very near T_N, where it is known from direct quasielastic-neutron-scattering measurements[3] that $\chi(\vec{q})$ is relatively isotropic in $\vec{q}$. Thus the decrease of $\Delta H_{\parallel,\perp}$ down to 70 K and the subsequent divergence indicates a changeover from ferromagnetism to antiferromagnetism, which in this case involves a crossover from two- to three-dimensional fluctuation behavior.

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Note added.—Since this work was submitted for publication, K. Kawasaki has pointed out to us that he has developed an alternative theory, discussed briefly in Phys. Lett. 26A, 543 (1968), which predicts $1/T_2 \sim \tau^{-9/2\nu+2-2\alpha}$, valid for both $\alpha > 0$ and < 0. With the use of current values for the Heisenberg model, $\nu \sim \frac{2}{3}$, $\alpha \sim -\frac{1}{8}$, this gives an exponent of $-\frac{3}{4}$, in excellent agreement with our experimental value -0.7 ± 0.1. Full details of this theory have not yet been published, so it is not possible to consider its applicability to $NiCl_2$ in detail.

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Mass Discrepancy in the Iron Region*

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We have found an indication of systematic discrepancies in the tabulated mass values in the iron region. We have measured the Q value for $^{58}Ni(p,\alpha)^{55}Co$ and found it to be -1.3410 ± 0.0029 MeV. This differs by 17.3 keV from the value of -1.3583 ± 0.0045 MeV calculated from the 1971 mass tables.

In the 1971 compilation of atomic masses,[1] the comment appears on page 365, "Even after multiplying the errors by 1.5, the new results for ^{57}Fe differ by 3 errors from older results. The earlier mass doublets in this whole region are connected in a satisfactory way by dependable reaction energy values. Unless the new value itself is in error by as much as about 27 keV, this would mean that these earlier values contain a rather large systematic error." We have just found a discrepancy in the ^{58}Ni-^{55}Co mass difference which suggests that there may well be rather large errors in the compilation values in this mass region. During the course of our measurement[2] of accurate excitation energies in ^{55}Co we noted differences of almost 20 keV in the Q value for $^{58}Ni(p,\alpha)^{55}Co$ from that calculated from the masses given in the 1971 table even though the stated uncertainties for ^{58}Ni and ^{55}Co were 3.1 and 3.3 keV, respectively. In order to resolve this apparent discrepancy we have made an accurate measurement of the ground-state Q

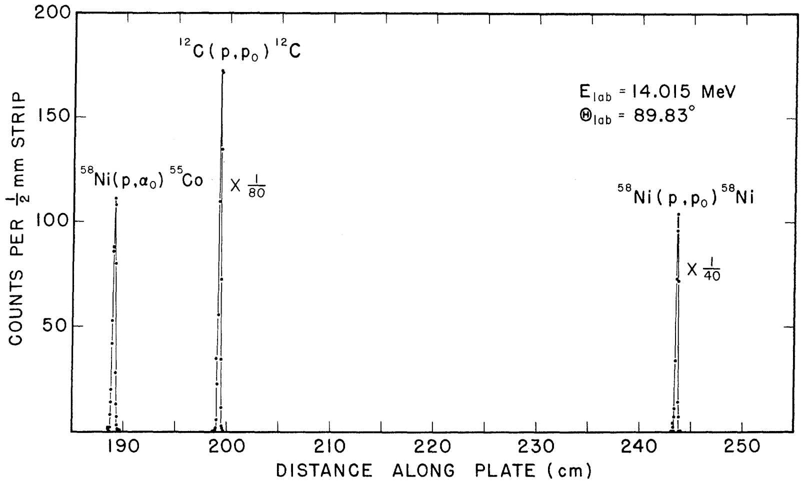

FIG. 1. Typical particle groups used in measuring the Q value for ^{58}Ni$(p,\alpha)^{50}$Co. The proton group elastically scattered from the nickel target was recorded simultaneously with the α-particle group from the reaction. The proton group elastically scattered from carbon was recorded on a neighboring zone of the nuclear track plate and came from a carbon foil target. The magnetic fields of the beam analyzer and spectrograph were constant.

value for the reaction ^{58}Ni$(p,\alpha)^{55}$Co.

Targets were prepared by the vacuum deposition of isotopically enriched ^{58}Ni metal (99.9%) onto 20 μg/cm^2 carbon-foil backing. Proton beams were produced with the University of Notre Dame's model FN tandem Van de Graaff accelerator with the nominal energy of the incident proton beam being determined by magnetic analysis. The reaction products were momentum analyzed with our new 100-cm modified broad-range magnetic spectrograph, and nuclear track plates placed at the focal surface of the spectrograph were employed as particle detectors. Protons and α particles were recorded simultaneously but the difference in track length and track density allowed easy particle identification.

