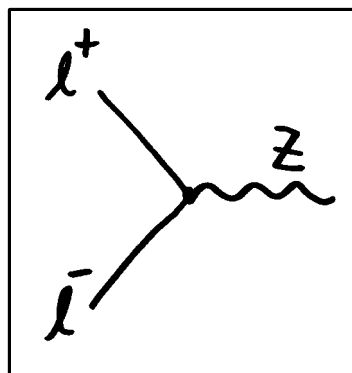
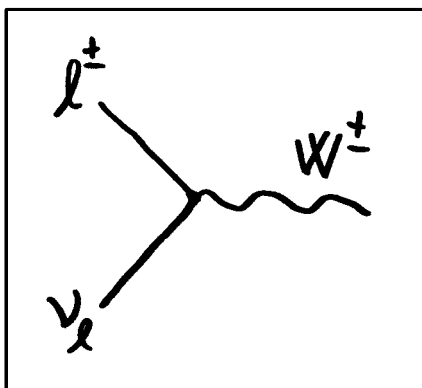
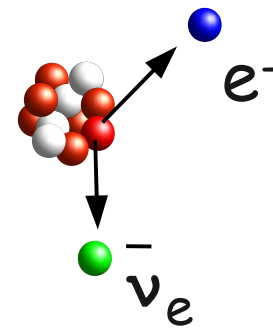


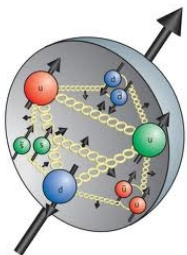
Elmag sily



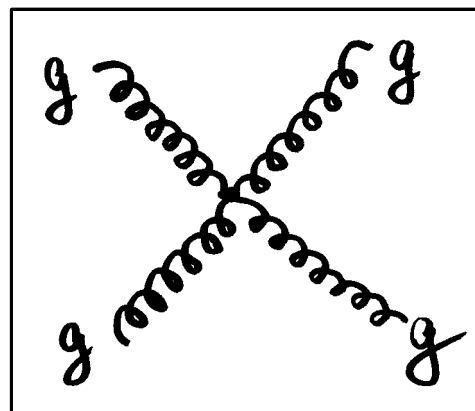
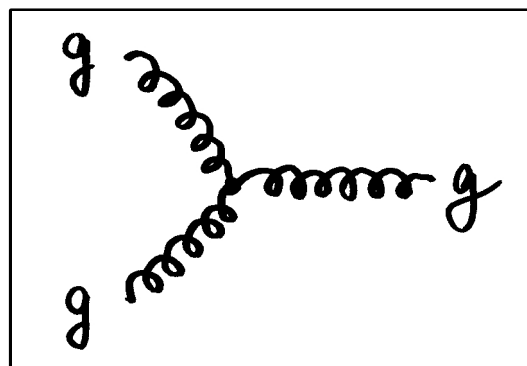
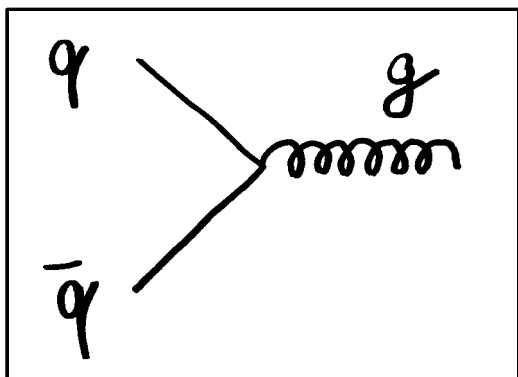
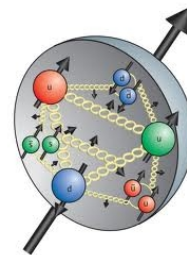


