Odkrycie tetrakwarku w Fermilabie (D0)

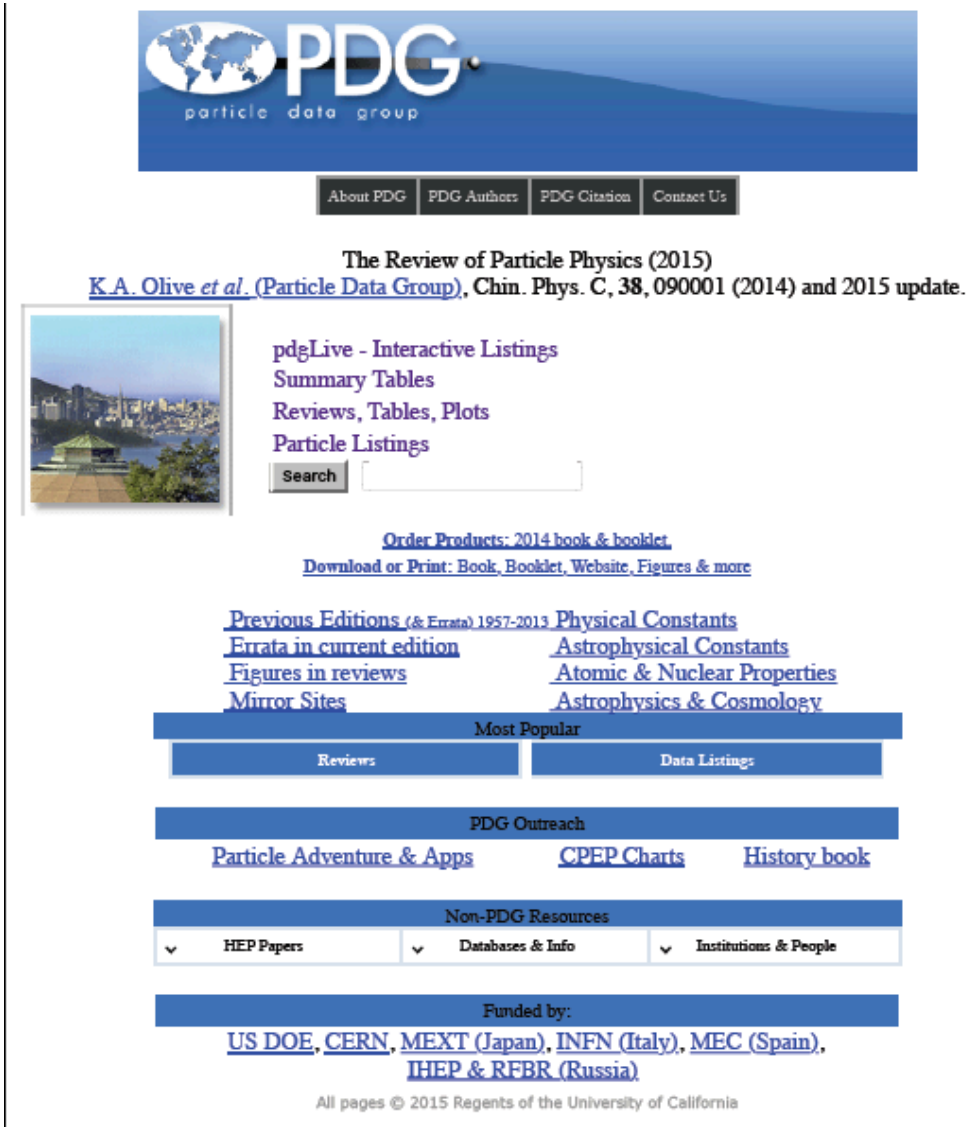
24.02.2016.

http://arxiv.org/pdf/1602.07588v1.pdf

Observation of a new $B_s^0\pi^\pm$ state

http://pdg.lbl.gov

Particle Data Group on line



BOTTOM MESONS
$(B = \pm 1)$

$B^+ = u\overline{b}$, $B^0 = d\overline{b}$, $\overline{B}^0 = \overline{d}\,b$, $B^- = \overline{u}\,b$, similarly for B^*'s

BOTTOM, STRANGE MESONS
$(B = \pm 1, S = \mp 1)$

$B_s^0 = s\overline{b}$, $\overline{B}_s^0 = \overline{s}\,b$, similarly for B_s^*'s

B_s^0

$I(J^P) = 0(0^-)$

I, J, P need confirmation. Quantum numbers shown are quark-model predictions.

