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

Problem set 4, date 7.6.00 9:30h Seminarraum KPI/III

left over from last time:

1 **ρ-meson- production in π N scattering:** A pion scatters off a resting nucleon. From which energy on (kinetic beam energy t_π and c.m. energy $\sqrt{s}$) can one produce two pions ($\pi N \longrightarrow \pi\pi N$)? Calculate the invariant mass spectrum $F(\sqrt{s_{\pi\pi}})$ for the production of the pion pair under the assumption that an intermediate ρ-meson is formed which decays into the two pions ($\pi N \rightarrow \rho N \rightarrow \pi\pi N$). The first coupling is assumed to be constant, while the $\rho\pi\pi$ coupling is taken to be p-wave (c.f. (56-59) in the lecture notes).

and some new problems:

2 **Phase shifts and the phase of the scattering amplitude:** Write the phase shift in terms of the real and imaginary parts of the scattering amplitude for elastic scattering in a given partial wave.

3 **Phase shifts for an attractive square-well potential:**

a Derive the s-wave phase shift for an attractive square-well potential of depth V_0 and radius a using the general expression given in the lectures:

$$\tan\delta_\ell = \frac{k\hat{j}'_\ell(kr)\chi(r) - \hat{j}_\ell(kr)\chi'(r)}{k\hat{n}'_\ell(kr)\chi(r) - \hat{n}_\ell(kr)\chi'(r)}\Big|_{r=R} \ ,$$

where R should be large than the range of the potential.

b Compute the s-wave phase shift for low energies ($ka << 1$).

c Use e.g. Mathematica to compute the phase shift for $\mu = 1, V = -10, R = 2$ and momentum k between 0 and 10. What do you observe? (We will try to arrange a computer with Mathematica for the excercises on Wednesday, so that those who want can try out their solutions.)