3. The Convergence of the Brueckner-Goldstone Series

We will study in this section the convergence of the Brueckner-Goldstone expansion order by order. In general, the expansion will contain diagrams involving the single-particle potential energy U (See A). Obviously, their contribution will depend on the choice of U, which in turn depends on what pure g matrix diagrams one is trying to cancel out by these "U diagrams". Therefore let us first concentrate on diagrams that do not involve U.

The first order diagrams are shown in Fig. 2. Here, Fig. 2b is the "exchange" of 2a. In the previous section, we made a crude estimate of the direct diagram 2a as $\frac{1}{2}\rho\sum_{\vec{m},\vec{n}}(g_s+v_\ell)$ $\simeq$ +8 -59 MeV = -51 MeV. The exchange diagram can be similarly evaluated. However, one can see that the exchange diagram is "almost" diagonal, inasmuch as the momentum transfer $\vec{m}-\vec{n}$ is quite small, so that for a given $\vec{m}$ and $\vec{n}$, it should not be very different from the direct term. But, for a spin-isospin independent potential, the states $\vec{m}$ and $\vec{n}$ must have the same spin-isospin values in the exchange diagram. Consequently, the exchange diagram contribution is multiplied by an additional factor of $-\frac{1}{4}$, the minus sign arising from the Goldstone rule mentioned in A. As a result, the total first order contribution should be about 3/4 the direct term, i.e. about -39 MeV. We wish to emphasize again, that whereas the ease with which such estimates can be made is the great advantage of the BBP