

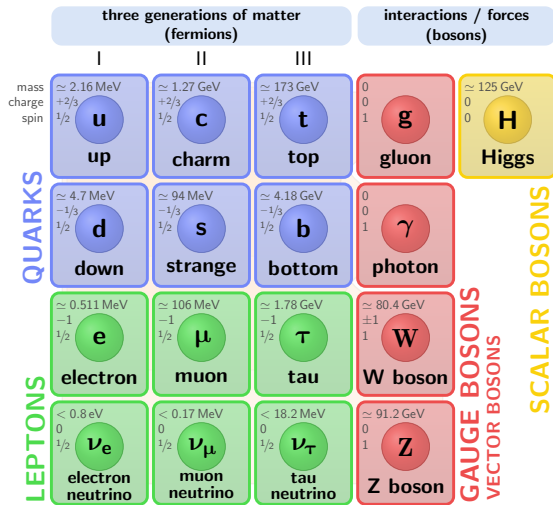
Standard Model of Particle Physics

Izaak Neutelings

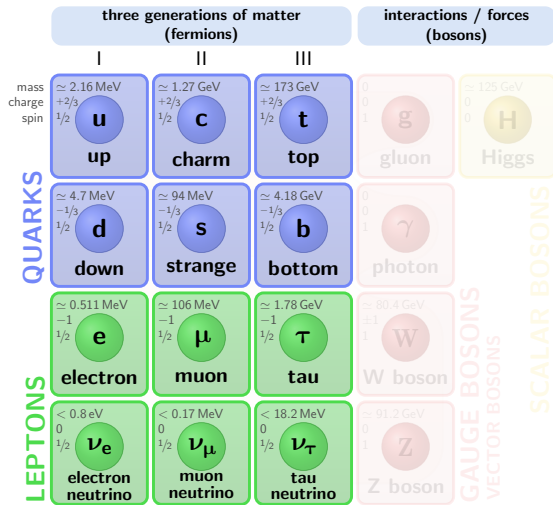
University of Zurich

2023

Standard Model of Particle Physics

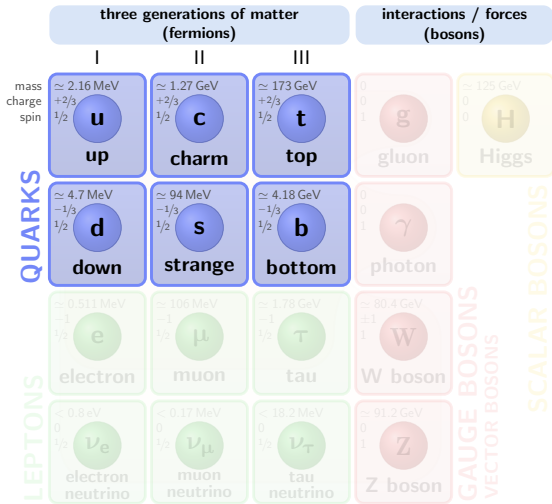


Standard Model of Particle Physics



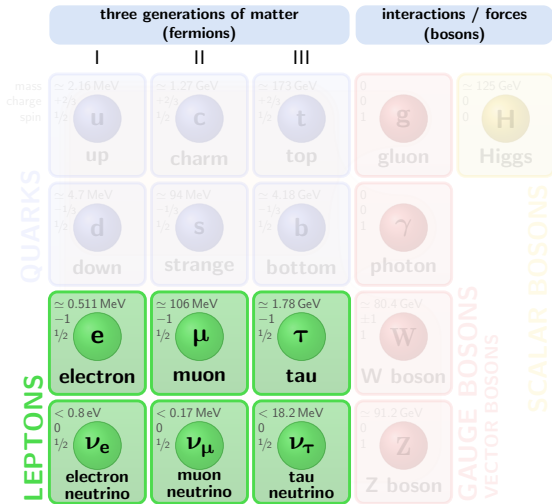
- **Fermions** of spin $1/2$, which make up matter

