

three generations of matter
(fermions)

interactions / forces
(bosons)

mass
charge
spin

I

II

III

$\approx 2.2 \text{ MeV}$
 $+2/3$
 $1/2$
u
up

$\approx 1.3 \text{ GeV}$
 $+2/3$
 $1/2$
c
charm

$\approx 173 \text{ GeV}$
 $+2/3$
 $1/2$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-1/3$
 $1/2$
d
down

$\approx 96 \text{ MeV}$
 $-1/3$
 $1/2$
s
strange

$\approx 4.2 \text{ GeV}$
 $-1/3$
 $1/2$
b
bottom

0
0
1
 γ
photon

$\approx 0.511 \text{ MeV}$
 -1
 $1/2$
e
electron

$\approx 106 \text{ MeV}$
 -1
 $1/2$
 μ
muon

$\approx 1.777 \text{ GeV}$
 -1
 $1/2$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

$< 1.0 \text{ eV}$
0
 $1/2$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

LEPTONS

GAUGE BOSONS
VECTOR BOSONS

SCALAR BOSONS

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\simeq 2.2 \text{ MeV}$
 $+2/3$
 $1/2$

u

up

$\simeq 1.3 \text{ GeV}$
 $+2/3$
 $1/2$

c

charm

$\simeq 173 \text{ GeV}$
 $+2/3$
 $1/2$

t

top

0
0
1

g

gluon

$\simeq 125 \text{ GeV}$
0
1

H

Higgs

QUARKS

$\simeq 4.7 \text{ MeV}$
 $-1/3$
 $1/2$

d

down

$\simeq 96 \text{ MeV}$
 $-1/3$
 $1/2$

s

strange

$\simeq 4.2 \text{ GeV}$
 $-1/3$
 $1/2$

b

bottom

0
0
1

γ

photon

$\simeq 0.511 \text{ MeV}$
 -1
 $1/2$

e

electron

$\simeq 106 \text{ MeV}$
 -1
 $1/2$

μ

muon

$\simeq 1.777 \text{ GeV}$
 -1
 $1/2$

τ

tau

$\simeq 80.4 \text{ GeV}$
 ± 1
1

W

W boson

GAUGE BOSONS
VECTOR BOSONS

SCALAR BOSONS

LEPTONS

$< 1.0 \text{ eV}$
0
 $1/2$

ν_e

electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$

ν_μ

muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$

ν_τ

tau neutrino

$\simeq 91.2 \text{ GeV}$
0
1

Z

Z boson

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\simeq 2.2 \text{ MeV}$
 $+2/3$
 $1/2$

u

up

$\simeq 1.3 \text{ GeV}$
 $+2/3$
 $1/2$

c

charm

$\simeq 173 \text{ GeV}$
 $+2/3$
 $1/2$

t

top

0
0
1

g

gluon

$\simeq 125 \text{ GeV}$
0
1

H

Higgs

QUARKS

$\simeq 4.7 \text{ MeV}$
 $-1/3$
 $1/2$

d

down

$\simeq 96 \text{ MeV}$
 $-1/3$
 $1/2$

s

strange

$\simeq 4.2 \text{ GeV}$
 $-1/3$
 $1/2$

b

bottom

0
0
1

γ

photon

SCALAR BOSONS

$\simeq 0.511 \text{ MeV}$
 -1
 $1/2$

e

electron

$\simeq 106 \text{ MeV}$
 -1
 $1/2$

μ

muon

$\simeq 1.777 \text{ GeV}$
 -1
 $1/2$

τ

tau

$\simeq 80.4 \text{ GeV}$
 ± 1
1

W

W boson

GAUGE BOSONS
VECTOR BOSONS

LEPTONS

$< 1.0 \text{ eV}$
0
 $1/2$

ν_e

electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$

ν_μ

muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$

ν_τ

tau neutrino

$\simeq 91.2 \text{ GeV}$
0
1

Z

Z boson

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
u
up

$\approx 1.3 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
c
charm

$\approx 173 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
d
down

$\approx 96 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
s
strange

$\approx 4.2 \text{ GeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
b
bottom

0
0
1
 γ
photon

$\approx 0.511 \text{ MeV}$
-1
 $\frac{1}{2}$
e
electron

$\approx 106 \text{ MeV}$
-1
 $\frac{1}{2}$
 μ
muon

$\approx 1.777 \text{ GeV}$
-1
 $\frac{1}{2}$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

