Magnetic Moment Distribution in Ni-Pd Alloys*

J. W. CABLE AND H. R. CHILD
Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830
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Polarized neutron measurements of both the Bragg and diffuse scattering were made for a series of ferromagnetic Ni-Pd alloys to determine the distribution of magnetic moment in this alloy system. Polycrystalline samples containing 25, 50, 71, and 92 at.% Pd were used. The individual Ni and Pd moment values determined independently from the Bragg and diffuse scattering data agree and vary with composition. Both moments increase with increasing Pd content to a maximum of about $1.2\mu_B$/Ni near 90 at.% Pd and $0.2\mu_B$/Pd in the 50–70 at.% Pd region. Extrapolation of the results to the Ni-rich region indicates that isolated Pd atoms in a Ni environment have no moment but produce an enhanced Ni moment. Such Ni moment enhancement has not been previously observed for Ni-based alloys.

I. INTRODUCTION

FERROMAGNETIC Ni and paramagnetic Pd form a continuous series of solid solution alloys which are ferromagnetic throughout most of the composition range. The magnetization measurements[1–3] show a decreasing average moment with increasing Pd content. The moment decreases linearly by $0.11\mu_B$ per Pd atom to about 50 at.% Pd, falls more rapidly in the Pd-rich region and approaches zero at a critical concentration of about 2 at.% Ni. This magnetic behavior and its implications to the electronic structures of the constituents can be better understood with knowledge of the individual Ni and Pd moment behavior. Such information can be obtained from neutron diffuse scattering measurements in combination with either neutron Bragg scattering or bulk magnetization measurements. The diffuse scattering measurements for the Ni-Pd system have not been previously attempted because the expected cross section is below the detection limit for the usual unpolarized beam technique. With polarized neutrons, however, the expected cross section is an order of magnitude larger, and the diffuse scattering measurements become feasible. In this paper we report polarized neutron measurements of both the Bragg and diffuse scattering which provide a description of the individual Ni and Pd moment behavior in the Ni-Pd alloy system.

II. BRAGG SCATTERING MEASUREMENTS

The intensity of neutrons Bragg scattered from a ferromagnet is proportional to[4]

$$b^2+2(\mathbf{q}\cdot\boldsymbol{\lambda})bp+q^2p^2\,,$$

in which b and p are the nuclear and magnetic scattering amplitudes, $\mathbf{q}$ is the magnetic interaction vector, and $\boldsymbol{\lambda}$ is a unit vector describing the polarization state of the neutron. In the polarized neutron method,[5] the incoming neutrons are polarized parallel and then antiparallel to the magnetization direction of the sample and perpendicular to the scattering vector. Under these conditions, $\mathbf{q}\cdot\boldsymbol{\lambda}=\pm1$ for the two neutron spin states and the ratio of the spin-up–to–spin-down intensities is given by

$$R=(b+p)^2/(b-p)^2\,, \tag{1}$$

from which the magnetic amplitudes are readily determined, provided the nuclear amplitudes are known. The magnetic amplitude is given by

$$p=(e^2\gamma/2mc^2)\mu f \tag{2}$$

in which $e^2\gamma/2mc^2=0.27\times10^{-12}$ cm, μ is the atomic magnetic moment, and f is the unpaired electron form factor. In the case of a ferromagnetic alloy one measures an average amplitude given by

$$\bar{p}=(e^2\gamma/2mc^2)(c_A\mu_Af_A+c_B\mu_Bf_B)\,, \tag{3}$$

in which the c's are fractional concentrations of the constituents. In the present study, we want to extract the individual atomic moment values from these average amplitudes and will therefore need appropriate form factors for each of the constituent atoms. Free-atom form-factor calculations agree remarkably well with the observations for Fe,[6] Co,[7] and Ni [8] and are therefore used in this study.

