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V.M.Maltsev, N.K.Dushutin

DUAL MODELS IN FORMALISM OF RANDOM PROCESSES

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In previous studies, in which high-energy hadron interactions were analyzed on the basis of the random process approximation, it was presumed that the production probability for particles of one sort is the same. In this case the definite particle production probability remains a scalar. It is possible, however, to generalize this statement, presuming, that the generation process of one particle appears to be random, in some respect. Then, the production probability becomes a vector. The dimensionality of this vector coincides in the limit with the number of particles, produced in the reaction.

We can characterize the exclusive reaction

$$a + b \rightarrow c_1 + c_2 + \dots + c_n \qquad (1)$$

of any n -particle formation in the final state by the probability $P(x_1, \dots, x_n)$,* where the i -th particle production probability x_i , is a random quantity, assuming the values in the interval $[0, 1]$.

The quantity $P(x_1, \dots x_n)$ can be represented as follows:

$$P(x_1, \dots, x_n) = p(x_1) \dots p(x_n) p(x_1 | x_2) \dots p(x_1 | x_n) p(x_2 | x_3) \dots$$

$$\dots p(x_{n-1} | x_n) p(x_1 | x_2 x_3) \dots p(x_1 | x_2 \dots x_n) \dots \qquad (2)$$

where conditional probabilities $p(x_i | x_{i+1} \cdots x_k)$ characterize i -th particle correlation with particles $i+1, \dots, k$.

We will obtain the shape of distribution for the absolute density $p(x_i)$. If we divide the whole process of i -th particle formation into a number of intervals, in each of which the generation of a particle either occurs or not, then the particle production probability in m-interval will be equal to

$$p_m(x_i) = x_i(1-x_i)^{m-1}. \tag{3}$$

For the probability density in the limit of an infinitesimal interval length we have

$$\frac{dp(x_i)}{dx_i} = (1-x_i)^{b_i}\, x_i . \tag{4}$$

Then we presume that only pair-correlations exist, i.e. there is short-range interaction as in Feynman-gas /2/. So only conditional probabilities $p(x_i|x_j)$ will differ from zero, moreover, their quantity is, apparently, proportional to the difference $(x_i - x_j)$. Hence, we obtain the following equation for density probability

$$\frac{\partial^n P(x_1,\dots,x_n)}{\partial x_1 \dots \partial x_n} \approx \{\prod_{i=1}^{n} x_i(1-x_i)^{b_i}\} \prod_{1\le i<j\le n}(x_i - x_j) \tag{5}$$

and n-particle production probability is equal to

$$P(x_1,\dots,x_n) = \int_0^1 \{\prod_{i=1}^{n} dx_i(1-x_i)^{b_i} x_i\} \prod_{1\le i<j\le n}(x_i - x_j). \tag{6}$$

Then we will come to the following equation for $P(x_1,\dots x_n)$ if we consider cross-channel contribution, in which it is advisable to replace the x_i-creation by $(1-x_i)$ annihilation probabilities:

$$P(x_1,\dots,x_n) = \int_0^1 \{\prod_{i=1}^{n} dx_i(1-x_i)^{b_i+1} x_i^{a_i+1}\} \prod_{1\le i<j\le n}(x_i - x_j) \tag{7}$$

which coincides with the distribution, obtained in the Veneziano model /3/. If we presume that there exists the correlation between i-th and all other particles and that the processes in the elementary intervals do not correlate, then for such a conditional probability we get

$$p(x_i|x_{i+1}\dots x_n) = x_i x_{i+1}\dots x_n(1 - x_i x_{i+1}\dots x_n)^{c_{in}} . \tag{8}$$

Hence, accounting cross-channel contribution, we have the equation for the exclusive reaction (1) probability as follows

$$P(x_1,\dots,x_n) = \int_0^1 \{\prod_{i=1}^{n} dx_i(1-x_i)^{b_i+1} x_i^{a_i+1+n-i}\} \prod_{1\le i<j\le n}(1-x_{ij})^{c_{ij}+1}, \tag{9}$$

where $x_{ij} = \prod_{\ell=i}^{j} x_\ell$ which coincides with the distribution, obtained in the Reggeized dual model /4/.

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