▲ relativistic kinematics:

$$(P_a + P_b)^2 = \begin{pmatrix} E_{beam}(x_a + x_b) \\ 0 \\ 0 \\ E_{beam}(x_a - x_b) \end{pmatrix}^2 \qquad P_a = \begin{pmatrix} E_{beam} x_a \\ 0 \\ 0 \\ +E_{beam} x_a \end{pmatrix} \qquad P_b = \begin{pmatrix} E_{beam} x_b \\ 0 \\ 0 \\ -E_{beam} x_b \end{pmatrix}$$

$$= 4E^2_{beam} x_a x_b = E^2_{cm} x_a x_b \qquad \hat{s} = (P_a + P_b)^2 + s^0$$

$$= s \cdot x_a x_b$$

rapidity $y = \frac{1}{2} \ln\left(\frac{E+p_z}{E-p_z}\right)$

$y_{hard} = \frac{1}{2} \ln\left(\frac{x_a}{x_b}\right)$

pseudo-rapidity (for $s=0$)

$\eta = -\ln(\tan \vartheta/2)$ $\quad -2{,}5 < \eta < 2{,}5$ leptons $\quad -5 < \eta < 5$ jets

$\cos\vartheta = \tanh(\eta)$ $\qquad \Delta R = \sqrt{(\Delta\eta)^2 + (\Delta\phi)^2}$

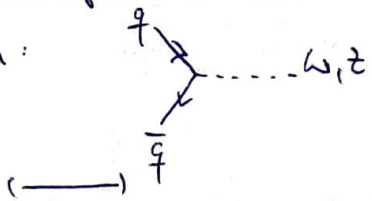
$E_T = E \cdot \sin\vartheta$

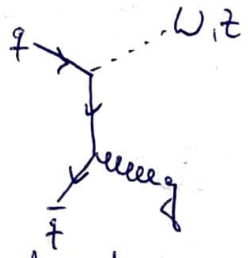
▲ symmetries and conserved quantities - clear

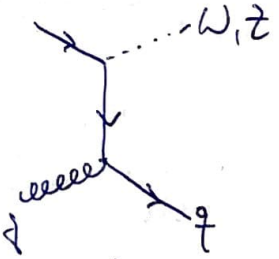
▲ Standard Model - clear

▲ properties of $W^\pm, Z$

Production:







not whole proton take part in interaction, only partons -> carry fraction x of whole momentum

each parton described by PDF f_i

$$\sum_i \int f_i(x) dx = 1$$

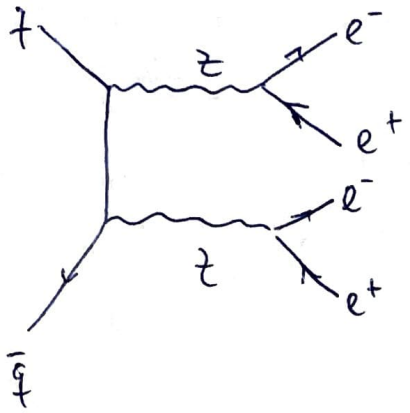
≈ ½ of momentum is carried by valence quarks

decay: $W \to l \bar{\nu}_l$, jets $\qquad Z \to l\bar{l}$, jets, $\nu_l \bar{\nu}_l$

$m = 80\,GeV$ 1/3 2/3 $\qquad m_Z = 91\,GeV$ 10% 70% 20%

$$\frac{d\sigma}{dp_T} \propto \frac{1}{\sqrt{\frac{1}{4}M_W^2 - p_T^2}} \to \text{arccos-peak at } \tfrac{1}{2} M_W$$

▷ Z^0 - Pair production and search for new physics



background

top-quark pair-production

bottom-quark pair-production

$q\bar{q} \rightarrow H^0 \rightarrow ZZ \rightarrow 4l$

SUSY → for each fermionic degree of freedom there is a bosonic degree of freedom

→ search for SUSY in $4l$ final states

neutralinos (mixing of Higgs and neutral Gauge bosons)

$\tilde{l}$-squark production

→ search for 4th generation quark

$q\bar{q} \rightarrow d_4\bar{d}_4 \rightarrow tW^-\bar{t}W^+ \rightarrow lW^+W^-\bar{l}\nu^-\nu^+$

↳ two to four leptons

$l\bar{l} \rightarrow \nu_4\bar{\nu}_4 \rightarrow lW^-\bar{l}W^+$

→ $Z'Z' \rightarrow 4l$ with $m_{Z'} > m_Z$

▷ The ATLAS detector

- ▷ inner detector
- ▷ elm calorimeter
- ▷ hadron calorimeters
- ▷ muon chambers

Questions before last session:

1.) $m_Z^2 = \begin{pmatrix} E_e + E_{e^+} \\ p_e - p_e \end{pmatrix}^2 = (2p_e)^2 = 4p_e^2 \Rightarrow p_e = \frac{m_Z}{2}$

2.) some argument $p_e = 1{,}5\ \frac{GeV}{c}$

3.) $p_W = p_e + p_\nu$

4.)