

## 2.5.2 Lepton number, baryon number and strangeness

All particles are assigned quantum numbers which help to determine how they interact or decay.



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### Lepton number

All leptons are assigned a lepton number.

- An electron ( $e^-$ ) has an electron lepton number  $L_e = +1$ .
- Its associated electron neutrino ( $\nu_e$ ) has an electron lepton number  $L_e = +1$ .
- The anti-electron ( $e^+$ ) has an electron lepton number  $L_e = -1$ .
- The anti-electron neutrino ( $\bar{\nu}_e$ ) has an electron lepton number  $L_e = -1$ .

We can see that the particles have lepton number +1 and the antiparticles have a lepton number -1.

The same pattern is observed for the muon.

- A muon ( $\mu^-$ ) has a muon lepton number  $L_\mu = +1$ .
- The muon neutrino ( $\nu_\mu$ ) has a muon lepton number  $L_\mu = +1$ .
- The anti-muon ( $\mu^+$ ) has a muon lepton number  $L_\mu = -1$ .
- The anti-muon neutrino ( $\bar{\nu}_\mu$ ) has a muon lepton number  $L_\mu = -1$ .

(1) ✍ Write down the tau lepton numbers ( $L_\tau$ ) for the tau ( $\tau^-$ ), the tau neutrino ( $\nu_\tau$ ), the anti-tau ( $\tau^+$ ), and the anti-tau neutrino ( $\bar{\nu}_\tau$ ).

All hadrons (baryons and mesons) have a lepton number  $L_{e,\mu,\tau} = 0$ , because they aren't leptons!

### Baryon number

- All baryons have a baryon number  $B = +1$
- All anti-baryons have a baryon number  $B = -1$ .

Mesons and leptons have a baryon number  $B = 0$ , because they aren't baryons!

(2) ✍ What baryon number would the following have: a proton, an anti-neutron, a positive pion, a positron?

### Strangeness

- All hadrons which contain a strange quark ( $s$ ) are assigned a strangeness number  $S = -1$ .
- All hadrons which contain an anti-strange quark ( $\bar{s}$ ) are assigned a strangeness number  $S = +1$ .

Leptons, and hadrons which don't contain a strange quark have strangeness  $S=0$ .

(3) ✍️ What strangeness number would the following particles have: a proton ( $p$ ), an anti-muon neutrino ( $\bar{\nu}_\mu$ ), a negative kaon ( $K^-$ ), a positive pion ( $\pi^+$ ), an anti-neutron ( $\bar{n}$ )?

(4) ✍️ Now complete the following table:

particle	Particle name	Charge Q	$L_e$	$L_\mu$	$L_\tau$	B	S
$e^-$	electron	-1	1	0	0	0	0
$\bar{\nu}_\tau$	anti-tau neutrino	0	0	0	-1	0	0
$\mu^-$	muon						
$p$	proton	+1	0	0	0	+1	0
$\bar{p}$							
$K^-$	negative kaon						
$\pi^+$	positive pion	+1	0	0	0	0	0
$K^0$	neutral kaon	0	0	0	0	0	+1
$\tau^+$	anti-tau						