Bragg scattering measurements were made at 298°K on polycrystalline samples containing 25, 50, and 71 at.% Pd and at 78°K for a 92 at.% Pd alloy. The observed flipping ratios were corrected for incomplete polarizing and flipping efficiencies, depolarization in the sample and the single transmission effect. The latter takes account of the different coherent scattering cross sections for the two neutron spin states. The effect is proportional to the nuclear magnetic cross term, $\bar{b}\bar{p}$, and is therefore largest for the Ni-rich alloys. Experimentally the correction varies from 3% for the 25 at.%

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[3] G. Fischer, A. Herr, and A. J. P. Meyer, J. Appl. Phys. **39**, 545 (1968).
[4] O. Halperin and M. H. Johnson, Phys. Rev. **55**, 898 (1939).
[5] R. Nathans, C. G. Shull, G. Shirane, and A. Andresen, J. Phys. Chem. Solids **10**, 138 (1959).
[6] C. G. Shull and Y. Yamada, J. Phys. Soc. Japan Suppl. B-III **17**, 1 (1962).
[7] R. M. Moon, Phys. Rev. **136**, A195 (1964).
[8] H. A. Mook, Phys. Rev. **148**, 495 (1966).

Pd alloy to 0.4% for the 92 at.% Pd alloy. The other corrections are even smaller (<1%) because of the high polarizing and flipping efficiencies (>99%) and polarization transmissions (97–100%) of the various samples.

The corrected form-factor results for these alloys are given in Tables I–IV. They are presented in the form of

TABLE I. Bragg scattering results for $Ni_{0.749}Pd_{0.251}$.

hkl	$(\sin\theta)/\lambda$	$\bar{\mu}f$ (obs.)	$\bar{\mu}f$ (calc.)[a]
111	0.238	0.403±0.003	0.404
200	0.274	0.356±0.003	0.354
220	0.388	0.232±0.003	0.235
311	0.455	0.166±0.003	0.173
222	0.475	0.164±0.006	0.166
400	0.549	0.103±0.009	0.100
331	0.598	0.093±0.003	0.090
420	0.614	0.060±0.006	0.077

[a] $\mu_{Ni}=0.77$, $\mu_{Pd}=0.12$, $\gamma=0.29$; $g_{Ni}=2.28$, $g_{Pd}=2.5$.

TABLE II. Bragg scattering results for $Ni_{0.498}Pd_{0.502}$.

hkl	$(\sin\theta)/\lambda$	$\bar{\mu}f$ (obs.)	$\bar{\mu}f$ (calc.)[a]
111	0.232	0.321±0.003	0.324
200	0.268	0.282±0.003	0.277
220	0.378	0.179±0.003	0.181
311	0.444	0.121±0.002	0.129
222	0.464	0.130±0.004	0.129
400	0.535	0.071±0.003	0.069
331	0.583	0.069±0.002	0.070
420	0.599	0.046±0.002	0.057
422	0.656	0.052±0.003	0.047
333 511	0.695	0.015±0.003	0.029
440	0.757	0.035±0.005	0.028
531	0.792	0.013±0.003	0.020

[a] $\mu_{Ni}=0.79$, $\mu_{Pd}=0.21$, $\gamma=0.23$; $g_{Ni}=2.33$, $g_{Pd}=2.5$.

TABLE III. Bragg scattering results for $Ni_{0.288}Pd_{0.712}$.

hkl	$(\sin\theta)/\lambda$	$\bar{\mu}f$ (obs.)	$\bar{\mu}f$ (calc.)[a]
111	0.228	0.193±0.003	0.196
200	0.263	0.169±0.003	0.168
220	0.372	0.105±0.003	0.106
311	0.436	0.071±0.003	0.075
222	0.456	0.070±0.005	0.073
400	0.526	0.030±0.008	0.040
331	0.573	0.036±0.005	0.040
420	0.588	0.034±0.003	0.032
422	0.645	0.019±0.008	0.027

[a] $\mu_{Ni}=0.70$, $\mu_{Pd}=0.16$, $\gamma=0.27$; $g_{Ni}=2.46$, $g_{Pd}=2.5$.

TABLE IV. Bragg scattering results for $Ni_{0.077}Pd_{0.923}$.

hkl	$(\sin\theta)/\lambda$	$\bar{\mu}f$ (obs.)	$\bar{\mu}f$ (calc.)[a]
111	0.224	0.099±0.002	0.100
200	0.259	0.084±0.002	0.081
220	0.366	0.047±0.002	0.048
311	0.430	0.025±0.002	0.030
222	0.449	0.028±0.005	0.033
400	0.518	0.004±0.005	0.009
331	0.565	0.018±0.002	0.016
420	0.579	0.014±0.002	0.010
422	0.634	0.006±0.005	0.011

[a] $\mu_{Ni}=0.88$, $\mu_{Pd}=0.12$, $\gamma=0.12$; $g_{Ni}=2.5$, $g_{Pd}=2.5$.