Standard Model of Particle Physics



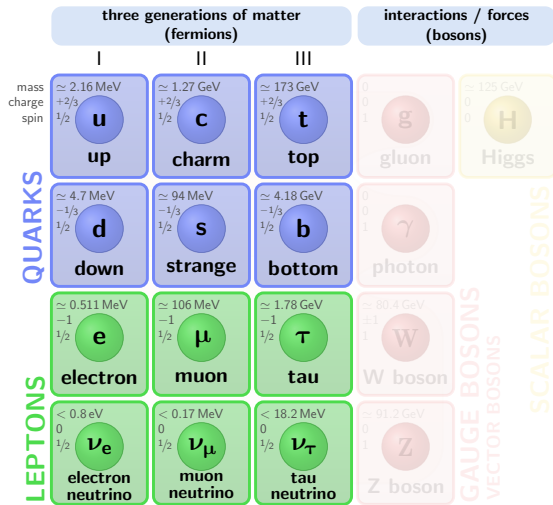
- ▶ **Fermions** of spin $1/2$, which make up matter
 - ▶ Quarks

Standard Model of Particle Physics



- ▶ **Fermions** of spin $1/2$, which make up matter
 - ▶ Quarks
 - ▶ Leptons

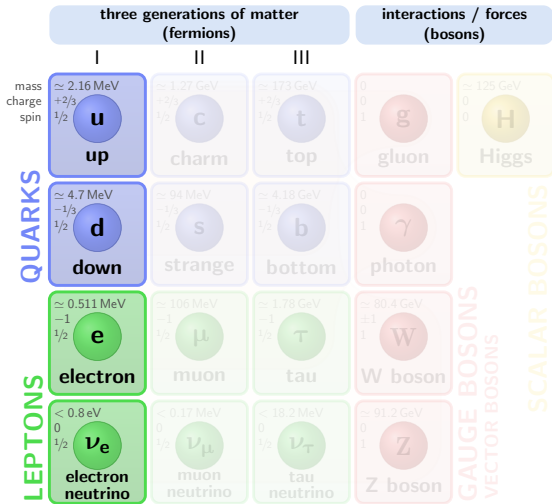
Standard Model of Particle Physics



► **Fermions** of spin $1/2$, which make up matter

- Quarks
- Leptons
- Three generations

Standard Model of Particle Physics



- ▶ **Fermions** of spin $1/2$, which make up matter
 - ▶ Quarks
 - ▶ Leptons
 - ▶ Three generations

Standard Model of Particle Physics

three generations of matter (fermions)				interactions / forces (bosons)						
		I	II	III						
mass charge spin	$\approx 2.16 \text{ MeV}$ $+2/3$ $1/2$	u up	$\approx 1.27 \text{ GeV}$ $+2/3$ $1/2$	c charm	$\approx 173 \text{ GeV}$ $+2/3$ $1/2$	t top	0 0 1	g gluon	$\approx 125 \text{ GeV}$ 0 0	H Higgs
	$\approx 4.7 \text{ MeV}$ $-1/3$ $1/2$	d down	$\approx 94 \text{ MeV}$ $-1/3$ $1/2$	s strange	$\approx 4.18 \text{ GeV}$ $-1/3$ $1/2$	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	$\approx 1.78 \text{ GeV}$ -1 $1/2$	τ tau	$\approx 80.4 \text{ GeV}$ ± 1 1	W W boson		
LEPTONS	$< 0.8 \text{ eV}$ 0 $1/2$	ν_e electron neutrino	$< 0.17 \text{ MeV}$ $1/2$	ν_μ muon neutrino	$< 18.2 \text{ MeV}$ $1/2$	ν_τ tau neutrino	$\approx 91.2 \text{ GeV}$ 0 1	Z Z boson		
							SCALAR BOSONS			
						GAUGE BOSONS VECTOR BOSONS				

