Computational Physics Lab

Analysis of Large Data Sets: Invariant Masses

03/26/2009

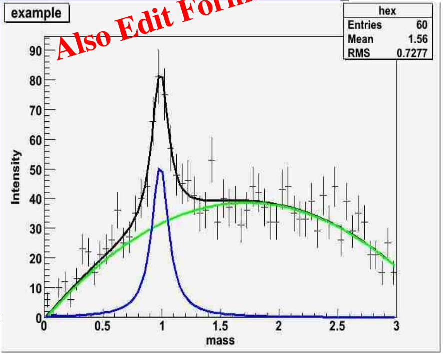
Outline

1. Mass Spectra
   - Three-Vectors
   - Four-Vectors

Remember from Project 9 ...

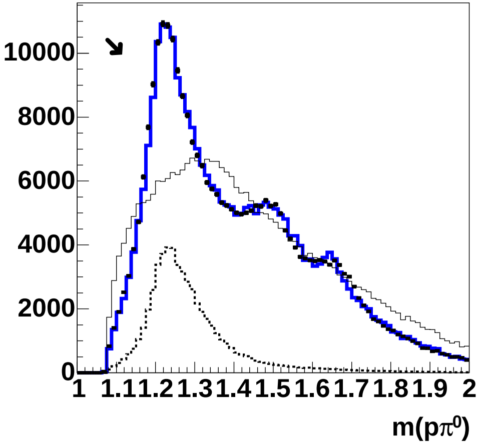
```
// Add these commands to the end of the doFit() function
// improving the figure
 TF1* backFcn = new TF1("backFcn",
                                  background,0,3,3);
 backFcn->SetLineColor(3);
 TF1* bwFcn = new TF1("bwFcn", brietWigner,0,3,3);
 bwFcn->SetLineColor(4);

 double par[6];
 fitFcn->GetParameters(par);

 backFcn->SetParameters(par);
 backFcn->Draw("same");

 bwFcn->SetParameters(&par[3]);
 bwFcn->Draw("same");
```

Also Edit Format Interactively!



Photoproduction of Mesons

$$\gamma p \rightarrow X \rightarrow \Delta^+\pi^0 \rightarrow p\pi^0\pi^0 \rightarrow p\gamma\gamma\gamma\gamma$$



Example:

We want to study

$$\gamma p \rightarrow N^* \rightarrow p\pi^0\pi^0$$

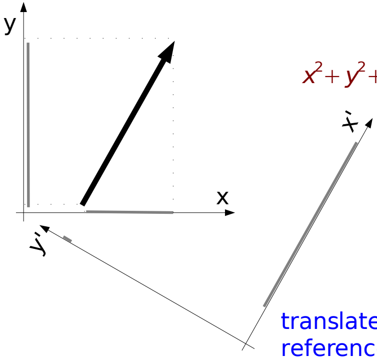
- Measure p, π^0's
- Use inv. mass: $m^2 = E^2 - p^2$

3-Vectors

Magnitude is invariant under translations and rotations

$$\vec{r}\cdot\vec{r}=\vec{r}'\cdot\vec{r}'$$

$$x^2+y^2+z^2=x'^2+y'^2+z'^2$$



translated & rotated reference frame

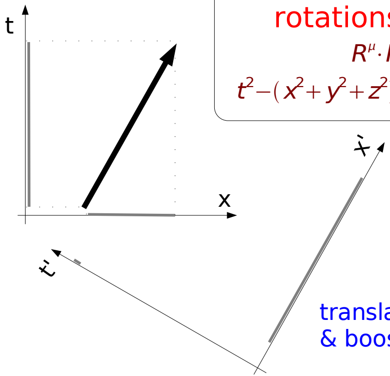
4-Vectors: (x, y, z, t)

Magnitude is invariant under translations, rotations, and boosts.

$$R^\mu \cdot R^\mu = R'^\mu \cdot R'^\mu$$

$$t^2 - (x^2 + y^2 + z^2) = t'^2 - (x'^2 + y'^2 + z'^2)$$

units of $c=1$



translated, rotated,
& boosted reference frame

4-Momentum: (P_x, P_y, P_z, E)

four-momentum

$$P^\mu(E, \vec{p})$$

magnitude squared of the four-momentum

natural units(c=1)

$$P^\mu \cdot P^\mu = P^\mu P_\mu$$

$$P^\mu P_\mu = E^2 - \vec{p} \cdot \vec{p} = E^2 - p^2$$

$$E^2 = P^\mu P_\mu + p^2$$

standard units

$$E^2 = (P^\mu P_\mu) c^4 + (pc)^2$$

$$E^2 = (m_o^2) c^4 + (pc)^2$$

Einstein's Equation

The magnitude is the invariant rest mass