$\bar{\mu}f$ values which were obtained from the observed flipping ratios by use of the nuclear amplitudes: $b_{Ni}=1.03\times10^{-12}$ cm and $b_{Pd}=0.59\times10^{-12}$ cm. The quoted errors correspond to counting statistics only and should probably be doubled to include uncertainties in the above described corrections. Individual moment values, μ_{Ni} and μ_{Pd}, were determined from the first three reflections by use of assumed free-atom form factors. We have used the unrestricted Hartree-Fock Ni^{+2} form factor,[9] which gives the best agreement with the observations on pure Ni, and an unpublished Hartree-Fock calculation of Watson and Freeman for Pd^{+2}, which agrees reasonably well with the Pd form factor in Pd_3Fe.[10] These free-atom form factors consist of spin and orbital contributions and can be written as

$$f=(2/g)f_{\rm spin}+[(g-2)/g]f_{\rm orb}. \tag{4}$$

The spin and orbital contributions to the form factor are based on the g-factor data of Fischer, Herr, and Meyer[3] which show a linear increase from about 2.18 for Ni to 2.58 for Pd. The magnetic disorder scattering results, which are discussed in Sec. III, show that the average moments and therefore the average g factors are heavily weighted to the Ni side for all except the most dilute Ni alloy. We therefore take $g_{Ni}=\bar{g}$ and $g_{Pd}=2.5$ for all compositions. The error introduced into the moment value determination by the uncertainty in this approximation to the individual g factors is small. For example a 5% error in g_{Ni} produces a 2% error in μ_{Ni} for the 50% alloy. The form factor also contains a term which describes the asphericity in the spin distribution. This has the form[11]

$$f_{\rm aspher}=(2/g)(\tfrac{5}{2}\gamma-1)A_{hkl}\langle j_4\rangle, \tag{5}$$

in which γ is the fractional E_g occupation, A_{hkl} is a function of scattering direction, and $\langle j_4\rangle$ is the aspherical term. This contribution is negligible for the first three reflections and therefore has no effect on the individual moment determinations, but becomes important for some of the higher reflections. Of the reflections listed, those most sensitive to the asphericity are the (222), (400), and (331). Comparison of the observed $\bar{\mu}f$ values for these three reflections with those calculated for a spherical distribution was used for the determination of the γ values given in Table V. These show the same dominant T_{2g} symmetry of the unpaired electron distribution as in pure Ni. In the last column of Tables I–IV are the $\bar{\mu}f$ values calculated from the individual moments, g factors and γ values indicated below each table. These are in good agreement with the observed $\bar{\mu}f$ values. The results are summarized in Table V.

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[9] R. E. Watson and A. J. Freeman, Phys. Rev. **120**, 1125 (1960).

[10] G. Shirane, R. Nathans, S. J. Pickart, and H. A. Alperin, in *Proceedings of the International Conference on Magnetism, Nottingham, 1964* (The Institute of Physics and The Physical Society, London, 1965), p. 223.

[11] R. J. Weiss and A. J. Freeman, J. Phys. Chem. Solids **10**, 147 (1959).

TABLE V. Summary of bragg scattering results for Ni-Pd alloys.

at.% Pd	μ_{Ni}	μ_{Pd}	$\bar{\mu}$	σ_T (μ_B/atom)	γ
25	0.77±0.02	0.14±0.10	0.61±0.03	0.558	0.29±0.05
50	0.79±0.03	0.21±0.05	0.50±0.03	0.500	0.23±0.04
71	0.71±0.05	0.14±0.04	0.31±0.03	0.302	0.27±0.11
92	0.88±0.10	0.12±0.02	0.17±0.02	0.136	0.12±0.11

The saturation magnetization values σ_T were obtained by the ballistic method on the same samples and at the same temperatures for which the neutron measurements were made. Comparison with the $\bar{\mu}$ values from the neutron measurements shows that conduction-electron polarization is smaller for these Ni-Pd alloys than for pure Ni for which a value of $-0.1\mu_B$ was observed.[8]

