Sign of the Mixing Ratio δ

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The sign of δ (the ratio of the reduced matrix element corresponding to multipole order L' to that corresponding to multipole order L) is compared for s-wave protons in (p,γ,γ) and (γ,γ) correlations. In both cases, Lloyd's convention gives the proper sign of δ.

THE purpose of this paper is to point out some theoretical and experimental relationships in (p,γ_1,γ_2) triple correlations and (γ_1,γ_2) angular correlations which may help answer the question of the sign of the interference terms and which may give a wider basis for continued experimental investigations regarding this question of sign.

We use the usual symbols for the (γ_1,γ_2) cascade (Fig. 1) and we deal with mixtures between two multipoles of each gamma ray. The mixing ratio δ is defined as the ratio of the reduced matrix element corresponding to multipole order L' to that corresponding to multipole order L.

When there are interference terms in the correlation function, we prefer to discuss the actual dipole-quadrupole mixtures for which the coefficient of $P_2(\cos\theta)$ in the interference term, according to Biedenharn and Rose,[1] can be written as f_1f_2, where f_1 and f_2 refer to γ_1 and γ_2, respectively.

According to Lloyd's formalism[2] the coefficient of the interference term can be written as k_1k_2, where (apart from factors nonessential to the sign)

$$k_1=(j\|L_1\|j_1)(j\|L_1'\|j_1),$$
$$k_2=(j_2\|L_2\|j)(j_2\|L_2'\|j).$$

Consequently, the reduced matrix elements always appear in the form $(J_f\|L\|J_i)$ where J_f and J_i, respectively, refer to the final and initial states in each transition in the cascade.

Because

$$(J_f\|L\|J_i)=(-1)^{J_f-J_i+L}(J_i\|L\|J_f),$$

$k_1=(-1)^{L_1+L_1'}f_1$ and $k_2=f_2$. Consequently, for dipole-quadrupole mixtures $k_1=-f_1$, $k_2=f_2$. "The Ofer effect"[3] is consistent with this, but his experiments are also consistent with $k_1=f_1$, $k_2=-f_2$.

By comparing the (p,γ_1,γ_2) triple correlation with the (γ_1,γ_2) directional correlation one can get information about the sign of δ. If we deal with the triple correlation function of the (p,γ_1,γ_2) reaction for s-wave protons, this function is the same as the (γ_1,γ_2) directional correlation function, because the proton is then decoupled. We see that we get agreement regarding the sign, if the (p,γ_1,γ_2) triple correlation function is calculated with Ferguson's tables[4] with an additional correction of Huby[5] according to which the interference terms are multiplied with $(-1)^{L_{12}-L_{12}'}$, which with our symbols is $(-1)^{L_1-L_1'}=(-1)^{L_1+L_1'}$.

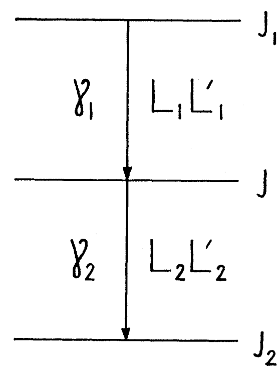

FIG. 1. Symbols for γ radiation.

This would seem to give an opportunity for an experimental confirmation of Lloyd's formalism.

[1] L. C. Biedenharn and M. E. Rose, Rev. Mod. Phys. **25**, 746 (1953).
[2] S. P. Lloyd, Phys. Rev. **85**, 904 (1952).
[3] S. Ofer, Phys. Rev. **114**, 870 (1959).
[4] A. J. Ferguson and A. R. Rutledge, Coefficients for Triple Correlation Analysis in Nuclear Bombardment Experiments, AECL, Chalk River report, CRP-615 (1957).
[5] A. J. Ferguson (private communication).