$< 1.0 \text{ eV}$
0
 $\frac{1}{2}$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $\frac{1}{2}$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $\frac{1}{2}$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

LEPTONS

GAUGE BOSONS
VECTOR BOSONS

SCALAR BOSONS

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$

u

up

$\approx 1.3 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$

c

charm

$\approx 173 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$

t

top

0
0
1

g

gluon

$\approx 125 \text{ GeV}$
0
1

H

Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$

d

down

$\approx 96 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$

s

strange

$\approx 4.2 \text{ GeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$

b

bottom

0
0
1

γ

photon

$\approx 0.511 \text{ MeV}$
-1
 $\frac{1}{2}$

e

electron

$\approx 106 \text{ MeV}$
-1
 $\frac{1}{2}$

μ

muon

$\approx 1.777 \text{ GeV}$
-1
 $\frac{1}{2}$

τ

tau

$\approx 80.4 \text{ GeV}$
 ± 1
1

W

W boson

$< 1.0 \text{ eV}$
0
 $\frac{1}{2}$

ν_e

electron neutrino

$< 0.17 \text{ eV}$
0
 $\frac{1}{2}$

ν_μ

muon neutrino

$< 18.2 \text{ MeV}$
0
 $\frac{1}{2}$

ν_τ

tau neutrino

$\approx 91.2 \text{ GeV}$
0
1

Z

Z boson

LEPTONS

GAUGE BOSONS
VECTOR BOSONS

SCALAR BOSONS

three generations of matter
(fermions)

interactions / forces
(bosons)

I

II

III

mass
charge
spin

$\simeq 2.2 \text{ MeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
u
up

$\simeq 1.3 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
c
charm

$\simeq 173 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
t
top

0
0
1
g
gluon

$\simeq 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\simeq 4.7 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
d
down

$\simeq 96 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
s
strange

$\simeq 4.2 \text{ GeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
b
bottom

0
0
1
 γ
photon

$\simeq 0.511 \text{ MeV}$
-1
 $\frac{1}{2}$
e
electron

$\simeq 106 \text{ MeV}$
-1
 $\frac{1}{2}$
 μ
muon

$\simeq 1.777 \text{ GeV}$
-1
 $\frac{1}{2}$
 τ
tau

$\simeq 80.4 \text{ GeV}$
 ± 1
1
W
W boson

LEPTONS

$< 1.0 \text{ eV}$
0
 $\frac{1}{2}$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $\frac{1}{2}$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $\frac{1}{2}$
 ν_τ
tau neutrino

$\simeq 91.2 \text{ GeV}$
0
1
Z
Z boson

GAUGE BOSONS
VECTOR BOSONS

SCALAR BOSONS

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+2/3$
 $1/2$
u
up

$\approx 1.3 \text{ GeV}$
 $+2/3$
 $1/2$
c
charm

$\approx 173 \text{ GeV}$
 $+2/3$
 $1/2$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-1/3$
 $1/2$
d
down

$\approx 96 \text{ MeV}$
 $-1/3$
 $1/2$
s
strange

$\approx 4.2 \text{ GeV}$
 $-1/3$
 $1/2$
b
bottom

0
0
1
 γ
photon

$\approx 0.511 \text{ MeV}$
 -1
 $1/2$
e
electron

$\approx 106 \text{ MeV}$
 -1
 $1/2$
 μ
muon

$\approx 1.777 \text{ GeV}$
 -1
 $1/2$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

LEPTONS

$< 1.0 \text{ eV}$
0
 $1/2$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

GAUGE BOSONS
VECTOR BOSONS

SCALAR BOSONS

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
u
up

$\approx 1.3 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
c
charm

$\approx 173 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
d
down

$\approx 96 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
s
strange

$\approx 4.2 \text{ GeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
b
bottom

0
0
1
 γ
photon

$\approx 0.511 \text{ MeV}$
 -1
 $\frac{1}{2}$
e
electron

$\approx 106 \text{ MeV}$
 -1
 $\frac{1}{2}$
 μ
muon

$\approx 1.777 \text{ GeV}$
 -1
 $\frac{1}{2}$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

$< 1.0 \text{ eV}$
0
 $\frac{1}{2}$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $\frac{1}{2}$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $\frac{1}{2}$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

GAUGE BOSONS
VECTOR BOSONS

SCALAR BOSONS

LEPTONS

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+2/3$
 $1/2$
u
up

$\approx 1.3 \text{ GeV}$
 $+2/3$
 $1/2$
c
charm

$\approx 173 \text{ GeV}$
 $+2/3$
 $1/2$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-1/3$
 $1/2$
d
down