III. DIFFUSE SCATTERING MEASUREMENTS

The diffuse scattering of neutrons from a ferromagnetic binary alloy contains a disorder component which arises from the fluctuations in scattering density. For a binary AB alloy with nuclear scattering amplitudes b_A and b_B, and magnetic scattering amplitudes p_A and p_B, the differential cross section for this disorder scattering is given by[12]

$$\frac{d\sigma}{d\Omega}=S(K)[(b_A-b_B)^2+2(\mathbf{q}\cdot\boldsymbol{\lambda})(b_A-b_B)(p_A-p_B)+q^2(p_A-p_B)^2], \quad (6)$$

in which the scattering function $S(K)$ is defined as[13]

$$S(K)=c_Ac_B\left[1+\sum_R \alpha(R)\frac{\sin KR}{KR}-\sum_R \beta(R)\times\left(\frac{\sin KR}{KR}-\cos KR\right)\right] \quad (7)$$

for polycrystalline scatterers. Here, K is the scattering vector of magnitude $4\pi\sin\theta/\lambda$, the c's are fractional concentrations, and the $\alpha(R)$'s and $\beta(R)$'s are short-range order and size-effect parameters, With the incoming neutron beam polarized parallel or antiparallel to the sample magnetization and perpendicular to K, the cross sections become

$$\frac{d\sigma^{\pm}}{d\Omega}=S(K)(\Delta b\pm\Delta p)^2, \quad (8)$$

in which the $\pm$ signs refer to spin-up and spin-down neutrons. The difference between the spin-up and spin-down cross sections is

$$\Delta\frac{d\sigma}{d\Omega}\equiv\frac{d\sigma^+}{d\Omega}-\frac{d\sigma^-}{d\Omega}=S(K)4\Delta b\Delta p. \quad (9)$$

This difference cross section provides a direct measurement of Δp which is related to the moment difference by

$$\Delta p=0.27\times10^{-12}(\mu_Af_A-\mu_Bf_B). \quad (10)$$

Difference cross-section measurements were made at 298°K for pure Ni and for alloys containing 25, 50, and 71-at.% Pd and at 78°K for a 92 at.% Pd alloy. The room-temperature measurements were made on flat-plate samples of 2-mm thickness while the 78° data were obtained for a 0.6×3-cm cylindrical sample. A typical set of intensity measurements is shown in Fig. 1. The higher intensity with spin-up neutrons shows that Δb and Δp have the same sign and, since $b_{Ni}>b_{Pd}$, that $p_{Ni}>p_{Pd}$. The 2θ dependence of the intensity difference is less pronounced for the other compositions than that shown in Fig. 1 for the 50 at.% alloy. Since the Bragg scattering is spin-dependent, a correction for the difference in transmission of spin-up and spin-down neutrons is required, and this must be applied to the total diffuse intensity. The multiple Bragg scattering is also spin-dependent and requires an additional correction. Just as in the Bragg scattering case, the corrections are proportional to the nuclear magnetic cross term and are therefore most important in the Ni-rich region. Measurement of the spurious "difference cross section" for pure Ni therefore provides a good test of the correction procedure. The measured "difference cross section" for pure Ni has no K dependence and a magnitude of 44±2 mb. The correction calculated from the observed transmission values and the multiple scattering treatment of Brockhouse, Corliss, and Hastings[14] is 43 mb. The excellent agreement provides assurance that the corrections can be properly applied to this alloy series. This is an important consideration since the corrections are sizeable in the Ni-rich region. For this series of alloys they vary from 30% for the 25 at.% Pd alloy to 3% for the 92 at.% Pd alloy.

The observed difference cross sections are shown in Fig. 2. These are in absolute units of mb sr^{-1} atom^{-1} as obtained by calibration with a standard V scatterer and have been corrected for single transmission and multiple Bragg scattering effects. All of the cross sections show some K dependence but this is especially pronounced in the case of the 50 at.% Pd alloy. In order to determine the variation of this K dependence with sample heat treatment and also to provide an additional check on the multiple Bragg scattering corrections,[15] measurements were made on three additional samples of this

[12] M. F. Collins and J. B. Forsyth, Phil. Mag. **8**, 401 (1963).
[13] B. E. Warren, B. L. Averbach, and B. W. Roberts, J. Appl. Phys. **22**, 1493 (1951).
[14] B. N. Brockhouse, L. M. Corliss, and J. M. Hastings, Phys. Rev. **98**, 1721 (1955).
[15] I. A. Blech and B. L. Averbach, Phys. Rev. **137**, A1113 (1965).

