Physics 745 - Group Theory

Solution Set 26

1. [10] Below is a list of reactions that are possible. You should know the charge and baryon number of the proton (p), electron (e) and neutron (n). Deduce the charge *Q* and baryon number *B* of all listed particles, namely

$$\bar{p}, \pi, K_L, \bar{\pi}, \bar{\nu}, \nu, \mu, Z, \bar{\mu}, \Lambda_c$$

Any particle with a bar over it is the anti-particle of the corresponding particle; for example, $\bar{p}$ is the anti-proton. Comment: In many cases I have done my best to disguise the particles by not giving them standard names.

$$\bar{p} + p \to \pi + n + \bar{p}$$
$$K_L \to \pi + \bar{\pi}$$
$$n \to p + e + \bar{\nu}$$
$$\nu + n \to \mu + p$$
$$Z \to \mu + \bar{\mu}$$
$$\Lambda_c \to p + K_L$$

The $\bar{p}$ is the anti-particle of the proton, and hence has both charge and baryon number -1. In the first reaction, the left side is neutral, as is the neutron, so the π must have charge +1 to compensate for the $\bar{p}$. Not counting the pion, the other particles have cancelling baryon number, so the pion has baryon number zero. In the second reaction, the anti-pion has opposite charges from the pion, so those charges cancel, and the K_L must have no charge of either kind. For the neutron decay, the neutron and proton have cancelling baryon number, and there is no net charge on either side not counting the anti-neutrino, so the anti-neutrino (and hence the neutrino) has charge of zero for both kinds. In the neutrino/neutron interaction, there is baryon number 1 and charge zero on the right, and to get it to work out, the muon must have charge -1 and baryon number zero. The anti-muon therefore has charge +1 and baryon number zero. The *Z* must be doubly neutral again. Finally, since the right side in the last equation has baryon number +1 and charge +1, the Λ_c must have these values as well. Our results are contained in the table at right.

	Q	***B***
$\bar{p}$	-1	-1
π	+1	0
K_L	0	0
$\bar{\pi}$	-1	0
$\bar{\nu}$	0	0
ν	0	0
μ	-1	0
Z	0	0
$\bar{\mu}$	+1	0
Λ_c	+1	+1