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 $\sqrt{s}/N = const.$

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

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

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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.