Four measurements of the ^{58}Ni(p,α) ground-state Q value were made at the nominal input energies of 14.0 and 15.0 MeV and at the observation angles of 90 and 120°. The input energy and observation angle were then accurately determined from analysis of the elastic proton groups from ^{58}Ni and ^{12}C. The target was placed in reflection geometry so that no corrections for the α-particle energy loss would be necessary. To avoid problems with correcting for the energy loss in the nickel of the protons scattered from the ^{12}C backing, a separate ^{12}C elastic proton group was recorded from a 10-μg/cm^2 carbon foil. A typical set of data is shown in Fig. 1. The proton elastic group from the carbon target is shown together with the ^{58}Ni proton and α groups. The charge collection was the same for both the ^{12}C and ^{58}Ni runs.

TABLE I. Q-value measurements for ^{58}Ni$(p,\alpha_0)^{58}$Co.

Run	Input energy (MeV)	θ (deg)	Q value (MeV)
1	14.0130	119.860	−1.3413
2	15.0142	119.996	−1.3409
3	14.0152	89.830	−1.3414
4	15.0136	89.680	−1.3404
			Average −1.3410[a]

[a]Standard deviation of the mean, σ_m, is 0.23 keV; total uncertainty is 2.9 keV.

The results of the four measurements are given in Table I. The good agreement among the four runs is reflected in the small value of the standard deviation of the mean. The internal errors are calculated according to standard procedures described by Stocker *et al.*[3] The uncertainty given includes estimates of uncertainties in the following quantities: the position of a group on the plate, beam spot position, reaction angle, input energy, spectrograph field, and spectrograph calibration curve.

The Q value calculated from the 1971 mass table is −1.3853 MeV which differs from our value by 17.3 keV. It is clear, therefore, that the mass difference between ^{58}Ni and ^{55}Co given in the 1971 mass table is in error by several times the stated uncertainty. In order to determine if this is an isolated case or if there are systematic discrepancies in masses throughout this region we have begun a series of Q-value measurements to connect these other masses. In the meantime one should exercise caution in using masses in this region, as for example, in comparing excitation energies obtained from charged-particle reactions with those obtained from resonance studies such as (p,γ) which require accurately known mass differences.

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Precise Single-Scattering Optical-Potential Fit to 1-GeV p-^{4}He Elastic Scattering

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Using a relativistic form for the relation between the nucleon-nucleon scattering amplitude and the scattering operator, a single-scattering nucleon-nucleus optical potential is found which gives a precise fit with no adjustable parameters to the small-angle scattering of protons on ^{4}He at 1-GeV incident lab energy. The method then allows a determination of the ratio of real to imaginary nucleon-nucleon foward-scattering amplitudes at other energies such as 600 MeV.

Many attempts have been made to fit the data[1] on high-energy elastic scattering of protons by ^{4}He using a multiple-scattering theory.[2-4] These attempts usually use the Glauber formalism and a nucleon-nucleon (n-n) scattering amplitude of the form

$$f(q)=(4\pi)^{-1}(i+\rho)k\sigma_T\exp(-\beta^2q^2), \tag{1}$$

where q is the momentum transfer, k the momentum in the nucleon-nucleus (n-N) center-of-mass system, ρ the ratio of real to imaginary part of the forward n-n amplitude, and σ_T is the total n-n cross section. The shape parameter β^2 is taken to be 2.5 $(\mathrm{GeV}/c)^{-2}$ for protons with 1-GeV lab kinetic energy. In order to reproduce the magnitude of the small-angle differential cross section, the Glauber formalism requires multiple scattering up to and including triple scattering (i.e., three-body correlations in the nuclear wave function must be specified); even allowing for some play in the choice of ρ, retaining just the single-scattering term in the formalism leads to cross sections which are too large by factors of 2 or more.[2,3] This failure to reproduce the forward data normalization is also found in a simple Watson optical-potential theory[5] when the same nonrelativistic form (1) is used for the n-n scattering amplitude. (In this case, the predicted results are too small by a factor of 2.) The intent of this note is to show that a *reasonable* relativistic choice for the n-n amplitude leads to a good fit—*with no adjustable parameters*—to the small-angle data at 1 GeV when used in the single-scattering part of the Watson multiple-scattering optical potential.

Using the impulse approximation, this potential can be written as $V=\langle 0|t|0\rangle$ where t is the n-n scattering operator and the expectation value is with respect to the ^{4}He ground state. A major problem[6] is the determination of the relation between the energy parameters of t and V: Which energy in the n-n system corresponds to a given energy in the n-N system? Nonrelativistically, straightforward calculations for forward scattering show that this energy relationship is such that the relative velocity of the two nucleons —projectile and target—is the same for the n-n and the n-N systems. We *assume* that this velocity relation holds true relativistically in the lab coordinate system. Thus, observers on the target nucleon—one isolated, the other in the target nucleus—see the projectile nucleon with the same incident speed. Therefore,

$$\frac{s(s-4m^2)}{(s-2m^2)^2}=\frac{\lambda(S,m^2,M^2)}{(S-m^2-M^2)^2}, \tag{2}$$