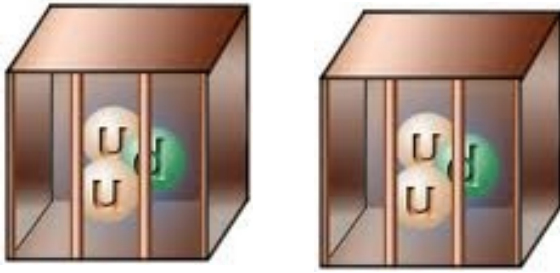
Slabé sily



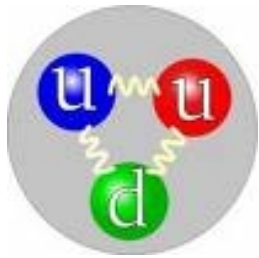
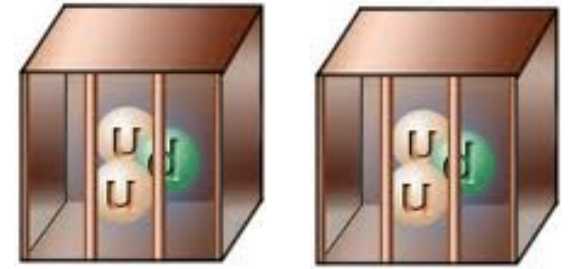