$\approx 96 \text{ MeV}$
 $-1/3$
 $1/2$
s
strange

$\approx 4.2 \text{ GeV}$
 $-1/3$
 $1/2$
b
bottom

0
0
1
 γ
photon

$\approx 0.511 \text{ MeV}$
 -1
 $1/2$
e
electron

$\approx 106 \text{ MeV}$
 -1
 $1/2$
 μ
muon

$\approx 1.777 \text{ GeV}$
 -1
 $1/2$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

$< 1.0 \text{ eV}$
0
 $1/2$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

**GAUGE BOSONS
VECTOR BOSONS**

LEPTONS

SCALAR BOSONS

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+2/3$
 $1/2$

u

up

$\approx 1.3 \text{ GeV}$
 $+2/3$
 $1/2$

c

charm

$\approx 173 \text{ GeV}$
 $+2/3$
 $1/2$

t

top

0
0
1

g

gluon

$\approx 125 \text{ GeV}$
0
1

H

Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-1/3$
 $1/2$

d

down

$\approx 96 \text{ MeV}$
 $-1/3$
 $1/2$

s

strange

$\approx 4.2 \text{ GeV}$
 $-1/3$
 $1/2$

b

bottom

0
0
1

γ

photon

$\approx 0.511 \text{ MeV}$
 -1
 $1/2$

e

electron

$\approx 106 \text{ MeV}$
 -1
 $1/2$

μ

muon

$\approx 1.777 \text{ GeV}$
 -1
 $1/2$

τ

tau

$\approx 80.4 \text{ GeV}$
 ± 1
1

W

W boson

$< 1.0 \text{ eV}$
0
 $1/2$

ν_e

electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$

ν_μ

muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$

ν_τ

tau neutrino

$\approx 91.2 \text{ GeV}$
0
1

Z

Z boson

LEPTONS

**GAUGE BOSONS
VECTOR BOSONS**

SCALAR BOSONS

three generations of matter
(fermions)

interactions / forces
(bosons)

	I	II	III	
mass charge spin	$\simeq 2.2 \text{ MeV}$ $+2/3$ $1/2$	$\simeq 1.3 \text{ GeV}$ $+2/3$ $1/2$	$\simeq 173 \text{ GeV}$ $+2/3$ $1/2$	0 0 1
QUARKS	u up	c charm	t top	g gluon
	$\simeq 4.7 \text{ MeV}$ $-1/3$ $1/2$	$\simeq 96 \text{ MeV}$ $-1/3$ $1/2$	$\simeq 4.2 \text{ GeV}$ $-1/3$ $1/2$	0 0 1
	d down	s strange	b bottom	γ photon
	$\simeq 0.511 \text{ MeV}$ -1 $1/2$	$\simeq 106 \text{ MeV}$ -1 $1/2$	$\simeq 1.777 \text{ GeV}$ -1 $1/2$	$\simeq 80.4 \text{ GeV}$ ± 1 1
LEPTONS	e electron	μ muon	τ tau	W W boson
	$< 1.0 \text{ eV}$ 0 $1/2$	$< 0.17 \text{ eV}$ 0 $1/2$	$< 18.2 \text{ MeV}$ 0 $1/2$	$\simeq 91.2 \text{ GeV}$ 0 1
	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino	Z Z boson
				GAUGE BOSONS VECTOR BOSONS
				SCALAR BOSONS

three generations of matter
(fermions)

interactions / forces
(bosons)

	I	II	III	
mass	$\simeq 2.2 \text{ MeV}$	$\simeq 1.3 \text{ GeV}$	$\simeq 173 \text{ GeV}$	0
charge	$+2/3$	$+2/3$	$+2/3$	0
spin	$1/2$	$1/2$	$1/2$	1
QUARKS	u up	c charm	t top	g gluon
	$\simeq 4.7 \text{ MeV}$	$\simeq 96 \text{ MeV}$	$\simeq 4.2 \text{ GeV}$	0
	$-1/3$	$-1/3$	$-1/3$	0
	$1/2$	$1/2$	$1/2$	1
	d down	s strange	b bottom	γ photon
LEPTONS	$\simeq 0.511 \text{ MeV}$	$\simeq 106 \text{ MeV}$	$\simeq 1.777 \text{ GeV}$	$\simeq 80.4 \text{ GeV}$
	-1	-1	-1	± 1
	$1/2$	$1/2$	$1/2$	1
	e electron	μ muon	τ tau	W W boson
	$< 1.0 \text{ eV}$	$< 0.17 \text{ eV}$	$< 18.2 \text{ MeV}$	$\simeq 91.2 \text{ GeV}$
	0	0	0	0
	$1/2$	$1/2$	$1/2$	1
	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino	Z Z boson
				GAUGE BOSONS VECTOR BOSONS
				SCALAR BOSONS