Mass $m_{B_s^0} = 5366.79 \pm 0.23$ MeV

$m_{B_s^0} - m_B = 87.33 \pm 0.23$ MeV

Mean life $\tau = (1.510 \pm 0.005) \times 10^{-12}$ s

$c\tau = 452.7\ \mu$m

?

typowe czasy życia

μ

$J = \frac{1}{2}$

Mass $m = 105.6583715 \pm 0.0000035$ MeV
Mean life $\tau = (2.1969811 \pm 0.0000022) \times 10^{-6}$ s

$e^- \overline{\nu}_e \nu_\mu$

τ

$J = \frac{1}{2}$

Mass $m = 1776.86 \pm 0.12$ MeV
$(m_{\tau^+} - m_{\tau^-})/m_{\text{average}} < 2.8 \times 10^{-4}$, CL = 90%
Mean life $\tau = (290.3 \pm 0.5) \times 10^{-15}$ s

$\pi^{\pm}$

$I^G(J^P) = 1^-(0^-)$

Mass $m = 139.57018 \pm 0.00035$ MeV (S = 1.2)
Mean life $\tau = (2.6033 \pm 0.0005) \times 10^{-8}$ s (S = 1.2)

$\mu^+ \nu_\mu$

π^0

$I^G(J^{PC}) = 1^-(0^{-+})$

Mass $m = 134.9766 \pm 0.0006$ MeV (S = 1.1)
$m_{\pi^\pm} - m_{\pi^0} = 4.5936 \pm 0.0005$ MeV
Mean life $\tau = (8.52 \pm 0.18) \times 10^{-17}$ s (S = 1.2)

2γ

czas życia a szerokość

stała „konwersji” $h/2\pi = 6.58 \times 10^{-22}$ MeV s

$$\Gamma = \frac{\hbar}{\tau}$$

π^0 : 8.5×10^{-17} s = 7.7 eV

ρ : 149.1 MeV = 4.4×10^{-24} s

ϕ : 4.27 MeV = 1.55×10^{-22} s

Δ : 120 MeV = = 5.4×10^{-24} s

J/Ψ: 92.9 keV = 7.1×10^{-21} s

BOTTOM, STRANGE MESONS
$(B = \pm 1,\ S = \mp 1)$

$B_s^0 = s\overline{b}$, $\overline{B}_s^0 = \overline{s}\,b$, similarly for B_s^{*}'s

B_s^0

$I(J^P) = 0(0^-)$

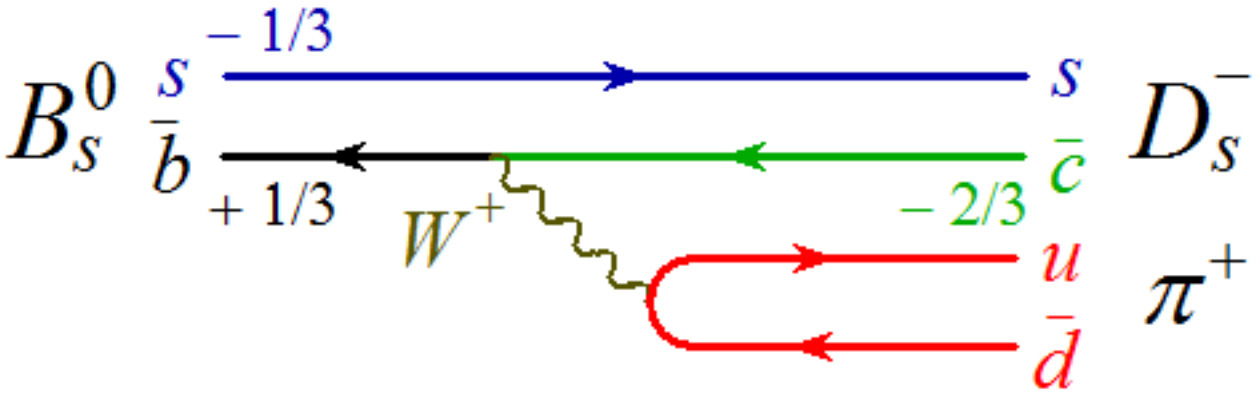
I, J, P need confirmation. Quantum numbers shown are quark-model predictions.