Silné sily

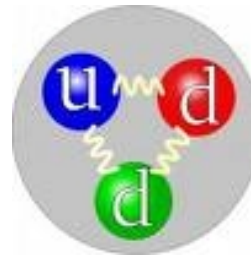




Uväznenie kvarkov



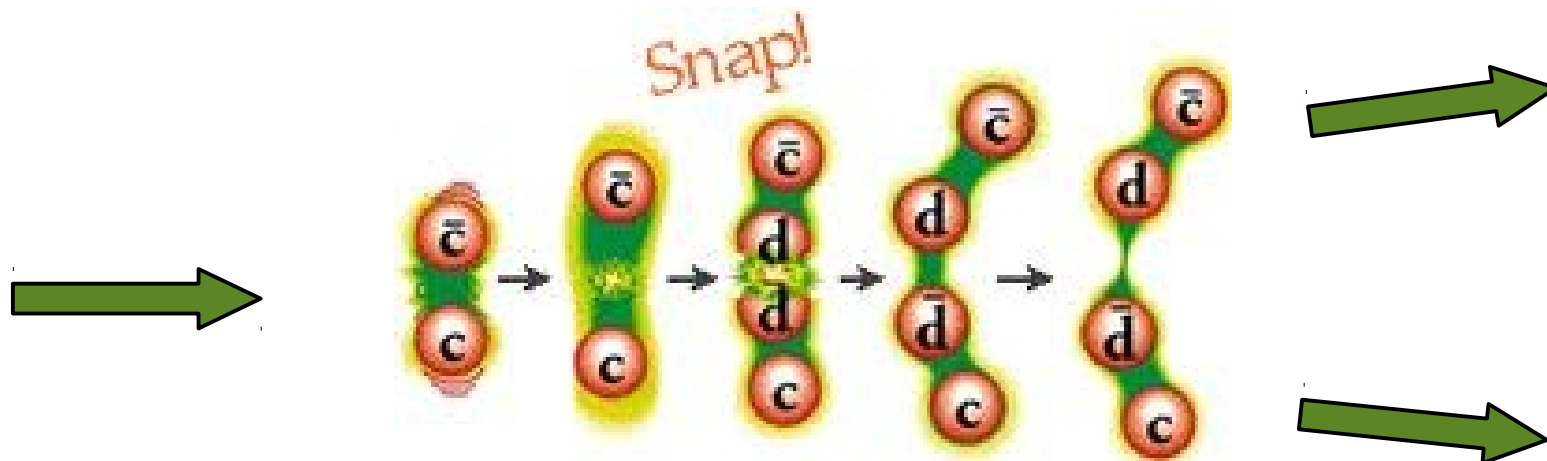
$$2/3 + 2/3 - 1/3 = 1$$

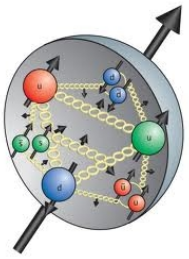


$$2/3 - 1/3 - 1/3 = 0$$

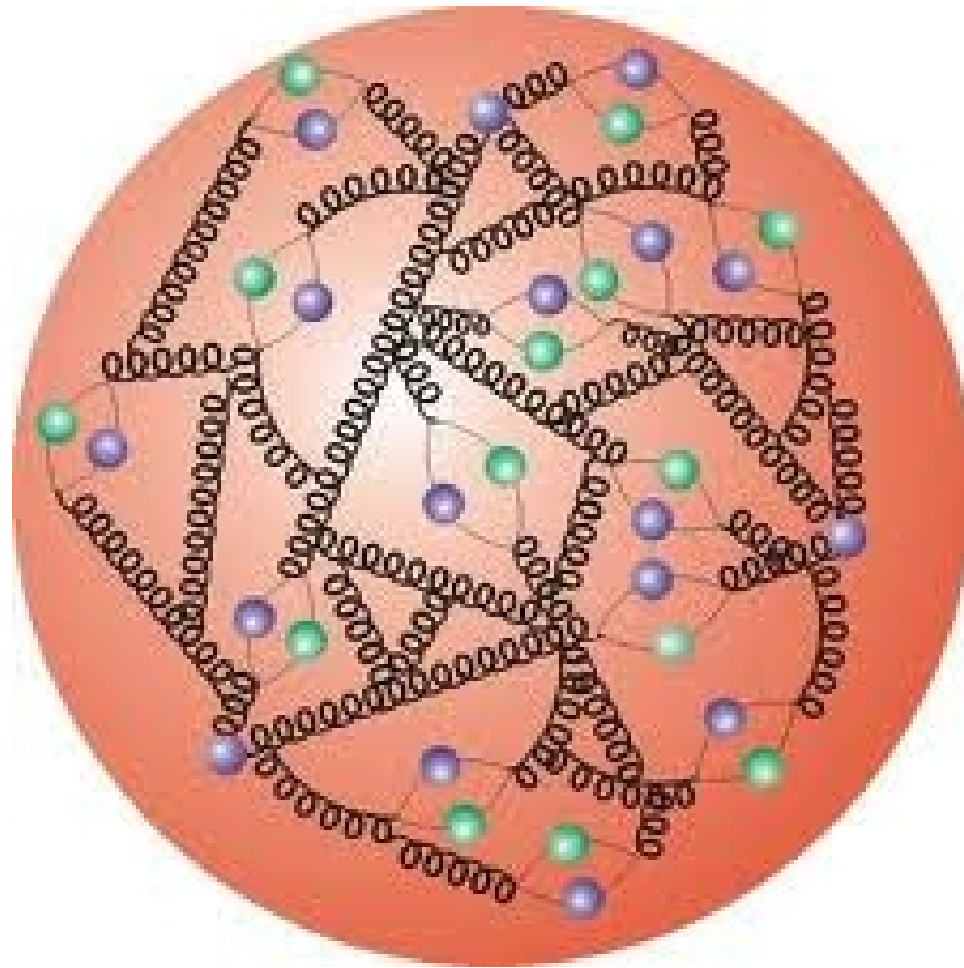
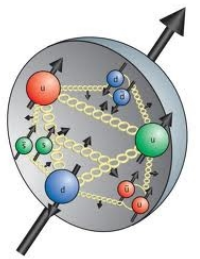


