$$+ P_2(\theta)\,(k_{0i}k_k + k_ik_{0k} - {}^2/_3\,\delta_{ik}\cos\theta)$$

$$+ P_3(\theta)\,(k_{0i}k_{0k} - {}^1/_3\,\delta_{ik}) + P_4(\theta)(k_ik_k - {}^1/_3\,\delta_{ik}),$$

$$P_1(\theta) = \frac{|B|^2 + |C|^2 + 2\mathrm{Re}\,[(A + D\cos\theta)\,C^*]}{3\,(d\sigma/d\Omega)_0};$$

$$P_2(\theta) = \frac{{}^3/_4\,|D|^2\cos\theta + \mathrm{Re}\,[(A+C)\,D^*]}{3\,(d\sigma/d\Omega)_0};$$

$$P_3(\theta) = \frac{-{}^1/_4\,|D|^2 - \frac{1}{\sin\theta}\,\mathrm{Im}\,(B^*D)}{3\,(d\sigma/d\Omega)_0};$$

$$P_4(\theta) = \frac{-{}^1/_4\,|D|^2 + \frac{1}{\sin\theta}\,\mathrm{Im}\,(B^*D)}{3\,(d\sigma/d\Omega)_0}.$$

In the second case,

$$d\sigma/d\Omega = (d\sigma/d\Omega)_0 + (d\sigma/d\Omega)_1 + (d\sigma/d\Omega)_2; \qquad (8)$$

$$\left(\frac{d\sigma}{d\Omega}\right)_0 = |A|^2 + \frac{2}{3}|B|^2 + \frac{2}{3}|C|^2 + \left(\frac{\cos^2\theta}{2} + \frac{1}{6}\right)|D|^2 + \frac{4}{3}\,\mathrm{Re}\,[A^*\,(C + D\cos\theta)] + \frac{2}{3}\,\mathrm{Re}\,(C^*D)\cos\theta; \qquad (9)$$

$$(d\sigma/d\Omega)_1 = 2\,\mathrm{Re}\,[(A + C + {}^1/_2\,D\cos\theta)\,B^*]\,(\mathbf{P}_{\mathrm{in}}\mathbf{n}); \qquad (10)$$

$$(d\sigma/d\Omega)_2 = \{|B|^2 + |C|^2 + 2\,\mathrm{Re}\,[(A + D\cos\theta)\,C^*]\}\,n_in_k\,\langle T_{ik}\rangle_{\mathrm{in}} + \{{}^3/_4\,|D|^2\cos\theta + \mathrm{Re}\,[(A+C)\,D^*]\}\,(k_{0i}k_k + k_ik_{0k})\,\langle T_{ik}\rangle_{\mathrm{in}} + \{-{}^1/_4\,|D|^2 + (\sin\theta)^{-1}\,\mathrm{Im}\,(B^*D)\}\,k_{0i}k_{0k}\,\langle T_{ik}\rangle_{\mathrm{in}} - \{{}^1/_4\,|D|^2 + (\sin\theta)^{-1}\,\mathrm{Im}\,(B^*D)\}\,k_ik_k\,\langle T_{ik}\rangle_{\mathrm{in}}. \qquad (11)$$

The cross section for an unpolarized deuteron beam is given by (9), whereas (10) and (11) result from initial polarization of the deuteron beam, with (10) corresponding to the polarization vector and (11) corresponding to the polarization tensor.

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[1] J. V. Lepore, Phys. Rev. 79, 137 (1950).
[2] S. Wright, Phys. Rev. 99, 996 (1955).
[3] N. Mott and H. Massey, *Theory of Atomic Collisions*.
[4] L. Wolfenstein and I. Ashkin, Phys. Rev. 85, 947 (1952).
[5] R. Dalitz, Proc. Phys. Soc. (London) A65, 175 (1952).