three generations of matter
(fermions)

interactions / forces
(bosons)

mass
charge
spin

I

II

III

$\approx 2.2 \text{ MeV}$
 $+2/3$
 $1/2$
u
up

$\approx 1.3 \text{ GeV}$
 $+2/3$
 $1/2$
c
charm

$\approx 173 \text{ GeV}$
 $+2/3$
 $1/2$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-1/3$
 $1/2$
d
down

$\approx 96 \text{ MeV}$
 $-1/3$
 $1/2$
s
strange

$\approx 4.2 \text{ GeV}$
 $-1/3$
 $1/2$
b
bottom

0
0
1
 γ
photon

SCALAR BOSONS

$\approx 0.511 \text{ MeV}$
 -1
 $1/2$
e
electron

$\approx 106 \text{ MeV}$
 -1
 $1/2$
 μ
muon

$\approx 1.777 \text{ GeV}$
 -1
 $1/2$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

GAUGE BOSONS
VECTOR BOSONS

LEPTONS

$< 1.0 \text{ eV}$
0
 $1/2$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

three generations of matter
(fermions)

interactions / forces
(bosons)

mass
charge
spin

I

II

III

$\approx 2.2 \text{ MeV}$
 $+2/3$
 $1/2$
u
up

$\approx 1.3 \text{ GeV}$
 $+2/3$
 $1/2$
c
charm

$\approx 173 \text{ GeV}$
 $+2/3$
 $1/2$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-1/3$
 $1/2$
d
down

$\approx 96 \text{ MeV}$
 $-1/3$
 $1/2$
s
strange

$\approx 4.2 \text{ GeV}$
 $-1/3$
 $1/2$
b
bottom

0
0
1
 γ
photon

$\approx 0.511 \text{ MeV}$
-1
 $1/2$
e
electron

$\approx 106 \text{ MeV}$
-1
 $1/2$
 μ
muon

$\approx 1.777 \text{ GeV}$
-1
 $1/2$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

LEPTONS

$< 1.0 \text{ eV}$
0
 $1/2$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

GAUGE BOSONS
VECTOR BOSONS

SCALAR BOSONS

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+2/3$
 $1/2$
u
up

$\approx 1.3 \text{ GeV}$
 $+2/3$
 $1/2$
c
charm

$\approx 173 \text{ GeV}$
 $+2/3$
 $1/2$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-1/3$
 $1/2$
d
down

$\approx 96 \text{ MeV}$
 $-1/3$
 $1/2$
s
strange

$\approx 4.2 \text{ GeV}$
 $-1/3$
 $1/2$
b
bottom

0
0
1
 γ
photon

SCALAR BOSONS

$\approx 0.511 \text{ MeV}$
-1
 $1/2$
e
electron

$\approx 106 \text{ MeV}$
-1
 $1/2$
 μ
muon

$\approx 1.777 \text{ GeV}$
-1
 $1/2$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

GAUGE BOSONS
VECTOR BOSONS

LEPTONS

$< 1.0 \text{ eV}$
0
 $1/2$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
u
up

$\approx 1.3 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
c
charm

$\approx 173 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
d
down

$\approx 96 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
s
strange

$\approx 4.2 \text{ GeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
b
bottom

0
0
1
 γ
photon

SCALAR BOSONS

$\approx 0.511 \text{ MeV}$
-1
 $\frac{1}{2}$
e
electron

$\approx 106 \text{ MeV}$
-1
 $\frac{1}{2}$
 μ
muon

$\approx 1.777 \text{ GeV}$
-1
 $\frac{1}{2}$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

GAUGE BOSONS

VECTOR BOSONS

LEPTONS

$< 1.0 \text{ eV}$
0
 $\frac{1}{2}$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $\frac{1}{2}$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $\frac{1}{2}$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
u
up

$\approx 1.3 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
c
charm

$\approx 173 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
d
down

$\approx 96 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
s
strange

$\approx 4.2 \text{ GeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
b
bottom