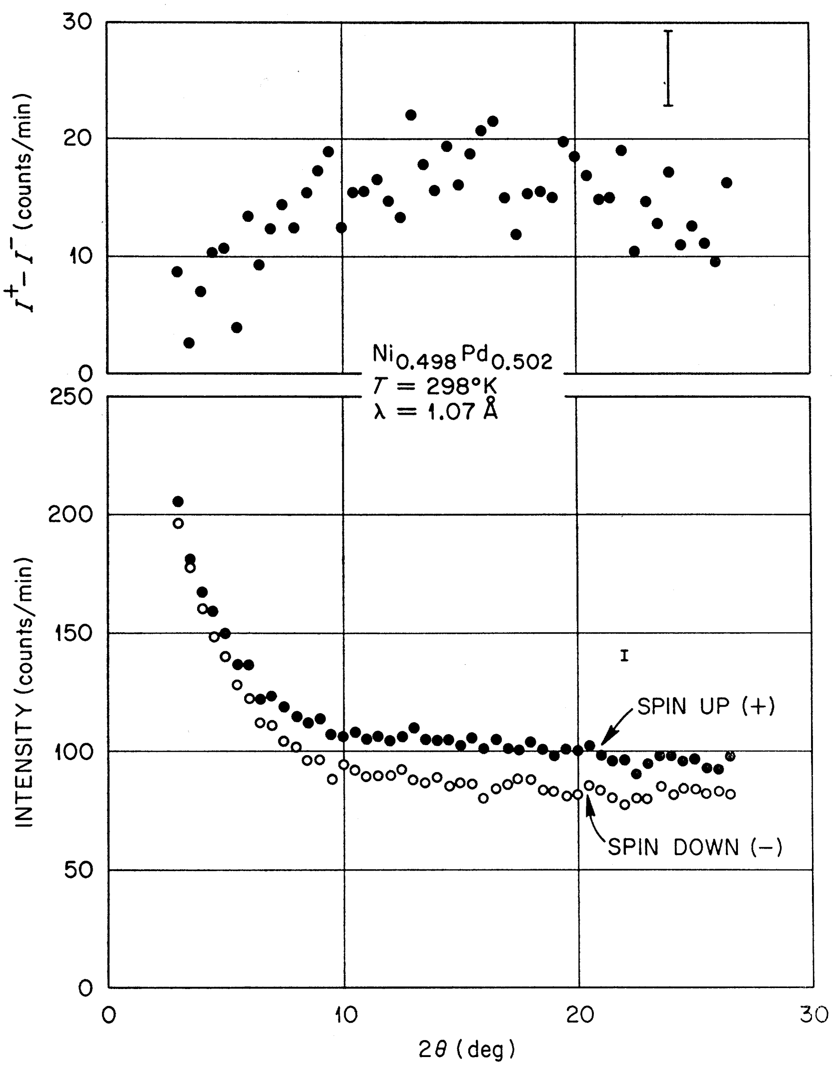

FIG. 1. Intensity-versus-scattering angle (2θ) data for the 50% Pd alloy.

same composition. These were a 0.6×3-cm cylinder cut from the drop cast ingot, the same cylinder after annealing at 1000°C for 24 h and quenching to room temperature and a 1×3-cm cylinder annealed at 1000°C and quenched. Within the experimental error of ±8 mb all three cylindrical samples give the same cross section and this agrees quite well with that obtained for the flat-plate sample. The averaged cylindrical data and the flat-plate data are represented by the filled and open circles, respectively, in Fig. 2(b).