► **Fermions** of spin $1/2$, which make up matter

- Quarks
- Leptons
- Three generations

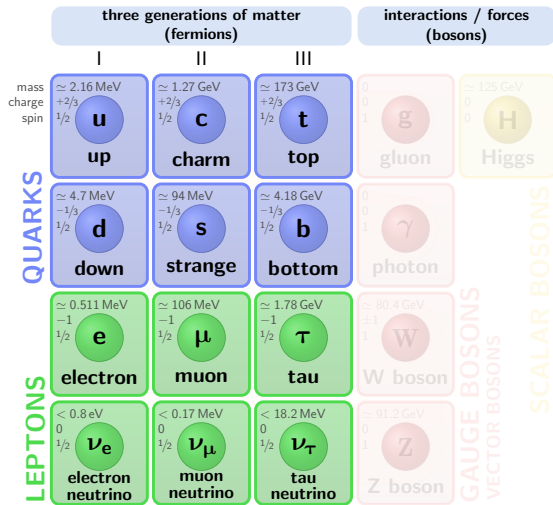
Standard Model of Particle Physics

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I	II	III		
mass charge spin $\approx 2.16 \text{ MeV}$ $+\frac{2}{3}$ $\frac{1}{2}$ u up	$\approx 1.27 \text{ GeV}$ $+\frac{2}{3}$ $\frac{1}{2}$ c charm	$\approx 173 \text{ GeV}$ $+\frac{2}{3}$ $\frac{1}{2}$ t top	0 0 1 g gluon	$\approx 125 \text{ GeV}$ 0 0 H Higgs
$\approx 4.7 \text{ MeV}$ $-\frac{1}{3}$ $\frac{1}{2}$ d down	$\approx 94 \text{ MeV}$ $-\frac{1}{3}$ $\frac{1}{2}$ s strange	$\approx 4.18 \text{ GeV}$ $-\frac{1}{3}$ $\frac{1}{2}$ b bottom	0 0 1 γ photon	
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► **Fermions** of spin $1/2$, which make up matter

- **Quarks**
- **Leptons**
- Three generations

Standard Model of Particle Physics



► **Fermions** of spin $1/2$, which make up matter

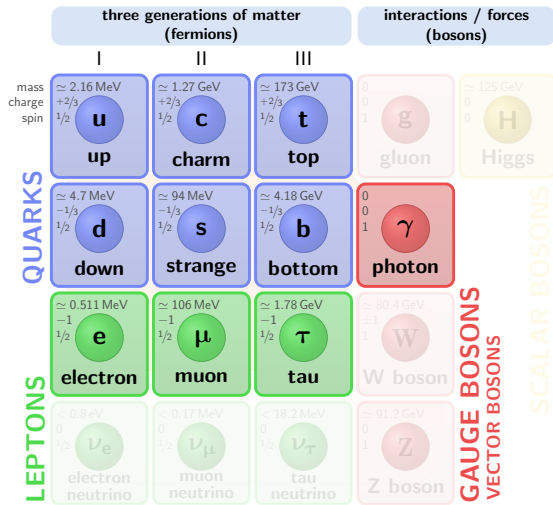
- Quarks
- Leptons
- Three generations

Standard Model of Particle Physics

three generations of matter (fermions)			interactions / forces (bosons)	
QUARKS	I	II	III	
	mass ≈ 2.16 MeV charge $+2/3$ spin $1/2$ u up	mass ≈ 1.27 GeV charge $+2/3$ spin $1/2$ c charm	mass ≈ 173 GeV charge $+2/3$ spin $1/2$ t top	mass ≈ 125 GeV charge 0 spin 0 H Higgs
	mass ≈ 4.7 MeV charge $-1/3$ spin $1/2$ d down	mass ≈ 94 MeV charge $-1/3$ spin $1/2$ s strange	mass ≈ 4.18 GeV charge $-1/3$ spin $1/2$ b bottom	mass 0 charge 0 spin 1 g gluon
	mass ≈ 0.511 MeV charge -1 spin $1/2$ e electron	mass ≈ 106 MeV charge -1 spin $1/2$ μ muon	mass ≈ 1.78 GeV charge -1 spin $1/2$ τ tau	mass ≈ 80.4 GeV charge ± 1 spin 1 W W boson
	mass < 0.8 eV charge 0 spin $1/2$ ν_e electron neutrino	mass < 0.17 MeV charge 0 spin $1/2$ ν_μ muon neutrino	mass < 18.2 MeV charge 0 spin $1/2$ ν_τ tau neutrino	mass ≈ 91.2 GeV charge 0 spin 1 Z Z boson
LEPTONS			GAUGE BOSONS VECTOR BOSONS	
			SCALAR BOSONS	

- **Fermions** of spin $1/2$, which make up matter
 - Quarks
 - Leptons
 - Three generations
- **Gauge bosons** of spin 1, which mediate the fundamental interactions

