

Lawrence Berkeley National Laboratory

Recent Work

Title

ANGULAR CORRELATIONS IN THE PRODUCTION AND DECAY OF SPIN-3/2 HYPERONS

Permalink

<https://escholarship.org/uc/item/3cp1g281>

Authors

Spitzer, Richard.

Stapp, Henry P.

Publication Date

1957-10-04

UNIVERSITY OF
CALIFORNIA

Radiation

Subsequent

TWO-WEEK LOAN COPY

*This is a Library Circulating Copy
which may be borrowed for two weeks.
For a personal retention copy, call
Tech. Info. Division, Ext. 5545*

ANGULAR CORRELATIONS
IN THE PRODUCTION AND DECAY
OF SPIN- $3/2$ HYPERONS

BERKELEY, CALIFORNIA

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

UCRL-8005

UNIVERSITY OF CALIFORNIA

Radiation Laboratory
Berkeley, California

Contract No. W-7405-eng-48

ANGULAR CORRELATIONS IN THE PRODUCTION
AND DECAY OF SPIN- $\frac{3}{2}$ HYPERONS

Richard Spitzer and Henry P. Stapp

October 4, 1957

Printed for the U. S. Atomic Energy Commission

ANGULAR CORRELATIONS IN THE PRODUCTION

AND DECAY OF SPIN- $\frac{3}{2}$ HYPERONS

Richard Spitzer and Henry P. Stapp

Radiation Laboratory
University of California
Berkeley, California

October 4, 1957

ABSTRACT

Simple relationships between the angular distribution in the decay of a spin- $\frac{3}{2}$ hyperon and the directions defined by the production mechanism are obtained for the case in which only final S and P waves contribute to the production process.

ANGULAR CORRELATIONS IN THE PRODUCTION

AND DECAY OF SPIN- $\frac{3}{2}$ HYPERONS

Richard Spitzer and Henry P. Stapp

Radiation Laboratory
University of California
Berkeley, California

October 4, 1957

The general expressions given by Spitzer and Stapp in UCRL-3796 (Rev)¹ (hereafter referred to as SS) relating the angular distribution of the decay products of a spin- $\frac{3}{2}$ hyperon to the parameters of the production process may be reduced to a rather simple form if only S and P waves are included.

Let the production cross section be written

$$I(\theta) = A + B \cos \theta + C \cos^2 \theta .$$

Equations (2.13), (2.18), and (2.19) and Tables I and II of SS show that neglecting the \underline{N} dependent terms (i.e., averaging over up-down), one may write the decay angular distribution in the form

$$W(\theta, \textcircled{H}, \textcircled{H}') = \frac{1}{4\pi} \left[1 + I^{-1}(\theta)(\alpha + \beta \cos \theta + \gamma \cos^2 \theta)(3 \cos^2 \textcircled{H}' - 1) \right. \\ \left. + I^{-1}(\theta)(\delta + \epsilon \cos \theta)(3 \cos \textcircled{H} \cos \textcircled{H}' - \cos \theta) \right. \\ \left. + I^{-1}(\theta)\rho(3 \cos^2 \textcircled{H} - 1) \right] .$$

¹ Richard Spitzer and Henry P. Stapp, Polarization and Angular Correlation in the Production and Decay of Particles of Spin $\frac{1}{2}$ and Spin $\frac{3}{2}$, UCRL-3796 (Rev.), July 1957.

-4-

The coefficients α, β, γ , etc. are constants, and the angles are defined (see SS)

$$\begin{aligned}\theta &= \angle (\text{initial nucleon, hyperon}), \\ \textcircled{H} &= \angle (\text{hyperon, final nucleon}), \\ \textcircled{H}' &= \angle (\text{initial nucleon, final nucleon}).\end{aligned}$$

This may be reduced to the form

$$\begin{aligned}4\pi I(\theta)W(\theta, \textcircled{H}'; \Phi) &= I(\theta) + \left\{ \alpha + (\beta + \delta)\cos\theta + (\gamma + \epsilon + \rho)\cos^2\theta \right\} \\ &\times (3\cos^2\textcircled{H}' - 1) + (\delta + \epsilon\cos\theta)(3\cos\textcircled{H}'\sin\textcircled{H}'\sin\theta\cos\Phi) \\ &\quad + \rho(6\cos\textcircled{H}'\cos\theta\sin\textcircled{H}'\sin\theta\cos\Phi) \\ &\quad + \rho\sin^2\theta(3\sin^2\textcircled{H}'\cos^2\Phi - 1),\end{aligned}$$

where Φ is the azimuthal angle of the final nucleon with respect to a polar axis along the velocity of the initial nucleon ($\Phi = 0$ if $\textcircled{H} = 0$). From Eqs. (2.12), (2.13), and (2.18) and Tables I and II of SS, one verifies

$$\begin{aligned}\beta + \delta &= \frac{1}{2} B, \\ \gamma + \epsilon + \rho &= \frac{1}{2} (A + C) - \alpha.\end{aligned}$$

Substituting these and averaging over Φ , one obtains

$$4\pi I(\theta)W(\theta, \textcircled{H}') = I(\theta)\left(\frac{3}{2}\cos^2\textcircled{H}' + \frac{1}{2}\right) - (A + \rho - 2\alpha)\sin^2\theta\left(\frac{3}{2}\cos^2\textcircled{H}' - \frac{1}{2}\right).$$

If the production angular distribution $I(\theta)$ is known, then the Φ -averaged decay angular distribution is completely determined by the single additional (constant) parameter $(A + \rho - 2\alpha)$. This parameter is positive and is

-5-

smaller than $\left[A - C + \sqrt{(A + C)^2 - B^2} \right] \leq 2 A$. This expression provides a convenient test of the hypothesis that the hyperon has spin- $\frac{3}{2}$. In the limiting case $\sin \theta \rightarrow 0$ one obtains the form given by Adair.²

This work was performed under the auspices of the U. S. Atomic Energy Commission.

²

R. K. Adair, Phys. Rev. 100, 19540 (1955).