In principle, the scattering function, $S(K)$, can be obtained from the nuclear disorder scattering, but, in fact, this was too small a fraction of the total diffuse scattering for a proper evaluation. Instead, the observed cross sections were least-squares fitted to Eq. (9) with the parameters $\Delta\mu$, $\alpha(R_i)$, $\beta(R_i)$. We find that short-range order parameters out to the second-neighbor shell are sufficient to reproduce the observed K dependence and that the size-effect parameters are negligible. The fitted curves are shown as the solid lines in Fig. 2 and the parameters are given in Table VI. The short-range order parameters are quite small and consequently not well determined. Indeed, with the exception of the 50 at.% alloy, the observed cross sections are nearly as well represented by unmodulated, random alloy cross sections. These are shown in Fig. 2 as the dashed curves which are normalized to the $\Delta\mu$ values of Table VI. In this analysis we have assumed that the Ni and Pd atoms have distinct moment values. If, in fact, the atomic magnetic moment values vary with near-neighbor environment then an additional K dependence is introduced into the scattering. The neutron scattering from such a system has been treated by Marshall[16] on the assumption of linear and additive moment disturbance effects. Fortunately, the modulation introduced by such effects has a similar K dependence to that introduced by

[16] W. Marshall, J. Phys. C1, 88 (1968).

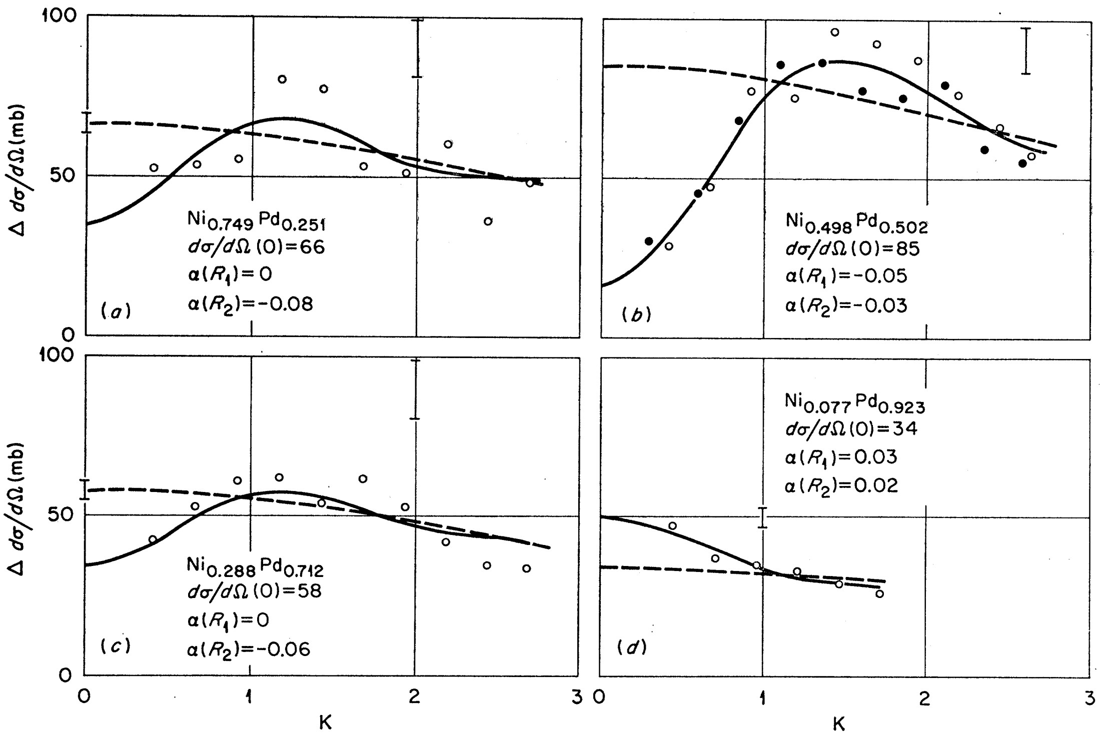

FIG. 2. Difference cross sections for Ni-Pd alloys. The solid curves are least-squares fitted to Eq. (9), and the dashed curves are the corresponding unmodulated cross sections. These intersect $K=0$ at $d\sigma/d\Omega(0)=4c_Ac_B\Delta b\Delta p$ with $\Delta p(0)=0.27\Delta\mu$. The open and closed data points in (b) refer to plate and cylindrical samples, respectively.

short range positional order so that the $\Delta\mu$ values obtained are independent of the model used in analyzing the cross sections.

