Joined Physics Analysis Center

Summer Workshop on the Reaction Theory
Exercise sheet 8

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June 12 – June 22 To be discussed on Tuesday of Week-II.

Classwork

1. Derive all the quantum numbers $I^G J^{PC}$ in the $t-$channel of the following reactions
   (a) $\pi\pi \to \pi\pi$ and $K\bar{K} \to K\bar{K}$
   (b) $\pi N \to \pi N$, $\pi N \to \eta N$ and $KN \to KN$
   (c) $\gamma N \to \eta N$ and $\gamma N \to \pi N$
   (d) $\pi\rho \to \rho\pi$

   Notation: $\pi = (\pi^+, \pi^-, \pi^0)$; $\rho = (\rho^+, \rho^-, \rho^0)$; $K = (K^+, K^0)$; $N = (p, n)$.
2. Assume that the Regge exchange form a $SU(3)$ octet and a $SU(3)$ singlet with the coupling for the octet and the singlet being different. Consider a vector and a tensor nonet (octet plus singlet). From the duality hypothesis and the absence of double charge meson, find the combination of octet-singlet tensor that decouples from $\pi\pi$. Use the SU(3) Clebsch-Gordan coefficients from Rev.Mod.Phys. 36 (1964) 1005. What are the quark content and the $K\bar{K}$ couplings of these states?
3. Assuming ideal mixing for the vector and tensor, derive the exchange degeneracy relations coming duality and the absence of resonance in the following reactions
   (a) $\pi\pi \to \pi\pi$
   (b) $K\bar{K} \to K\bar{K}$
   (c) $KN \to KN$
   (d) $\pi\rho \to \rho\pi$ (and $\pi\pi \to \rho\rho$)
4. Derive a Lorentz-covariant basis, the isospin decomposition and the crossing properties for the following reactions
   (a) $\pi N \to \pi N$ and $KN \to KN$
   (b) $NN \to NN$
   (c) $\omega \to \pi\pi\pi$ and $B \to J/\psi K\pi$
   (d) $\pi\rho \to \pi\rho$
   (e) $\gamma N \to \pi N$ and $\gamma^* N \to \pi N$ (use $F^{\mu\nu} = \epsilon^\mu k^\nu - \epsilon^\nu k^\mu$)