

Title: Particle Physics 2

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URL: <http://pirsa.org/10100112>

Abstract:

The story so far...

In the 1940's, '50's and '60's physicists found all sorts of particles that were not covered by the periodic table.

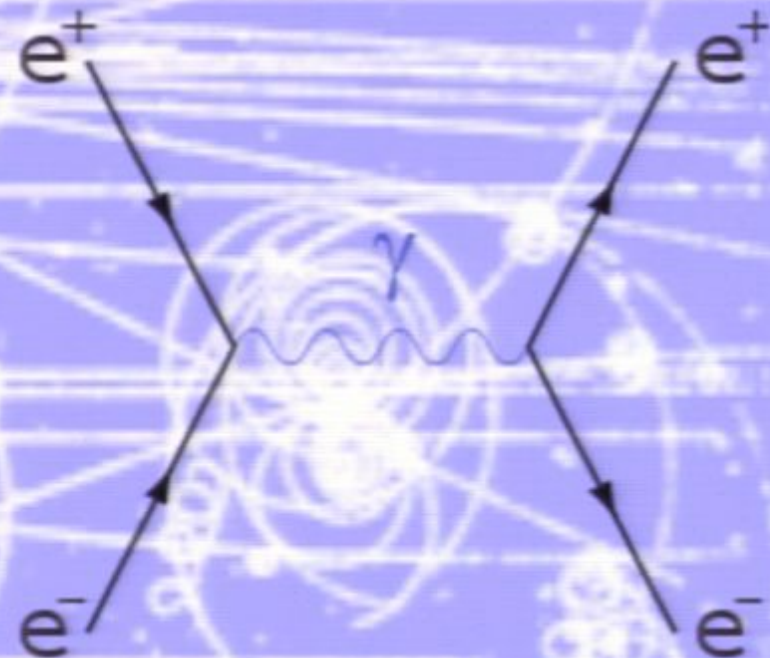
- **baryons (protons, the neutrons, and the deltas)**
- **mesons (pions and kaons)**
- **Leptons (electrons, electron neutrinos, muons and muon neutrinos)**

The story so far...

In the 1940's, '50's and '60's physicists found all sorts of particles that were not covered by the periodic table.

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- For every type of matter particle we've found, there also exists a corresponding antimatter particle, or antiparticle
- Antiparticles look and behave just like their corresponding matter particles, except they have opposite charges.
- When they meet they annihilate and form energy
- The opposite can also happen



Particle Zoo

Baryons			Mesons			Leptons			Photon	
Symbol	Q	M (MeV/c ²)	Symbol	Q	M (MeV/c ²)	Symbol	Q	M (MeV/c ²)	Symbol	Q
p	+1	938	π^+	+1	140	e	-1	0.531	γ	0
\bar{p}	-1	938	π^-	-1	140	\bar{e}	+1	0.531		
n	0	940	π^0	0	135	ν_e	0	<0.0000022		
\bar{n}	0	940	κ^+	+1	494	$\bar{\nu}_e$	0	<0.0000022		
Δ^0	0	1230	κ^-	-1	494	μ	+1	106		
Δ^+	+1	1230	κ^0	0	498	ν_μ	0	<0.17		

