LA-UR- 94-1175

Conf-940725--

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SUBMITTED TO: Contributed Paper to the International Conference on Hypernuclear and Strange Particle Physics, Vancouver, B.C., Canada, July 4-8, 1994

MASTER

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FORM NO. 836 R4
ST. NO. 2629 5/81

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THE CASCADE-DEUTERON SYSTEM

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Recently there has been considerable speculation about the possible existence of the 'H' dibaryon (first proposed by Jaffe[1]), as a deeply bound six quark state. This in turn has generated considerable interest in doubly strange $\Lambda\Lambda$ hypernuclei such as ${}_{\Lambda\Lambda}^{6}$He. Confirmation of a claim for the observation of ${}_{\Lambda\Lambda}^{6}$He would argue strongly against the existence of a deeply bound 'H'.

To examine this problem we have considered the interaction of a Ξ hyperon with a deuteron in a full three-body analysis. We have included coupling between the $\Xi - N$ and the $\Lambda - \Lambda$ channels within the frame work of separable two-body interactions[2]. Ultimately, we will perform the full break-up calculation, *i.e.* $\Xi - d \rightarrow \Lambda\Lambda N$, with the hope of shedding some light on the interpretation of the neutron spectrum observed in Ξ^- capture on the deuteron. Here we present an ouline of how we derived the AGS equations for the ΞNN system. In the three-body system consisting of (Ξ, Λ and N) we have the following possible final states when a Ξ reacts with a deuteron:

$$\begin{aligned} \Xi + (NN) &\rightarrow \Xi + (NN) \qquad X_{\Xi\Xi} \\ &\rightarrow N_i + (\Xi N) \qquad X_{N_i\Xi} \\ &\rightarrow N_i + (\Lambda\Lambda) \qquad Y_{N_i\Xi} \\ &\rightarrow \Lambda_i + (\Lambda N_j) \qquad Y_{N_i\Xi}^{N_j} . \end{aligned} \tag{1}$$

If we were to turn off the coupling between the $\Xi - N$ and $\Lambda - \Lambda$ channels, then the system would decouple into two separate three-body problems; the ΞNN system and the $\Lambda\Lambda N$ system.

Initially it is productive to write down the AGS equations giving each particle a distinctive label, then to take the appropriate linear combinations of these equations to get the final equation for physical amplitudes with the correct anti-symmetry included. We chose to concentrate on the particle labeling only in deriving these equations, realizing that they are operator equations in the space of three-body states. These operator equations take the form

$$X_{\Xi\Xi} = \sum_{i=1}^{2} Z_{\Xi N_i} \tau_{N_i}^{\Xi\Xi} X_{N_i\Xi} + \sum_{i=1}^{2} Z_{\Xi N_i} \tau_{N_i}^{\Xi\Lambda} Y_{N_i\Xi} \tag{2}$$

$$X_{N_i\Xi} = Z_{N_i\Xi} + Z_{N_iN_j} \tau_{N_j}^{\Xi\Xi} X_{N_j\Xi} + Z_{N_iN_j} \tau_{N_j}^{\Xi\Lambda} Y_{N_j\Xi} + Z_{N_i\Xi} \tau_{\Xi}^{N_iN_j} X_{\Xi\Xi} \tag{3}$$

$$Y_{N_i\Xi} = \sum_{j=1}^{2} Z_{N_i\Lambda_j} \tau_{\Lambda_j}^{\Lambda_{(3-j)}N_i} Y^{N_i}_{\Lambda_j\Xi} \tag{4}$$

