replaced by

$$ {}_ok_R + {}_ok_{Nd} = {}_ek_M', \tag{4} $$

where ${}_ok_R$ and ${}_ok_{Nd}$ refer to the propagation vectors of the ordinary ruby and $CaWO_4$:Nd^{3+} laser waves, re-respectively, and ${}_ek_M'$ refers to the extraordinary, mixed (sum frequency), second-order polarization wave. The condition for enhanced generation of the mixed signal, i.e., the velocity of the second-order polarization wave equal to that of the mixed light wave, gives

$$ {}_e\mathbf{k}_M' = {}_e\mathbf{k}_M, \tag{5} $$

where ${}_e\mathbf{k}_M$ is the propagation vector for the extraordinary, mixed, light wave. To calculate θ_0 for velocity matching in the case of mixing the laser beams, one uses the equation

$$ \sin^2\theta_0 = \frac{({}_ek_M'\lambda_M)^{-2} - {}_on_M^{-2}}{{}_en_M^{-2} - {}_on_M^{-2}}, \tag{6} $$

when ${}_en_M$ and ${}_on_M$ are the extraordinary and ordinary indices of refraction, respectively, at the frequency of the mixed signal $\lambda_M^{-1} = \lambda_R^{-1} + \lambda_{Nd}^{-1}$. Values of θ_0 calculated in this manner and those measured experimentally with an $f/5.6$ focusing lens are given in Table II.

As can be seen from the data in Tables I and II, the $\theta_{0\,\mathrm{calc}}$ agree with the $\theta_{0\,\mathrm{exp}}$ in the case of SHG as well as in the case of mixing. Although not unexpected, this agreement is especially gratifying in the case of mixing since these experiments were somewhat more complex than those encountered in SHG.

TABLE II. Calculated and experimental values of the angle between the optic axis of the crystal and the direction of the two parallel laser beams which provides matched conditions for the generation of the mixed light waves.

		KDP	ADP
Ruby and $CaWO_4$:Nd^{3+}	$\theta_{0\,\mathrm{calc}}$	42.6°	43.7°
mixed laser beams	$\theta_{0\,\mathrm{exp}}$	42.6°±1°	44.7°±1°

ACKNOWLEDGMENTS

The authors would like to take this opportunity to thank several of their colleagues for important contributions to certain phases of the present research: Dr. K. Nassau for the Nd-doped $CaWO_4$ laser rods, Dr. L. F. Johnson for information on their behavior, Dr. J. A. Giordmaine and Dr. D. A. Kleinman who were a constant source of inspiration and useful information throughout the research, and finally, other colleagues whose names are too numerous to mention for loans of the various lasers and other pieces of apparatus which made these experiments possible.

PHYSICAL REVIEW VOLUME 128, NUMBER 5 DECEMBER 1, 1962

Pressure Dependence of the Intrinsic Magnetization of Iron and Nickel*

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(Received July 3, 1962)

The relative change in the saturation flux, $\Delta\Phi_s/\Phi_s$, has been observed on Fe and Ni at room temperature in the range up to 11 000 kg/cm² in hydrostatic pressure. It decreases almost linearly as the pressure increases for both Fe and Ni. In the derivation of the pressure coefficient of the specific intrinsic magnetization, $\sigma_s^{-1}(\Delta\sigma_s/\Delta p)$, the demagnetizing field of the specimen was taken into consideration. The $\sigma_s^{-1}(\Delta\sigma_s/\Delta p)$ obtained is -3.04×10^{-7} (kg/cm²)$^{-1}$ for Fe and -2.38×10^{-7} (kg/cm²)$^{-1}$ for Ni.

IN a previous work,[1] the effect of hydrostatic pressure on the specific intrinsic magnetization σ_s was observed for Fe and Ni at about 6000 kg/cm² at room temperature, and for Fe it was found from the measurements at several points below 6000 kg/cm² that σ_s decreased almost linearly with increasing pressure.

This paper concerns observations of the pressure dependence of σ_s in the range up to about 11 000 kg/cm² for both Fe and Ni at room temperature, and remarks on the formula for the pressure coefficient of σ_s, $\sigma_s^{-1}(\Delta\sigma_s/\Delta p)$, in the presence of the demagnetizing field in the specimen.

The experimental procedure will be briefly described here again. The pressure is generated with the standard Bridgman press[2] with a nickel-chromium-molybdenum steel cylinder which was newly designed. The pressure-transmitting medium is petroleum ether and the pressure is determined from a change in the electrical resistance of manganin wire which is calibrated with the freezing pressure of mercury. The specimens are polycrystalline rods of Fe (99.8%) and Ni (99.8%), all 5.5 mm in diameter and 14.5 mm in length. The effect of pressure on the saturation magnetization M_s is obtained by making a measurement of the flux difference between two specimens, on one of which the pressure is applied.