$$2/3 + 1/3 = 1$$

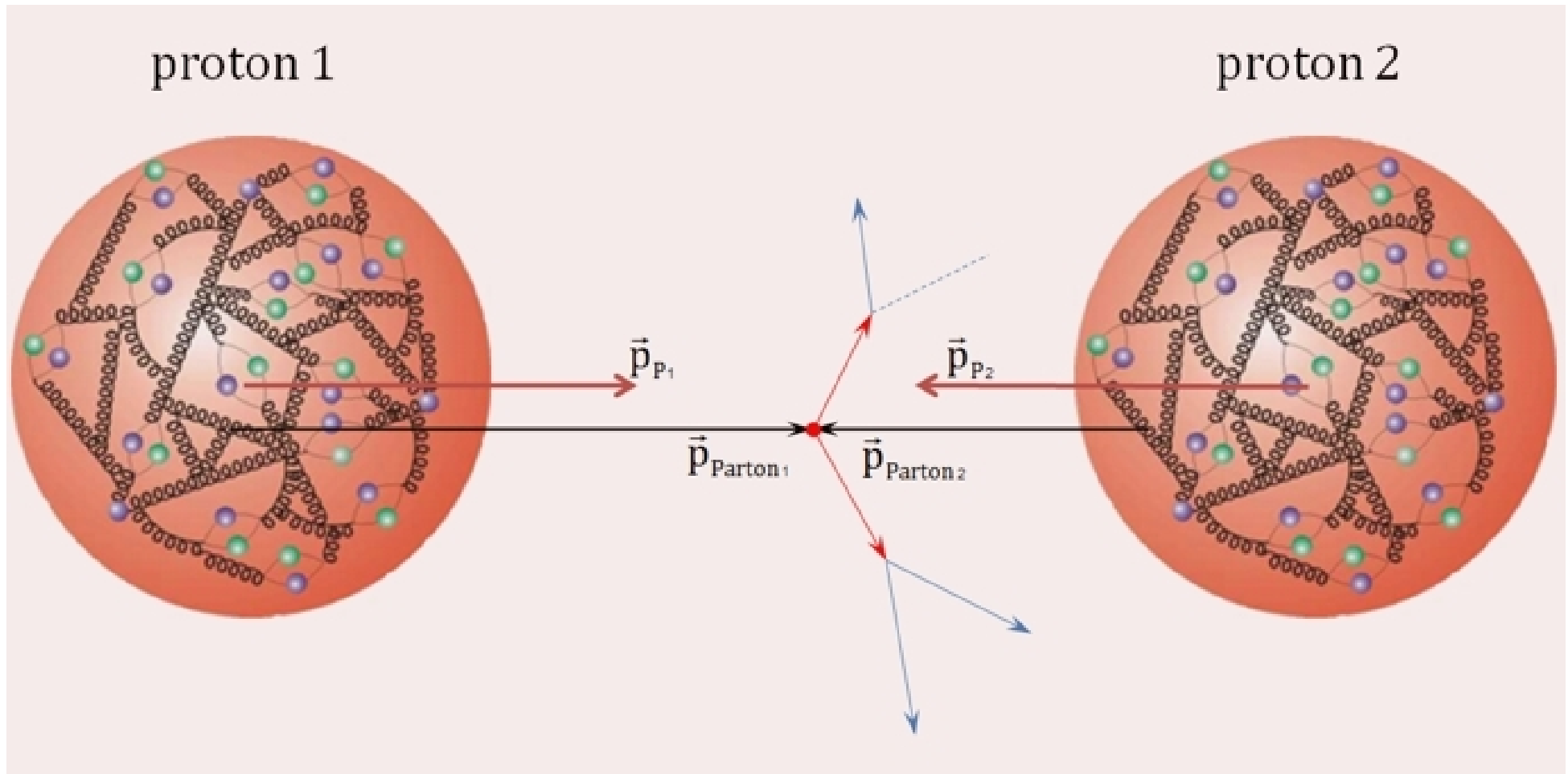


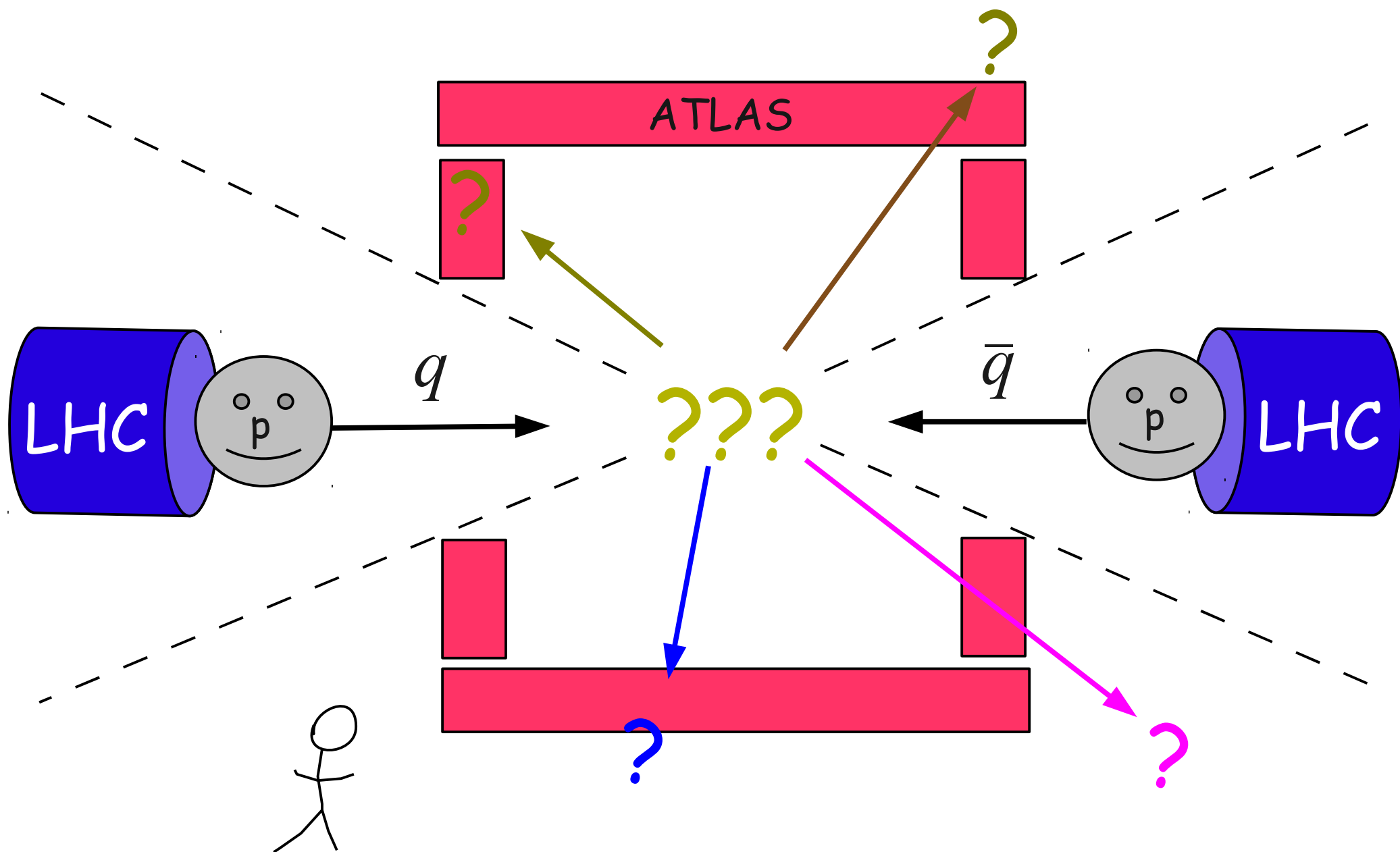


protón



Zrážka protonů





Záhada hmotnosti

Higgsov bozón

$$M_H > 1.26 M_Z$$