Mass $m_{B_s^0} = 5366.79 \pm 0.23$ MeV

B_s^0 DECAY MODES	Fraction (Γ_i/Γ)
D_s^- anything	(93 ±25) %

CHARMED, STRANGE MESONS
$(C = S = \pm 1)$

$D_s^+ = c\overline{s}$, $D_s^- = \overline{c}\,s$, similarly for D_s^{*}'s



W może się rozpaść na cokolwiek

BOTTOM, STRANGE MESONS
$(B = \pm 1, S = \mp 1)$

$B_s^0 = s\overline{b}$, $\overline{B}_s^0 = \overline{s}b$, similarly for B_s^{*}'s

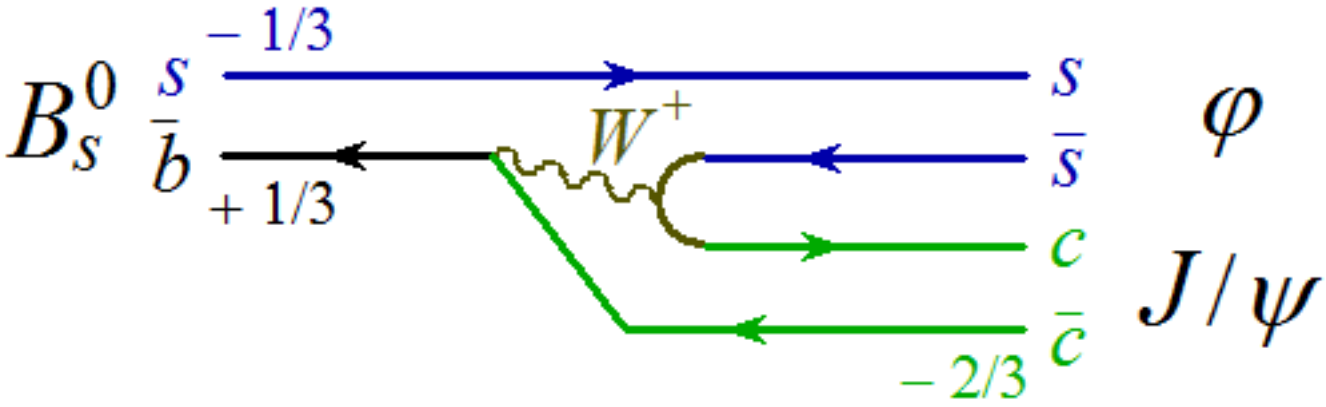
B_s^0

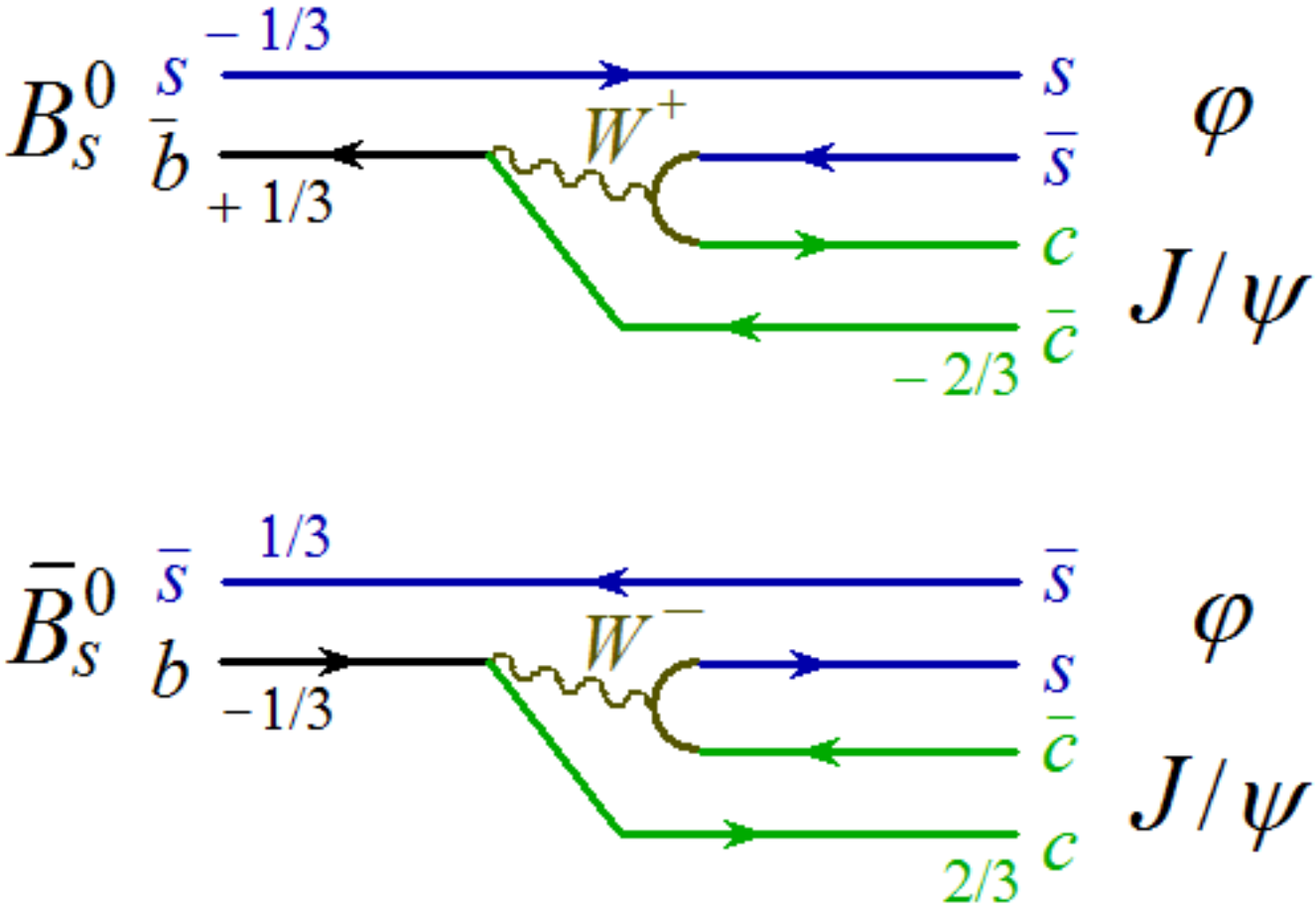
$I(J^P) = 0(0^-)$

I, J, P need confirmation. Quantum numbers shown are quark-model predictions.

Mass $m_{B_s^0} = 5366.79 \pm 0.23$ MeV

B_s^0 DECAY MODES	Fraction (Γ_i/Γ)
D_s^- anything	(93 ±25) %
$J/\psi(1S)\phi$	(1.08± 0.09) $\times 10^{-3}$


