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MICROSCOPIC CALCULATIONS OF A SINGLE PARTICLE ENERGIES

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We analyze the Λ single particle energies B_Λ , obtained from (π^+, K^+) and (π^-, K^-) reactions¹⁾ for hypernuclei from $A = 11$ to $A = 89$, in terms of phenomenological two and three body ΛN and ΛNN interactions which were obtained earlier from studies of ΛP scattering, the s-shell hypernuclei and the Λ -binding to nuclear matter²⁾. We show that the B_Λ values can be very well explained by use of the local density approximation based on calculating the Λ -binding to nuclear matter D as a function of density ρ , and the Λ momentum k_Λ . Thus, we calculate $D \equiv D(\rho, \epsilon, k_\Lambda)$, where ϵ is the space-exchange parameter in the ΛN potential (for details see ref. 2 & 3). The various expectation values are evaluated using the Fermi Hypernetted Chain Approximation. To take into account the fringing field the D was fitted with density dependent effective ΛN potential of the following form

$$V_{\Lambda N}(\rho, \epsilon, r) = V_0(\rho, \epsilon) T_\pi^2(r)$$

where T_π^2 corresponds to a 2π exchange mechanism with cutoff²⁾.

To obtain the Λ single particle potential the empirical nuclear density $\rho(r_N)$ for the appropriate core nucleus is folded with $V_{\Lambda N}(\rho, \epsilon, r)$:

$$U_\Lambda(\epsilon, r_\Lambda) \equiv \int V_{\Lambda N}(\rho, \epsilon, |\vec{r}_N - \vec{r}_\Lambda|) \rho(r_N) d\vec{r}_N$$

For the Λ effective mass m_Λ^*/m_Λ , we calculate the difference $D(\rho, \epsilon, k_\Lambda) - D(\rho, \epsilon, 0)$ which is then fitted with a quadratic momentum dependence. The B_Λ values corresponding to the Λ in the s, p, d and f orbitals are obtained by solving the appropriate Schrödinger equation.

We find that ΛN and ΛNN potentials, which give a consistent account of s-shell hypernuclei, of D , and of the ΛP scattering data, explain very well the data (see fig.). The B_Λ values are consistent with a purely dispersive density independent ΛNN potential and with one

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which also has a 2π exchange component. We find a strong correlation between ϵ and the Λ NN potentials; $\epsilon \approx .15 \pm .02$ with only a dispersive Λ NN potential and $\epsilon \approx .30 \pm .02$ with a dispersive Λ NN + 2π potential. From scattering data, $\epsilon \approx .13$ to $.38$

As expected, we find $m_{\Lambda}^*/m_{\Lambda}$ is proportional to ϵ . For $\epsilon \approx .15$, we find $m_{\Lambda}^*/m_{\Lambda} \approx 0.90$, whereas for $\epsilon \approx .30$, $m_{\Lambda}^*/m_{\Lambda} \approx 0.82$. In the phenomenological fits of ref.⁴⁾, based on a zero range approximation, the $m_{\Lambda}^*/m_{\Lambda} \approx 0.76 - 0.80$. These small values of $m_{\Lambda}^*/m_{\Lambda}$ may be attributed to the use of zero a range approximation.

The value of D which we obtain is quite well determined and insensitive to the particular form of potential used; $D \approx 27.9 \pm 0.4$ MeV.

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