0
0
1
 γ
photon

SCALAR BOSONS

$\approx 0.511 \text{ MeV}$
-1
 $\frac{1}{2}$
e
electron

$\approx 106 \text{ MeV}$
-1
 $\frac{1}{2}$
 μ
muon

$\approx 1.777 \text{ GeV}$
-1
 $\frac{1}{2}$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

GAUGE BOSONS
VECTOR BOSONS

LEPTONS

$< 1.0 \text{ eV}$
0
 $\frac{1}{2}$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $\frac{1}{2}$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $\frac{1}{2}$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+2/3$
 $1/2$
u
up

$\approx 1.3 \text{ GeV}$
 $+2/3$
 $1/2$
c
charm

$\approx 173 \text{ GeV}$
 $+2/3$
 $1/2$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-1/3$
 $1/2$
d
down

$\approx 96 \text{ MeV}$
 $-1/3$
 $1/2$
s
strange

$\approx 4.2 \text{ GeV}$
 $-1/3$
 $1/2$
b
bottom

0
0
1
 γ
photon

$\approx 0.511 \text{ MeV}$
 -1
 $1/2$
e
electron

$\approx 106 \text{ MeV}$
 -1
 $1/2$
 μ
muon

$\approx 1.777 \text{ GeV}$
 -1
 $1/2$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

$< 1.0 \text{ eV}$
0
 $1/2$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

LEPTONS

GAUGE BOSONS
VECTOR BOSONS

SCALAR BOSONS

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+2/3$
 $1/2$
u
up

$\approx 1.3 \text{ GeV}$
 $+2/3$
 $1/2$
c
charm

$\approx 173 \text{ GeV}$
 $+2/3$
 $1/2$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-1/3$
 $1/2$
d
down

$\approx 96 \text{ MeV}$
 $-1/3$
 $1/2$
s
strange

$\approx 4.2 \text{ GeV}$
 $-1/3$
 $1/2$
b
bottom

0
0
1
 γ
photon

$\approx 0.511 \text{ MeV}$
-1
 $1/2$
e
electron

$\approx 106 \text{ MeV}$
-1
 $1/2$
 μ
muon

$\approx 1.777 \text{ GeV}$
-1
 $1/2$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

$< 1.0 \text{ eV}$
0
 $1/2$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

LEPTONS

GAUGE BOSONS
VECTOR BOSONS

SCALAR BOSONS

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+2/3$
 $1/2$
u
up

$\approx 1.3 \text{ GeV}$
 $+2/3$
 $1/2$
c
charm

$\approx 173 \text{ GeV}$
 $+2/3$
 $1/2$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-1/3$
 $1/2$
d
down

$\approx 96 \text{ MeV}$
 $-1/3$
 $1/2$
s
strange

$\approx 4.2 \text{ GeV}$
 $-1/3$
 $1/2$
b
bottom

0
0
1
 γ
photon

$\approx 0.511 \text{ MeV}$
-1
 $1/2$
e
electron

$\approx 106 \text{ MeV}$
-1
 $1/2$
 μ
muon

$\approx 1.777 \text{ GeV}$
-1
 $1/2$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

$< 1.0 \text{ eV}$
0
 $1/2$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

LEPTONS

GAUGE BOSONS
VECTOR BOSONS

SCALAR BOSONS

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
u
up

$\approx 1.3 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
c
charm

$\approx 173 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
d
down

$\approx 96 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
s
strange

$\approx 4.2 \text{ GeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
b
bottom

0
0
1
 γ
photon

SCALAR BOSONS

$\approx 0.511 \text{ MeV}$
-1
 $\frac{1}{2}$
e
electron

$\approx 106 \text{ MeV}$
-1
 $\frac{1}{2}$
 μ
muon

$\approx 1.777 \text{ GeV}$
-1
 $\frac{1}{2}$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

GAUGE BOSONS
VECTOR BOSONS

LEPTONS

$< 1.0 \text{ eV}$
0
 $\frac{1}{2}$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $\frac{1}{2}$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $\frac{1}{2}$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
u
up

$\approx 1.3 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
c
charm

$\approx 173 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
d
down

$\approx 96 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
s
strange

$\approx 4.2 \text{ GeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
b
bottom

0
0
1
 γ
photon

SCALAR BOSONS

$\approx 0.511 \text{ MeV}$
 -1
 $\frac{1}{2}$
e
electron

$\approx 106 \text{ MeV}$
 -1
 $\frac{1}{2}$
 μ
muon

$\approx 1.777 \text{ GeV}$
 -1
 $\frac{1}{2}$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

LEPTONS

$< 1.0 \text{ eV}$
0
 $\frac{1}{2}$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $\frac{1}{2}$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $\frac{1}{2}$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