B_s^0
s
$\bar{b}$
$-1/3$
$+1/3$
W^+
s
$\bar{s}$
c
$\bar{c}$
$-2/3$
φ
J/ψ

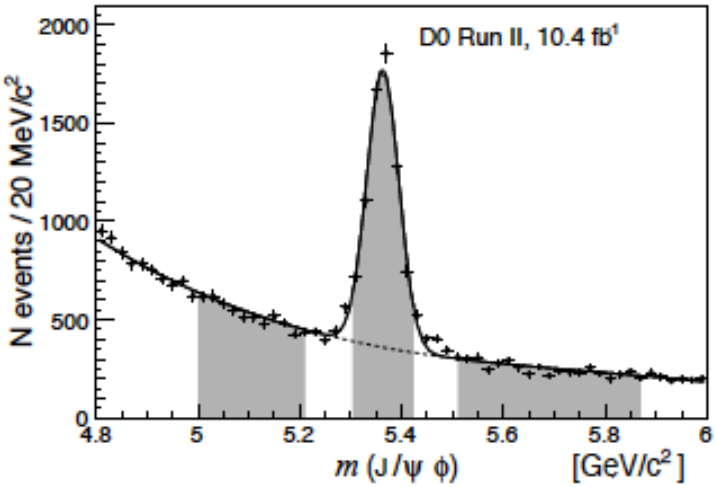

B_s^0
s
$\bar{b}$
$-1/3$
$+1/3$
W^+
s
$\bar{s}$
c
$\bar{c}$
$-2/3$
φ
J/ψ
$\bar{B}_s^0$
$\bar{s}$
b
$1/3$
$-1/3$
W^-
$\bar{s}$
s
$\bar{c}$
c
$2/3$
φ
J/ψ

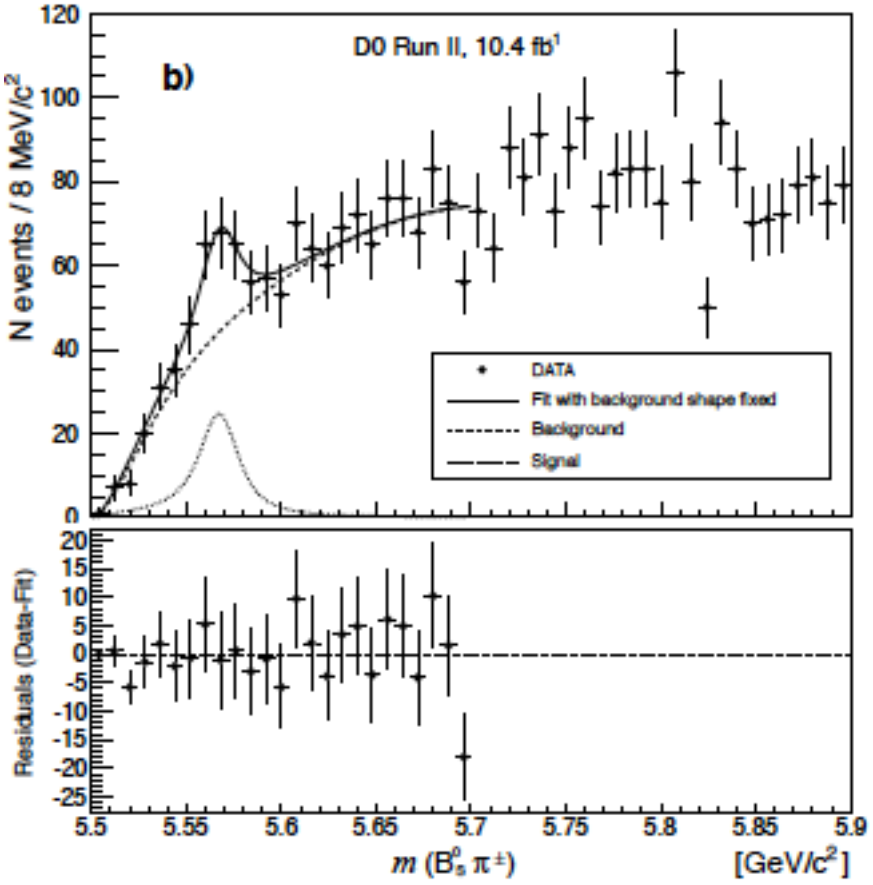
$J/\psi(1S)\phi$		$(\ 1.08\pm\ 0.09) \times 10^{-3}$

$J/\psi(1S)$ DECAY MODES		Fraction (Γ_i/Γ)	Cor
hadrons		(87.7 ±0.5) %	
virtual $\gamma \rightarrow$ hadrons		(13.50 ±0.30) %	
ggg		(64.1 ±1.0) %	
γgg		(8.8 ±1.1) %	
e^+e^-		(5.971±0.032) %	
$e^+e^-\gamma$	[a]	(8.8 ±1.4) $\times 10^{-3}$	
$\mu^+\mu^-$		(5.961±0.033) %	

