A corresponding set of fits with the completely absolute calculation corresponding to the solid lines in Fig. 2 can be made only if the data for $\hbar\omega > 0.05$ eV are ignored on the assumption that the discrepancy at higher energies may be disregarded for some unknown reason. We cannot justify abandoning the higher energy measurements, but it is reassuring to note that if the absolute calculation be fitted where it can be, below 0.05 eV, an equally nearly constant $I_{\text{eff}}(\vec{K})$ is obtained of mean value 0.52 ± 0.04 eV. The reason is that the K dependence of the enhancement is much more pronounced at low energies; the two fits, taken together, suggest that the observed virtual independence of K is a feature of the work not particularly sensitive to the detailed explanation assumed.

If this near constancy of the observed $I_{\text{eff}}(\vec{K})$ be taken at its face value, accepting uncritically for the moment that an estimate of s from an unhybridized tight-binding model can be relied upon to this degree, it would follow that the Fourier transform $I_{\text{eff}}(\vec{r})$ is close to δ_{r0} in form. This is in accordance with the long-familiar view that intra-atomic Coulomb repulsion is the dominant factor determining ferromagnetism in nickel. Assuming there is no contribution from the atoms beyond the nearest-neighbor positions, Fig. 3 would suggest that any one of the 12 nearest neighbors to a nickel atom contributes less than 10% of the on-site term at $r = 0$ to the "effective Coulomb integral" if the contribution is of the same sign, and less than 5% if the contribution is of the opposite sign. Both these limits are materially lower than the ~30% contribution estimated by Clogston[11] for nearest neighbors in palladium.

The latter value 0.52 ± 0.04 eV for I_{eff} corresponds to a susceptibility-enhancement factor at 1020°K of $5\frac{1}{2} \pm 1\frac{1}{2}$, which may be compared directly with the factor 8 obtained on dividing the measured[12] susceptibility at 1020°K by an estimate of $\frac{1}{2}g^2\mu_B{}^2 \int N(E)[-df/dE]dE$ from the best available density-of-states curves.[13]

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SINGLE-PARTICLE NEUTRON STATES IN ^{211}Pb†

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In this Letter we present the first observation of analog resonances in the excitation function for a (t,p) reaction. The parent analogs of these resonances are the states which would be formed by adding three neutrons to the target nucleus. In the present case a study of the reaction ^{208}Pb(t, p) has led to the assignment of the positions of several single-particle states in ^{211}Pb. Because of its remoteness from the stability line, only the excitation energies of a few levels in ^{211}Pb are known[1] from α decay studies. The observation of analog resonances in the reaction ^{208}Pb(t, p) corresponding to states in ^{211}Pb is forbidden by isobaric-spin-selection rules. Isobaric-spin-

forbidden effects in (p,d) and (d,p) reactions on the Pb isotopes have been reported.[2]

The triton beam was obtained from the Los Alamos three-stage Van de Graaff facility. The target was enriched in ^{208}Pb and was about 35 keV thick to the triton beam. Protons, deuterons, and tritons were identified and separated by means of a ΔE-E counter telescope in conjunction with an SDS 930 on-line computer. Energy spectra for all of these particles were obtained simultaneously.

Figure 1 shows the excitation functions at 165° lab for the reaction ^{208}Pb(t,p) to the ground and first-excited state of ^{210}Pb along with the triton elastic-scattering excitation function. The elastic-scattering data are a smooth function of energy. However, the (t,p_0) excitation function shows anomalies at approximately 16.0, 16.3, and probably 17.0 MeV. The first excited-state yield shows an anomaly near 17.0 MeV. These anomalies are ascribed to analogs of states in ^{211}Pb.

Further, by the following arguments we propose that these anomalies correspond to analogs of the $d_{5/2}, s_{1/2}, d_{3/2}(g_{7/2})$ states in ^{211}Pb. From proton elastic-scattering measurements on ^{204,206,208}Pb at several laboratories,[3,4] it has been established that the analogs of the $g_{9/2}$ states in ^{205}Pb, ^{207}Pb, and ^{209}Pb all occur at essentially the same proton energy (~14.95 MeV). This implies that the binding energy for the $g_{9/2}$ neutron is essentially the same for all of these isotopes. It therefore appears reasonable to assume that the $d_{5/2}$, $s_{1/2}$, and $d_{3/2}(g_{7/2})$ neutron binding energies in ^{209}Pb and ^{211}Pb are essentially the same. With this assumption we can predict the triton energies corresponding to the analogs of these various states in ^{211}Pb from the ^{208}Pb proton elastic-scattering measurements.[4] These energies are indicated by the vertical lines in Fig. 1. As can be seen, the observed anomalies occur at essentially the same energies as the predictions for $d_{5/2}$, $s_{1/2}$, and $d_{3/2}(g_{7/2})$ states.

The fact that the analogs of the $g_{9/2}$ and $i_{11/2}$ states are not observed is probably due to the higher angular momenta required to excite these states. This implies that the 17.0-MeV anomaly corresponds only to the $d_{3/2}$ portion of the $d_{3/2}$-$g_{7/2}$ doublet. The assumption that the transfer of higher angular momentum inhibits the observation of the $g_{9/2}$, $i_{11/2}$, and $g_{7/2}$ analog states is substantiated by our measurements of excitation functions for the reaction ^{208}Pb(p,t). No anomalies in the (p,t) yield were observed at the $g_{9/2}$ or $i_{11/2}$ analog states. However, anomalies were observed at the $d_{5/2}$ and $s_{1/2}$ analog states (these measurements did not extend high enough in energy to reach the $d_{3/2}$-$g_{7/2}$ doublet). In fact, the behavior of the observed anomalies in the reaction ^{208}Pb(p,t_0) at the $d_{5/2}$ and $s_{1/2}$ states looks the same as the 16- and 16.3-MeV anomalies shown here in the reaction ^{208}Pb(t,p_0).

