

B. L. Friman & J. Knoll, Lectures SS 2000

Problem set 2, date 17.5.00

- 1 **m_{\perp} -scaling:** for a system of N nucleons with given total invariant c.m. energy \sqrt{s} derive the probability distribution $W(m_{\perp}, y)$ of a newly produced particle like a pion, or η -meson as a function of m_{\perp} and rapidity of this particle. Hint: the new aspect is that the total phase-space consists of two pieces: the phase-space of N nucleons and that of N nucleons plus the extra particle. How would you write down a formula analogous to (44,45) for $W(\vec{p}_{\pi})$? How does this simplify, if the second phase-space part is small compared to the first one? Then transform this to a distribution in $W(m_{\perp}, y)$ and discuss the result.
- 2 **Correlations through momentum conservation:** Analog to eq. (67,68) write down the two-particle distribution $W(\vec{p}_1, \vec{p}_2)$ to observe two particles with momenta \vec{p}_1 and \vec{p}_2 and discuss the result as a function of the number of particles N at constant c.m. energy per particle $\sqrt{s}/N = \text{const}$.

For advanced practioners (and presumably only to be discussed a week later!):

- 3a **Dalitz plot:** (repetition from last time) Show that, for a three-body system at a given s , the differential phase space distribution

$$\frac{d\Phi_{1,2,3}(s)}{d\varepsilon_1 d\varepsilon_2}$$

is a constant inside the kinematically allowed region. Here the $(\varepsilon_1, \vec{p}_1)$ etc. are the 4-momenta of the particles in the c.m. frame of the system and $d\Phi_{1,2,3}/d\varepsilon_1 d\varepsilon_2$ is defined such that

$$\Phi_{1,2,3}(s) = \int d\varepsilon_1 d\varepsilon_2 \frac{d\Phi_{1,2,3}(s)}{d\varepsilon_1 d\varepsilon_2}$$

- 3b convert the above distribution into a distribution in the invariant cluster masses s_{23} and s_{13} of the pairs 23 and 13. This is called a Dalitz plot.
- 3c **Dalotz-plot for resonance decay:** How will the distribution look for the case, where a Φ -meson of mass of 1 GeV will decay into three pions, and one assumes that pions 2 and 3 result from an intermediate ρ -meson with properties given by a spectral function as in (56-59) of the lecture notes. For simplicity we treat the three pions as distinguishable particles such that only particles 2 and 3 stem from an intermediate ρ -meson.