$\phi(1020)$ DECAY MODES	Fraction (Γ_i/Γ)
K^+K^-	(48.9 ±0.5) %

w ten sposób identyfikujemy mezon B_s^0




D0 Run II, 10.4 fb^{-1}
b)
N events / 8 MeV/c^2
DATA
Fit with background shape fixed
Background
Signal
Residuals (Data-Fit)
m ($B_s^0 \pi^{\pm}$) [GeV/c^2]

Składniki materii, oddziaływania

u [q = 2/3] 3 MeV	**c** 1 275	**t** 173 000
d [q = − 1/3] 5 MeV	**s** 95	**b** 4 660
e [q = 1] 0.5 MeV	**μ** 105	**τ** 1 777
ν_e [q = 0] ?	ν_μ ?	ν_τ ?

spin 1/2

0, 80 000, 71 000, 0

foton (γ), $W^{\pm}$, Z^0, gluony, grawitacja

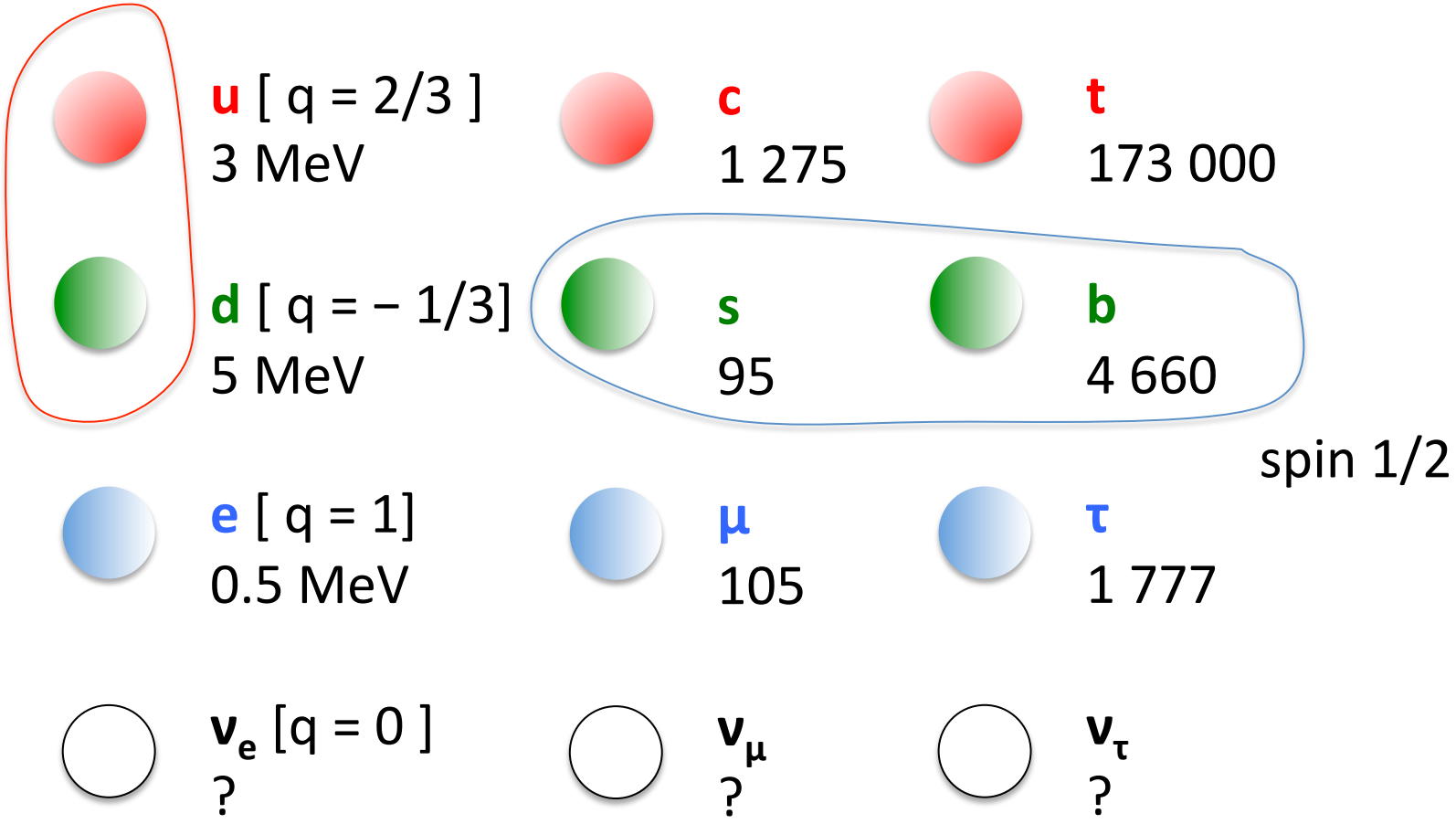
spin 1

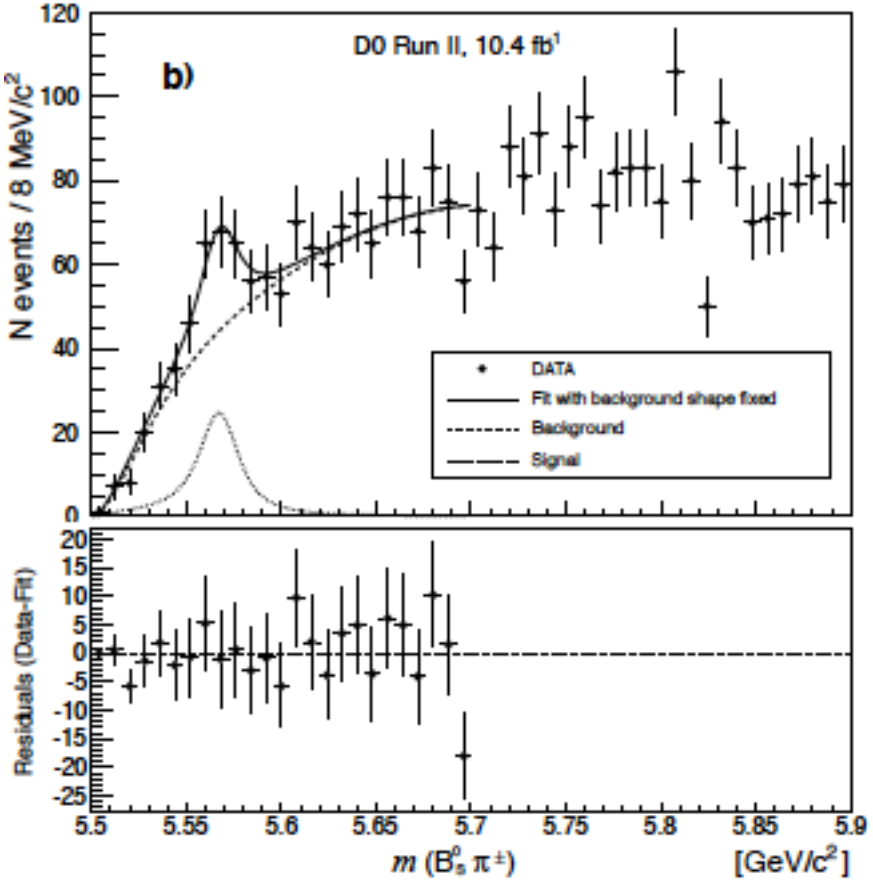
spin 0

bozon Higgsa

125 000

Składniki materii, oddziaływania





$\bar{b}s\ \bar{u}d$

$\bar{b}s\ u\bar{d}$

$b\bar{s}\ \bar{u}d$

$b\bar{s}\ u\bar{d}$

In summary, a structure is observed in the $B_s^0\pi^\pm$ invariant mass spectrum near threshold with a statistical significance, including the look-elsewhere effect, of 6.1σ. When the systematic uncertainties are included, the significance of the observed signal is 5.1σ. This structure may be interpreted as a tetraquark state with four different valence quark flavors, b, s, u, d. The mass and natural width of the observed $X(5568)$ state are $m = 5567.8 \pm 2.9\,(\text{stat})^{+0.9}_{-1.9}\,(\text{syst})$ MeV/c^2 and $\Gamma = 21.9 \pm 6.4\,(\text{stat})^{+5.0}_{-2.5}\,(\text{syst})$ MeV/c^2.

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