Note on the high-energy tail of the pion and γ -spectra in p-p collisions at 25
GeV
Hagedorn, Rolf

Published in Nuovo Cimento 15 (1960) 462-464

**This article has been scanned with the kind permission of the
Società Italiana di Fisica.**

From: Angela Oleandri <oleandri@sif.it>
Date: October 12, 2007 4:07:47 PM GMT+02:00
To: Salvatore Mele <Salvatore.Mele@cern.ch>
Subject: Re: Request for permission to reproduce published material.

Dear Dr Mele,

further to your request, sent in July to Carmen Vasini (herewith attached)
I'm pleased to inform you that the Italian Physical Society is happy to
grant you permission of reproduction of the listed material for your
archival purposes at no charges.

**Note on the High-Energy Tail
of the Pion and γ -Spectra in p-p Collisions at 25 GeV.**

R. HAGEDORN

CERN - Geneva

(ricevuto il 6 Novembre 1959)

Summary. — The energy distribution of high energy pions emerging from p-p collisions at 25 GeV is estimated using the statistical model. Indications for the calculation of the γ -spectrum from these data are given.

For some experiments high energy pions and γ -rays may be useful. In a paper on statistical theory applied to 25 GeV p-p collisions ⁽¹⁾ energy spectra and particle numbers were given as curves. The limited accuracy of drawing caused the high energy tail of the spectra to be suppressed. Of course in the numerical results on which the paper ⁽¹⁾ is based, much more information is contained and can be taken out if necessary. The high energy tail of the pion spectrum seems to be such an information and the present note gives the details on it.

It must be mentioned that the Table given below represents only an estimate. The contributions to the tail come from a few reactions only, namely those in which not many particles are produced. The accuracy of the phase-space integrals in each single reaction was prescribed to be $\leq 5\%$. A spectrum (whose sum equals the phase space integral for the reaction in question) contains 31 numbers, hence its statistical accuracy is $\sim 25\%$ for each number. The data given in the Table below are found by graphical smoothing out of

⁽¹⁾ R. HAGEDORN: *Nuovo Cimento*, **15**, 434 (1960).

histograms in which each number was given within $\pm 10\%$. Therefore the numbers in the Table are correct within 5% to 10% as far as the underlying theory is right.

The Table gives the *absolute* number of pions per kinetic energy interval of 100 MeV. In the paper ⁽¹⁾ all spectra were normalized to unity, therefore the low energy part of the Table differs from Fig. 7 of the paper ⁽¹⁾ by the mean pion number, which was chosen here $\langle n \rangle_{\pi} = 4.5$.

TABLE I. - *Absolute number of pions per 100 MeV.*

E_{kin} GeV	Total π	π^+	π^0	π^-
1.1	$7.8 \cdot 10^{-2}$	roughly $\frac{1}{3}$ of total π	roughly $\frac{1}{3}$ of total π	roughly $\frac{1}{3}$ of total π
1.2	$5.8 \cdot 10^{-2}$			
1.3	$4.2 \cdot 10^{-2}$			
1.4	$3.0 \cdot 10^{-2}$			
1.5	$2.1 \cdot 10^{-2}$			
1.6	$1.6 \cdot 10^{-2}$			
1.7	$1.1 \cdot 10^{-2}$			
1.8	$7.5 \cdot 10^{-3}$			
1.9	$5.3 \cdot 10^{-3}$			
2.0	$3.5 \cdot 10^{-3}$			
2.1	$2.3 \cdot 10^{-3}$	$4.3 \cdot 10^{-5}$	$2.7 \cdot 10^{-5}$	$2.0 \cdot 10^{-5}$
2.2	$1.5 \cdot 10^{-3}$			
2.3	$8.7 \cdot 10^{-4}$			
2.4	$4.9 \cdot 10^{-4}$			
2.5	$3.0 \cdot 10^{-4}$			
2.6	$1.6 \cdot 10^{-4}$			
2.7	$9.0 \cdot 10^{-5}$			
2.8	$4.8 \cdot 10^{-5}$			
2.9	$2.5 \cdot 10^{-5}$			
3.0	$1.2 \cdot 10^{-5}$			
3.1	$2.4 \cdot 10^{-6}$			
3.2	0	0	0	0

The charge analysis ⁽²⁾ has been carried through only for the extreme tail, since there one-, two-, and three-pion production contributes. The rule that each charge state obtains approximately $\frac{1}{3}$ of the total number becomes very inaccurate there as the Table shows. For the lower energy regions this approximation becomes tolerable and the long calculations for charge analysis are not justified. It may be interesting to note, that even to the high energy tail, as given here the π -77-isobar ($\frac{3}{2}; \frac{3}{2}$) gives important contributions.

⁽²⁾ See for instance: Multiple meson production from p-p collisions at 2.75 GeV according to a statistical theory: by F. CERULUS and R. HAGEDORN, CERN 59-3.

The γ -spectrum from π^0 decay has not been calculated explicitly. This can be done by using Equ. (16) of the paper ⁽¹⁾ and taking the limits of the integral for $m = \mu = 0$. For most purposes however one will need only pions going in the forward direction and then emitting a γ in the forward direction again.

Of course, the data apply to the CM system and must still be transformed to the lab. system. Though it is not reliable, one may assume isotropy of the pions in CM and get at least correct orders of magnitude.

* * *

I thank Dr. F. CERULUS (CERN) for giving me some coefficients for the charge analysis.

RIASSUNTO (*)

Si stima la distribuzione energetica dei pioni di alta energia emergenti da collisioni p-p a 25 GeV servendosi del modello statistico. Si danno indicazioni per il calcolo dello spettro γ a partire da questi dati.

(*) Traduzione a cura della Redazione.