In general, short-range order effects are expected to vary as c_Ac_B whereas the moment disturbance effects are expected to be more pronounced for dilute alloys. The observed behavior for the three more concentrated alloys is then more consistent with positional order effects than with the moment disturbance effects. It is for this reason that the cross sections have been analyzed in terms of short-range order parameters. The reversal in the sign of the modulation for the 92 at.% Pd alloy may well be associated wlth moment disturbance effects such as those observed[17] in the *Pd*-Fe and *Pd*-Co systems rather than with short-range order. The corresponding difference cross section is

$$\Delta\frac{d\sigma}{d\Omega}=4c_Ac_B\Delta b\Delta p(K)\,, \tag{11}$$

$$\Delta p(K)=0.27\left(\mu_{\mathrm{Ni}}f_{\mathrm{Ni}}-\mu_{\mathrm{Pd}}f_{\mathrm{Pd}}+\sum_R g(R)\frac{\sin KR}{KR}\right), \tag{12}$$

in which $g(R)$ is the moment disturbance produced at a Pd site due to a Ni atom at distance R. Comparison with Eq. (9) shows that the cross sections for these two models have similar K dependencies and that the short-range order parameters of one model are related to the moment disturbance parameters of the other by

$$g(R_i)=\Delta\mu\alpha(R_i)\,. \tag{13}$$

The data provide no distinction between the two models or some mixture of the two which includes both short range order and moment disturbance effects. For our purpose this is not essential since the important parameter $\Delta\mu$ is independent of the model. It is, however, of interest to examine the possible physical significance of the parameters on the basis of the moment disturbance model. With this linear and additive model the average Pd moment produced by the introduction of Ni into Pd is just the sum of the moment disturbance parameters times the Ni concentration. For the 92 at.% Pd alloy the parameters yield an average Pd moment of $0.04\pm0.02\mu_B$. This agrees reasonably well with the observed value of $0.06\pm0.01\mu_B$ and tends to support the moment disturbance model for this particular composition.

TABLE VI. Cross-section parameters for Ni-Pd alloys.

at.% Pd	$\Delta\mu=\mu_{\mathrm{Ni}}-\mu_{\mathrm{Pd}}$	$\alpha(R_1)$	$\alpha(R_2)$
25	0.74 ± 0.03	0.00 ± 0.02	-0.08 ± 0.04
50	0.72 ± 0.01	-0.05 ± 0.01	-0.03 ± 0.02
71	0.60 ± 0.03	0.00 ± 0.02	-0.06 ± 0.06
92	1.01 ± 0.04	$+0.03\pm0.01$	$+0.02\pm0.02$

[17] G. G. Low and T. M. Holden, Proc. Phys. Soc. (London) **89**, 119 (1966).

TABLE VII. Diffuse scattering results for Ni-Pd alloys.

at.% Pd	$\Delta\mu$	$\bar{\mu}$	μ_{Ni}	μ_{Pd}
25	0.74±0.03	0.558	0.74±0.01	0.00±0.03
50	0.72±0.01	0.500	0.86±0.01	0.14±0.01
71	0.60±0.03	0.302	0.73±0.03	0.13±0.01
92	1.01±0.04	0.136	1.07±0.04	0.06±0.01

The average magnetic moments obtained from the Bragg scattering measurements agree reasonably well with those from bulk magnetization measurements (Table V). This indicates that the conduction-electron polarization is less important for the Ni-Pd alloys than for pure Ni. If we neglect conduction-electron polarization then the average moment per alloy atom can be written as

$$\bar{\mu}=c_{Ni}\mu_{Ni}+c_{Pd}\mu_{Pd}. \tag{14}$$

The individual Ni and Pd moments are then

$$\mu_{Ni}=\bar{\mu}+c_{Pd}\Delta\mu\,,\quad \mu_{Pd}=\bar{\mu}-c_{Ni}\Delta\mu\,,$$

in which $\Delta\mu$ is the moment difference from the cross-section measurements. Results are given in Table VII. We note that the free atom form factor assumptions which are important in the analysis of the Bragg scattering data are of little consequence for these small K diffuse scattering measurements.

