Emanuele Rosi

Two particles decay useful formulae

Suppose we have the decay process $B \to K + \pi$ with given masses.
If, in the lab, we have the following four-momenta:

$$p_\pi^\mu = (E_\pi, \vec{p}_\pi) \qquad p_K^\mu = (E_K, \vec{p}_K)$$

then the invariant mass is:

$$s = \eta_{\mu\nu}\, p_{tot}^\mu\, p_{tot}^\nu = m_\pi^2 + m_K^2 + 2\left(\sqrt{m_\pi^2 + p_\pi^2}\,\sqrt{m_K^2 + p_K^2} - p_\pi\, p_K \cos(\theta)\right)$$

If we apply a gaussian distribution (e.g., due to the resolution of the detector) to p_π and another one to p_K we have to consider these changes

$$p_\pi \to p_\pi + \delta p_\pi \qquad p_K \to p_K + \delta p_K$$

First, the two factor squared under the square roots: they bring only positive contributions to invariant mass of the system. Second, the other two factors multiplying $\cos(\theta)$: they bring both positive and negative factors. At the end, the mean of invariant mass under a sample of 10^4 events is switched to higher mass than m_B. For this reason this effect is called **"smearing"**.