# Gauge Theories: Electroweak

Lecturer: Richard Ball

January 18, 2019

Imagine a world without electroweak:

- Still have electromagnetism (EM), massive hadrons, atoms, gravity etc.
- Parity (P) and charge conjugation (C) are still good symmetries
- Flavour is always conserved: everything lasts forever (and always existed)
- No neutrinos (would be non-interacting)

Neutrinos were first hypothesised by Pauli (1930) to explain the missing energy in $\beta$-decay. They were first observed in 1956 (Cowan-Reines). Parity violation was first directly observed in 1956/7 (Lee-Yang-Wu).

## 1 Chirality

Define the projection operators $P_R \equiv \frac{1}{2}(1+\gamma^5)$ and $P_L \equiv \frac{1}{2}(1-\gamma^5)$.