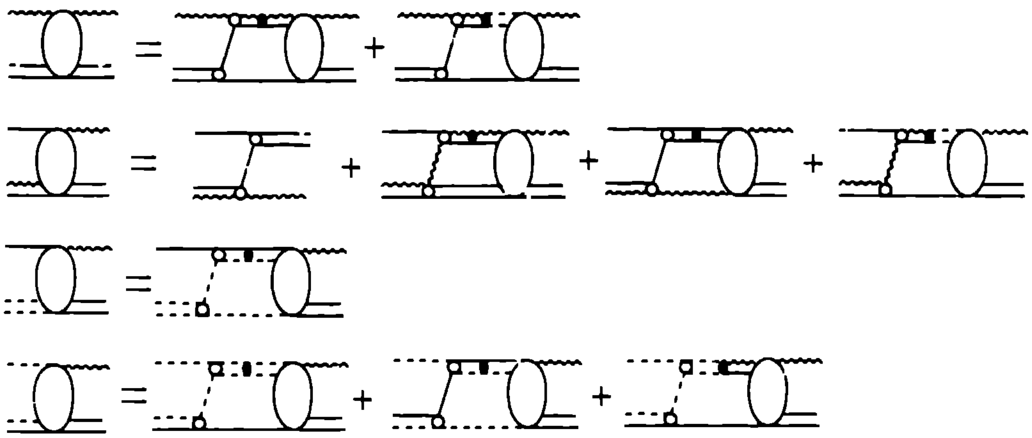
$$Y^{N_j}_{\Lambda_i\Xi} = Z_{\Lambda_i N_j} \tau^{\Lambda\Lambda}_{N_j} Y_{N_j\Xi} + Z_{\Lambda_i N_j} \tau^{\Lambda\Xi}_{N_j} X_{N_j\Xi} + Z_{\Lambda_i\Lambda_k} \tau^{\Lambda_i N_k}_{\Lambda_k} Y^{N_j}_{\Lambda_k\Xi} \;, \tag{5}$$

Where the amplitudes X and Y are defined in Eq. (1). Here, $\tau^{\beta\gamma}_{\alpha_i}$ represents the propagation of a pair in a quasi-particle state with initial channel γ, final channel β and particle α_i as spectator. The Born term $Z_{\alpha\beta}$ is the one particle exchange amplitude. With the following definitions of the physical amplitudes

$$X^{AS}_{\Xi\Xi} \equiv X_{\Xi\Xi} \qquad X^{AS}_{N\Xi} \equiv \frac{1}{\sqrt{2}} \left[X_{N_1\Xi} - X_{N_2\Xi}\right]$$

$$Y^{AS}_{N\Xi} \equiv \frac{1}{\sqrt{2}} \left[Y_{N_1\Xi} - Y_{N_2\Xi}\right] \qquad Y^{AS}_{\Lambda\Xi} \equiv \frac{1}{2} \left[Y^{N_1}_{\Lambda_1\Xi} - Y^{N_1}_{\Lambda_2\Xi} - Y^{N_2}_{\Lambda_1\Xi} + Y^{N_2}_{\Lambda_2\Xi}\right] , \tag{6}$$

we can combine the Eqs. (2) to (5) to arrive at the following system of equations for the physical amplitudes illustrated in diagramatic form where the solid line represents a N, the dashed line a Λ and the zig-zag line the Ξ.



In deriving these equations we have made use of the symmetries of the one particle exchange amplitudes.[2]

We will present results for $\Xi - d$ elastic scattering using the above equations for separable approximations to the $\Xi N - \Lambda\Lambda$ potentials resulting from the $SU(3)$ rotated OBE potentials with different short range cut-offs. These results will be compared with similar results based on separable potentials that fit the phase shifts resulting from quark model calculations for the $\Xi N - \Lambda\Lambda$ system. In this way we hope to ultimatly gain some insight into the effect of a bound state or resonance in the $\Xi N - \Lambda\Lambda$ system on the neutron spectrum in Ξ capture on the deutron.

REFERENCES

1. R. L. Jaffe, Phys. Rev. Lett. **38**, 195 (1977).
2. I. R. Afnan, B. F. Gibson, Phys. Rev. **C 41**, 2787 (1990).