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Charge Distribution of Mesons in Nucleon-Antinucleon Annihilation

A. I. NIKISHOV

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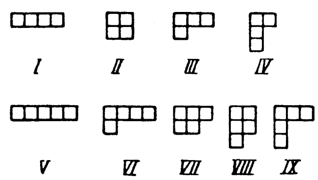
BELEN'KII and Rozental'[1] have studied the production of stars in antinucleon annihilation. On the basis of a statistical theory of multiple particle production they calculated the probabilities for processes of different multiplicites. We



present here the charge distribution which is calculated on the basis of isotopic spin conservation (see Refs. 2 and 3). As usual, p and n denote a proton and a neutron, while $\bar{p}$ and $\bar{n}$ denote an antiproton and an antineutron; annihilation products (π-mesons) are denoted by the signs of their charges. The charge distribution for $p\bar{n}$ is obtained from the distribution for $\bar{p}n$ by reversing the signs of meson charges. Table I shows the subdivision of processes of given multiplicity according to the charge states. If, for example, the annihilation cross section for $p\bar{p}$ into two mesons is σ_2, it can be seen from Table I that 0.167 of this cross section is due to the process $p + \bar{p} \to \pi^0 + \pi^0$ and 0.833 is due to $p + \bar{p} \to \pi^+ + \pi^-$.

If statistical theory is not used but only conservation of total isotopic spin, the charge distribution for a given multiplicity can be obtained only for processes that are characterized by a definite isotopic spin T, its projection T_3 and a definite Young scheme[4]. Such distributions are given in Refs. 5-7 for two and three mesons. We have done the same for four and five mesons. The results are given in Tables II and III. The Roman numerals at the top of the Tables indicate the Young schemes which correspond to the numerals in the Figure.

TABLE I

Number of Mesons	Charge distribution in $\bar{p}p$ and $n\bar{n}$ annihilation: Charge States	Relative statistical weight	Charge distribution in $\bar{p}n$ annihilation: Charge States	Relative statistical weight
2	0 0	0.167	— 0	1
	+ —	0.833		
3	0 0 0	0.150	+ — —	0.700
	+ — 0	0.850	— 0 0	0.300
4	+ + — —	0.400	+ — — 0	0.800
	+ — 0 0	0.578	— 0 0 0	0.200
	0 0 0 0	0.022		
5	+ + — — 0	0.640	+ + — — —	0.286
	+ — 0 0 0	0.340	+ — — 0 0	0.629
	0 0 0 0 0	0.020	— 0 0 0 0	0.085

TABLE II

$T=1$, $T_3=1$	III	IV	$T=1$, $T_3=1$	III	IV	$T=0$	I	II
+ + — 0	3/5	1	+ + — —	4/5	0	+ + — —	8/15	1/3
+ 0 0 0	2/5	0	+ — 0 0	1/5	1	+ — 0 0	2/15	2/3
						0 0 0 0	3/15	0

TABLE III

$T=1$, $T_3=1$	V	VI	VII	VIII	$T=1$, $T_3=0$	V	VI	VII	VIII	$T=0$	IX
+ + + — —	24/35	4/10	4/10	0	+ + — — 0	8/35	8/10	2/10	1	+ + — — 0	2/3
+ + — 0 0	8/35	3/10	6/10	1	+ — 0 0 0	12/35	2/10	8/10	0	+ — 0 0 0	1/3
+ 0 0 0 0	3/35	3/10	0	0	0 0 0 0 0	15/35	0	0	0	—	—

In conclusion I wish to thank Professor S. Z. Belen'kii who suggested this problem.

[1] S. Z. Belen'kii and I. L. Rozental', J. Exptl. Theoret. Phys. (U.S.S.R.) **30**, 595 (1956); Soviet Phys. JETP **3**, 786 (1956).

[2] E. Fermi, Phys. Rev. **92**, 452 (1953).

[3] R. H. Milburn, Rev. Mod. Phys. **27**, 3 (1955).

[4] L. D. Landau and E. M. Lifshitz, *Quantum Mechanics*, Gostekhizdat, 1948, p. 245.

[5] I. Kobzarev and I. Shmushkevich, Dokl. Akad. Nauk SSSR **102**, 929 (1955).

[6] V. B. Berestetskii, Dokl. Akad. Nauk SSSR **92**, 519 (1953).

[7] D. Amati and B. Vitale, Nuovo Cimento **2**, 719 (1955).

Translated by I. Emin
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Account of Retardation in the Interaction of Neutral Atoms

I. E. DZIALOSHINSKII
Institute for Physics Problems
Academy of Sciences, USSR

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CASIMIR and Polder[1] considered retardation in the interaction of two neutral atoms. They showed that the energy of interaction for distances