OBSERVED EVENTS	UNOBSERVED EVENTS
1) $n \rightarrow p + e + \underline{\nu}_e$	14) $n + p \rightarrow p + p$ charge
2) $\pi^+ + n \rightarrow p + \pi^0$	15) $p \rightarrow \pi^0 + \pi^+$ baryon
3) $\pi^- + p \rightarrow n + \pi^- + \pi^+$	16) $\pi^- \rightarrow e + \gamma$ lepton
4) $\pi^- + p \rightarrow p + \pi^0 + \pi^-$	17) $\pi^- + p \rightarrow n + e + \pi^+$ lepton
5) $\Delta^+ \rightarrow p + \pi^+$	18) $\Delta \rightarrow \pi^0 + \pi^- + \pi^+$ baryon
6) $\Delta^+ + \underline{n} \rightarrow \pi^0$	19) $\Delta \rightarrow \pi^- + \pi^+$ baryon
7) $p + \underline{p} \rightarrow e + e + \gamma + \gamma$	20) $\Delta \rightarrow n + \pi^0 + \underline{\nu}$ lepton
8) $\underline{e} + e \rightarrow \underline{\mu} + \underline{\mu}$	21) $p \rightarrow \pi^- + \pi^+$ baryon, charge
9) $p + \underline{\nu}_e \rightarrow n + \underline{e}$	22) $n + p \rightarrow n + \Delta + \underline{e}$ lepton
10) $p + p \rightarrow p + p + \pi^+ + \pi^-$	23) $\pi^+ + n \rightarrow \kappa^+ + \kappa^0$ baryon
11) $\pi^+ \rightarrow \underline{\mu} + \underline{\nu}_\mu$	24) $\pi^+ \rightarrow \underline{\mu} + \underline{\nu}_e$ lepton type
12) $\pi^0 \rightarrow \gamma + \gamma$	25) $\underline{\mu} \rightarrow \underline{e} + \underline{\nu}_\mu + \underline{\nu}_e$ lepton type
13) $\underline{\mu} \rightarrow \underline{e} + \underline{\nu}_\mu + \underline{\nu}_e$	26) $n + p \rightarrow \pi^0 + \underline{e}$ baryon, lepton

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Conservation Of Mass

- The mass of a closed system will stay constant over time
- Compare the masses before and after and see what you get

Conservation of Particles

- Do we have the same amount of particles on either side of the reactions?

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Conservation of Charge



Conservation of Baryon Number

Baryons		
Symbol	Q	M (MeV/c ²)
p	+1	938
<u>p</u>	-1	938
n	0	940
<u>n</u>	0	940
Δ^0	0	1230
Δ^+	+1	1230

Conservation of Meson Number

Mesons		
Symbol	Q	M (MeV/c ²)
π^+	+1	140
π^-	-1	140
π^0	0	135
κ^+	+1	494
κ^-	-1	494
κ^0	0	498

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8) $e + e \rightarrow \mu + \underline{\mu}$	21) $p \rightarrow \pi^- + \pi^+$ baryon, charge
9) $p + \underline{\nu}_e \rightarrow n + e$	22) $n + p \rightarrow n + \Delta + e$ lepton
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11) $\pi^+ \rightarrow \underline{\mu} + \nu_\mu$	24) $\pi^+ \rightarrow \mu + \underline{\nu}_e$ lepton type
12) $\pi^0 \rightarrow \gamma + \gamma$	25) $\underline{\mu} \rightarrow e + \underline{\nu}_\mu + \underline{\nu}_e$ lepton type
13) $\underline{\mu} \rightarrow e + \underline{\nu}_\mu + \nu_e$	26) $n + p \rightarrow \pi^0 + e$ baryon, lepton

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π^-	-1	140
π^0	0	135
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Conservation of Lepton Number

Leptons		
Symbol	Q	M(MeV/c ²)
e	-1	0.531
\bar{e}	+1	0.531
ν_e	0	< 0.0000022
$\bar{\nu}_e$	0	< 0.0000022
μ	+1	106
ν_μ	0	< 0.17

OBSERVED EVENTS	UNOBSERVED EVENTS
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12) $\pi^0 \rightarrow \gamma + \gamma$	25) $\mu^- \rightarrow e^- + \bar{\nu}_\mu + \bar{\nu}_e$ lepton type
13) $\bar{\mu} \rightarrow e^- + \bar{\nu}_\mu + \bar{\nu}_e$	26) $n + p \rightarrow \pi^0 + e^-$ baryon, lepton

No Signal

VGA-1

No Signal

VGA-1

No Signal

VGA-1

No Signal

VGA-1

No Signal

VGA-1

No Signal

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No Signal

VGA-1

No Signal

VGA-1

Normal Outline Notes Handout Slide Sorter

Slide 1

Slide 2

Slide 3

Introducing... QUARKS

We might be having trouble explaining why some particle types are conserved and others aren't!

So, let's propose this:

Baryons and Mesons are made from something else: quarks

Tasks View

Master Pages

Layouts

Table Design

Custom Animation

Slide Transition

Slide 1

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