IV. DISCUSSION

The individual Ni and Pd moment values obtained from these two independent neutron scattering measurements were corrected to 0°K by use of the relative magnetization data of Sadron[1] and the assumption that both moments follow the average temperature dependence. The corrected moments are given in Table VIII and Fig. 3. Both the Ni and Pd moments increase with increasing Pd content to a maximum of about 1.2 μ_B/Ni in the 90% Pd region and about 0.2 μ_B/Pd in the 50–70% Pd region. Extrapolation of the results to the Ni-rich region indicates that isolated Pd atoms in a Ni environment have no moment but produce an enhanced Ni moment. Such Ni moment enhancement has not been previously observed for Ni-based alloys. The effect of impurities on the Ni moment distribution has been determined for a wide variety of impurities in Ni. These studies[18,19] show that small negative charge separation impurities, such as Mn, Fe, or Rh, produce no moment disturbance at the Ni sites while larger charge separation impurities, either negative such as Cr, Mo, and W or positive such as Si, Ge, and Sn, produce negative moment disturbances which extend about 5 Å into the Ni host lattice. Recently, Cu was shown to produce a negative moment disturbance extending to first-neighbor Ni atoms.[20] Although the present results were not extended to alloys of sufficient dilution for direct observation of the effect, a positive Ni moment disturbance is indicated. Thus the zero charge separation impurity appears to be the only example for which a positive moment disturbance occurs in Ni-based alloys. This moment enhancement is small, about half the size of the opposite effect in the Ni-Cu system, and may be associated with a change in band structure on alloying. The effect is even smaller in terms of electron numbers if the g-factor behavior is considered. The moment distribution indicates that the Ni g factor approaches the average g factor of the alloy. The Ni spin moment accordingly approaches a maximum of $1\mu_B$ in the Pd-rich region.

TABLE VIII. Summary of Ni and Pd moment values.

	μ_{Ni}^0		μ_{Pd}^0		
at.% Pd	Bragg	Diffuse	Bragg	Diffuse	σ_0/σ_T
25	0.84±0.02	0.81±0.01	0.15±0.11	0.00±0.03	1.09
50	0.94±0.04	1.02±0.01	0.25±0.06	0.17±0.01	1.19
71	1.09±0.08	1.13±0.05	0.22±0.06	0.20±0.02	1.55
92	1.06±0.12	1.28±0.05	0.14±0.02	0.07±0.01	1.20

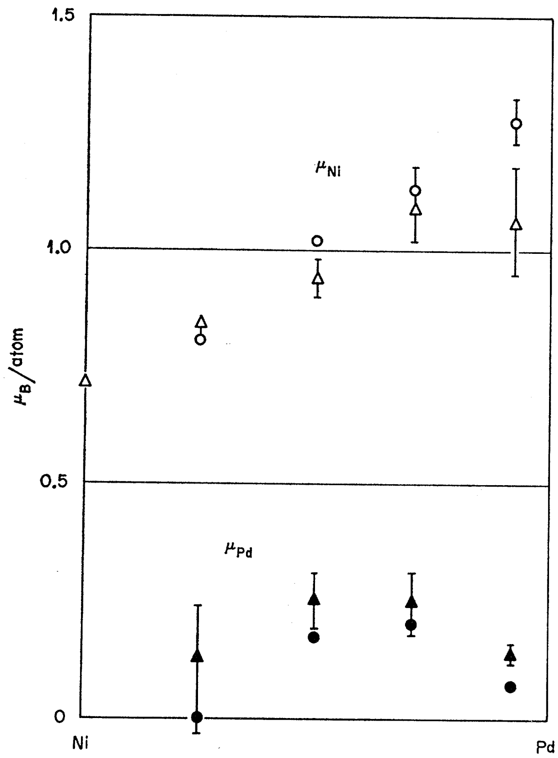

FIG. 3. The Ni and Pd moment behavior for Ni-Pd alloys. The circles and triangles represent the results of the diffuse and Bragg scattering measurements, respectively. The moment values are corrected to 0°K.

[18] M. F. Collins and G. G. Low, Proc. Phys. Soc. (London) **86**, 535 (1965).

[19] J. B. Comly, T. M. Holden, and G. G. Low, J. Phys. **C1**, 458 (1968).

[20] J. W. Cable, E. O. Wollan, and H. R. Child, Phys. Rev. Letters **22**, 1256 (1969).