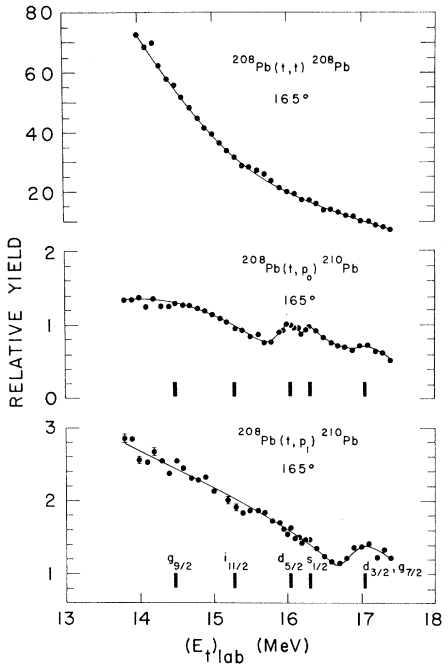

FIG. 1. Excitation functions at 165° lab for the reactions ^{208}Pb(t,t) and ^{208}Pb(t,p) to the ground and first excited states of ^{210}Pb. Representative error bars are shown for the (t,p_1) data. The errors for the other data are less than the size of the plotted points. The vertical lines indicate analog resonant energies predicted from ^{208}Pb(p,p) results.

We feel these arguments provide strong evidence that the anomalies at 16, 16.3, and 17 MeV observed in reaction ^{208}Pb(t,p) correspond to the analogs of the $d_{5/2}$, $s_{1/2}$, and $d_{3/2}$ states in ^{211}Pb. Also, it appears that the neutron binding energy for these single-particle states is approximately the same for both ^{209}Pb and ^{211}Pb.

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MICROSCOPIC CALCULATION OF THE Y^{89} ANALOG-STATE ESCAPE AND DAMPING WIDTHS

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Feshbach, Kerman, and Lemmer[1] have proposed a two-particle, two-hole (2p-1h) or doorway interpretation of intermediate structure. In this approach the decay width Γ of an intermediate structure resonance consists of two terms, viz.,

$$\Gamma = \Gamma^{\uparrow} + \Gamma^{\downarrow}. \tag{1}$$

Here $\Gamma^{\uparrow}$ is the escape width to the continuum and $\Gamma^{\downarrow}$ is the damping width for decay into more complicated states. If the latter is too large, then intermediate structure will not be observed; while if it is too small, then there are essentially no compound-nuclear resonances more complicated than 2p-1h. We thus expect $\Gamma^{\downarrow}$ to be non-negligible but not too large. The calculation of $\Gamma^{\downarrow}$ is rather formidable because it involves the 3p-2h and more complicated states. Yet in order to verify the underlying doorway description of intermediate structure, a detailed calculation of Γ is called for. In particular both escape and damping widths must be obtained in a microscopic particle-hole basis. We present the results of such a calculation in this Letter.

Analog doorway states are particularly interesting examples of intermediate structure. In this paper we examine the well-known Y^{89} $\frac{1}{2}^+$, $\frac{3}{2}^+$, and $\frac{5}{2}^+$ analog levels as our test calculation. These levels were found in the $Sr^{88}(p,p)Sr^{88}$ experiment of Cosman, Enge, and Sperduto[2] at proton energies of 6.0, 7.0, and 5.0 MeV, respectively. We calculate only the widths for elastic proton scattering and assume that the target $_{38}Sr_{50}^{88}$ is in its ground state. This state is taken to consist of closed neutron and proton shells (ground-state correlations are neglected).

As in the Feshbach theory of nuclear reactions,[3] the continuum single-proton state is not considered as a microscopic ingredient of the doorway states. This assumption should be reasonable for a medium heavy nucleus like Sr^{88} where a proton potential scattering resonance, if it does exist, is much wider then the intermediate structure widths. The single-proton part of the usual analog-state wave function is considered as simply an unbound proton moving in the field of the target. Its presence is manifested in the escape width.

A 2p-1h basis is used to describe the analog levels. In this scheme the Coulomb interaction is taken into account directly by using neutron and proton wave functions with different radial forms. The two-body Coulomb interaction is neglected in comparison with the two-body nuclear force. The specific details of this technique are given by the authors in another paper.[4] The basis of neutron and proton particles and holes is given in Fig. 1 relative to Sr^{88} as the zero energy. In our calculation, wave functions for the single neutron states were obtained from a Woods-Saxon well with spin-orbit coupling. For protons the Coulomb potential of a uniform sphere of charge was added. There are 19, 33, and 40 possible 2p-1h states of spins $\frac{1}{2}^+$, $\frac{3}{2}^+$, and $\frac{5}{2}^+$, respectively. Reference 4 indicates that in each case as expected only two states are necessary for the description of the analog levels in this nucleus. These are $|(1g_{9/2}1g_{9/2}^{-1})0^+J^\pi, J^\pi M\rangle$ and $|(2p_{1/2}2p_{1/2}^{-1})0^+J^\pi, J^\pi M\rangle$, i.e., a proton and neutron hole with the same spin are coupled to 0^+ which then couples with the neutron particle of spin J^π to give the total angular momentum J^π. Because of its simplicity, a delta function effective interaction was used with strength V_0 and the usual Soper mixture. We fixed V_0 by requiring that for each of $J^\pi = \frac{1}{2}^+$, $\frac{3}{2}^+$, and $\frac{5}{2}^+$ the analog