GAUGE BOSONS
VECTOR BOSONS

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
u
up

$\approx 1.3 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
c
charm

$\approx 173 \text{ GeV}$
 $+\frac{2}{3}$
 $\frac{1}{2}$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
d
down

$\approx 96 \text{ MeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
s
strange

$\approx 4.2 \text{ GeV}$
 $-\frac{1}{3}$
 $\frac{1}{2}$
b
bottom

0
0
1
 γ
photon

SCALAR BOSONS

$\approx 0.511 \text{ MeV}$
-1
 $\frac{1}{2}$
e
electron

$\approx 106 \text{ MeV}$
-1
 $\frac{1}{2}$
 μ
muon

$\approx 1.777 \text{ GeV}$
-1
 $\frac{1}{2}$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

GAUGE BOSONS
VECTOR BOSONS

LEPTONS

$< 1.0 \text{ eV}$
0
 $\frac{1}{2}$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $\frac{1}{2}$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $\frac{1}{2}$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+2/3$
 $1/2$
u
up

$\approx 1.3 \text{ GeV}$
 $+2/3$
 $1/2$
c
charm

$\approx 173 \text{ GeV}$
 $+2/3$
 $1/2$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-1/3$
 $1/2$
d
down

$\approx 96 \text{ MeV}$
 $-1/3$
 $1/2$
s
strange

$\approx 4.2 \text{ GeV}$
 $-1/3$
 $1/2$
b
bottom

0
0
1
 γ
photon

SCALAR BOSONS

$\approx 0.511 \text{ MeV}$
-1
 $1/2$
e
electron

$\approx 106 \text{ MeV}$
-1
 $1/2$
 μ
muon

$\approx 1.777 \text{ GeV}$
-1
 $1/2$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

GAUGE BOSONS
VECTOR BOSONS

LEPTONS

$< 1.0 \text{ eV}$
0
 $1/2$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+2/3$
 $1/2$
u
up

$\approx 1.3 \text{ GeV}$
 $+2/3$
 $1/2$
c
charm

$\approx 173 \text{ GeV}$
 $+2/3$
 $1/2$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-1/3$
 $1/2$
d
down

$\approx 96 \text{ MeV}$
 $-1/3$
 $1/2$
s
strange

$\approx 4.2 \text{ GeV}$
 $-1/3$
 $1/2$
b
bottom

0
0
1
 γ
photon

SCALAR BOSONS

$\approx 0.511 \text{ MeV}$
 -1
 $1/2$
e
electron

$\approx 106 \text{ MeV}$
 -1
 $1/2$
 μ
muon

$\approx 1.777 \text{ GeV}$
 -1
 $1/2$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

GAUGE BOSONS
VECTOR BOSONS

LEPTONS

$< 1.0 \text{ eV}$
0
 $1/2$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson

three generations of matter (fermions)

interactions / forces (bosons)

I

II

III

mass
charge
spin

$\approx 2.2 \text{ MeV}$
 $+2/3$
 $1/2$
u
up

$\approx 1.3 \text{ GeV}$
 $+2/3$
 $1/2$
c
charm

$\approx 173 \text{ GeV}$
 $+2/3$
 $1/2$
t
top

0
0
1
g
gluon

$\approx 125 \text{ GeV}$
0
1
H
Higgs

QUARKS

$\approx 4.7 \text{ MeV}$
 $-1/3$
 $1/2$
d
down

$\approx 96 \text{ MeV}$
 $-1/3$
 $1/2$
s
strange

$\approx 4.2 \text{ GeV}$
 $-1/3$
 $1/2$
b
bottom

0
0
1
 γ
photon

SCALAR BOSONS

$\approx 0.511 \text{ MeV}$
-1
 $1/2$
e
electron

$\approx 106 \text{ MeV}$
-1
 $1/2$
 μ
muon

$\approx 1.777 \text{ GeV}$
-1
 $1/2$
 τ
tau

$\approx 80.4 \text{ GeV}$
 ± 1
1
W
W boson

GAUGE BOSONS
VECTOR BOSONS

LEPTONS

$< 1.0 \text{ eV}$
0
 $1/2$
 ν_e
electron neutrino

$< 0.17 \text{ eV}$
0
 $1/2$
 ν_μ
muon neutrino

$< 18.2 \text{ MeV}$
0
 $1/2$
 ν_τ
tau neutrino

$\approx 91.2 \text{ GeV}$
0
1
Z
Z boson