Standard Model of Particle Physics



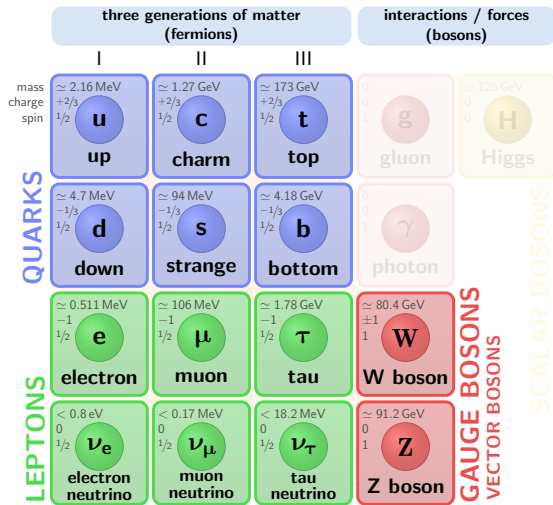
- ▶ **Fermions** of spin $1/2$, which make up matter
 - ▶ Quarks
 - ▶ Leptons
 - ▶ Three generations
- ▶ **Gauge bosons** of spin 1, which mediate the fundamental interactions
 - ▶ Electromagnetic interaction

Standard Model of Particle Physics

three generations of matter (fermions)			interactions / forces (bosons)	
I	II	III		
mass charge spin $\approx 2.16 \text{ MeV}$ $+\frac{2}{3}$ $\frac{1}{2}$ u up	$\approx 1.27 \text{ GeV}$ $+\frac{2}{3}$ $\frac{1}{2}$ c charm	$\approx 173 \text{ GeV}$ $+\frac{2}{3}$ $\frac{1}{2}$ t top	0 0 1 g gluon	$\approx 125 \text{ GeV}$ 0 0 H Higgs
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- **Fermions** of spin $1/2$, which make up matter
 - Quarks
 - Leptons
 - Three generations
- **Gauge bosons** of spin 1 , which mediate the fundamental interactions
 - Electromagnetic interaction
 - Strong interaction

Standard Model of Particle Physics



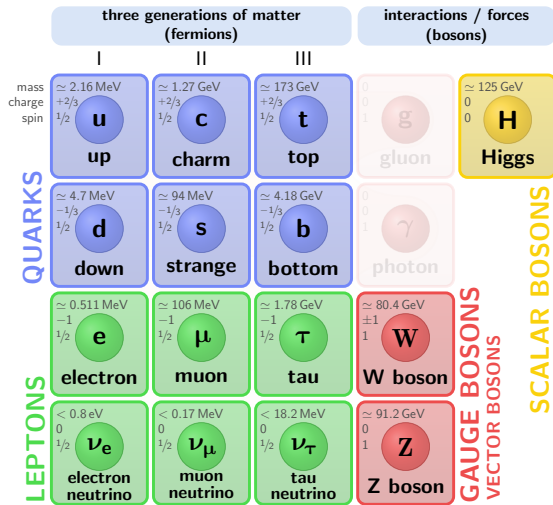
- ▶ **Fermions** of spin $1/2$, which make up matter
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 - ▶ Leptons
 - ▶ Three generations
- ▶ **Gauge bosons** of spin 1, which mediate the fundamental interactions
 - ▶ Electromagnetic interaction
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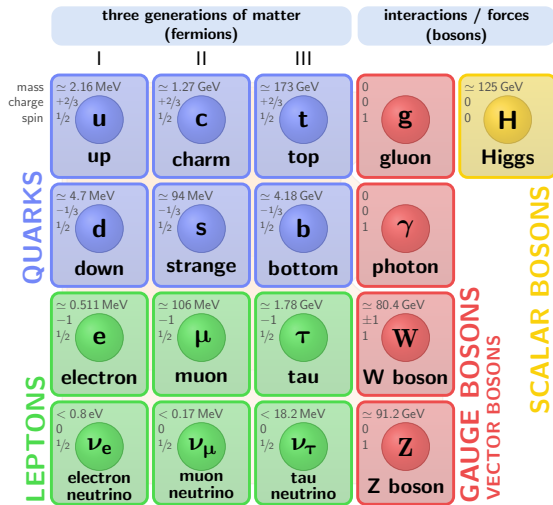
- ▶ **Fermions** of spin $1/2$, which make up matter
 - ▶ Quarks
 - ▶ Leptons
 - ▶ Three generations
- ▶ **Gauge bosons** of spin 1 , which mediate the fundamental interactions
 - ▶ Electromagnetic interaction
 - ▶ Strong interaction
 - ▶ Weak interaction
- ▶ One **scalar boson** of spin 0 , which gives mass to fermions and weak bosons

Standard Model of Particle Physics



- ▶ **Fermions** of spin $1/2$, which make up matter
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Standard Model of Particle Physics



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