* This work has been supported by the Scientific Research Expenditure of Ministry of Education of Japan.

[1] E. Tatsumoto, T. Kamigaichi, H. Fujiwara, Y. Kato, and H. Tange, J. Phys. Soc. Japan **17**, 592 (1962).

[2] P. W. Bridgman, *The Physics of High Pressure* (G. Bell and Sons, Ltd., London, 1958).

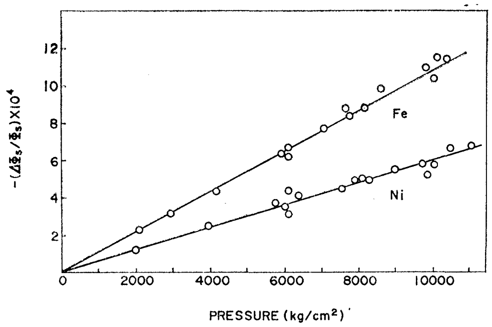

FIG. 1. Pressure dependence of $\Delta\Phi_s/\Phi_s$ for Fe and Ni at room temperature.

The measurement is done as follows. The two specimens are inserted in hardened beryllium copper vessels 35 mm in outer diameter and 50 mm in length; outside each of the vessels the same search coil is reversely wound, such that inside one of them the pressure can be applied. The two vessels are mounted parallel with each other and at the same time in parallel with the field between the poles of an electromagnet, so that no flux change may be observed in the absence of pressure, when the field sufficient to saturate the specimen is reversed. Then, when the pressure is applied, the flux change observed is due to the change in the saturation magnetization M_s with the pressure.

The relative flux change observed, $-\Delta\Phi_s/\Phi_s$, is plotted in Fig. 1. In the previous work, the measurements were done at several points below 6000 kg/cm^2 for Fe, but only at 6000 kg/cm^2 for Ni. However, the present measurements for both Fe and Ni have been done at intervals of about 2000 kg/cm^2 up to about 11 000 kg/cm^2. In Fig. 1 it may be seen that $-\Delta\Phi_s/\Phi_s$ increases almost linearly with the pressure for Ni as well as for Fe up to 11 000 kg/cm^2, as in the previous result for Fe.

The pressure coefficient of σ_s, $\sigma_s^{-1}(\Delta\sigma_s/\Delta p)$, has been given by the following relation[3]:

$$(1/\sigma_s)(\Delta\sigma_s/\Delta p)=(1/\Phi_s)(\Delta\Phi_s/\Delta p)+(1/3V)(\Delta V/\Delta p). \quad (1)$$

Here, $-V^{-1}(\Delta V/\Delta p)$ is the compressibility and Φ_s is the total flux due to the saturation magnetization of the specimen, $4\pi M_s qn$, where q and n are the cross-sectional area of the specimen and the total number of turns of the search coil, respectively. In practice, however, Φ_s is the total flux which is directly observable. Then, in the presence of the demagnetizing field, Φ_s should be taken as $4\pi(1-N/4\pi)M_s qn$, where N is the demagnetizing factor. As long as the dimensional ratio of the specimen is so small that N is large, the correction involving N may not be negligible, since nearly the same order correction as in $\Phi_s^{-1}(\Delta\Phi_s/\Delta p)$ is introduced in $\sigma_s^{-1}(\Delta\sigma_s/\Delta p)$. For the present specimens, $N/4\pi$ is estimated as 0.1 from Bozorth's chart.[4] Thus, for the ordinate scale $\Delta\Phi_s/\Phi_s$ in Fig. 1, the value of $N/4\pi$ is taken as 0.1 in $\Phi_s=4\pi(1-N/4\pi)M_s qn$.

From the results in Fig. 1, $\Phi_s^{-1}(\Delta\Phi_s/\Delta p)$ is determined as -1.09×10^{-7} (kg/cm^2)$^{-1}$ and -0.62×10^{-7} (kg/cm^2)$^{-1}$ for Fe and Ni, respectively. The compressibility is obtained from Bridgman's data[2] as 5.86×10^{-7} (kg/cm^2)$^{-1}$ and 5.28×10^{-7} (kg/cm^2)$^{-1}$, respectively, for Fe and Ni, since it may be taken as a constant in the present pressure range. Consequently, $\sigma_s^{-1}(\Delta\sigma_s/\Delta p)$ is obtained straightforwardly from Eq. (1) as -3.04×10^{-7} (kg/cm^2)$^{-1}$ for Fe and -2.38×10^{-7} (kg/cm^2)$^{-1}$ for Ni. In the present specimens, as the correction involving N on $\sigma_s^{-1}(\Delta\sigma_s/\Delta p)$ is only few percent, it is unnecessary to get the correct value of N.

The values of $\sigma_s^{-1}(\Delta\sigma_s/\Delta p)$ obtained are in fairly good agreement with some of the values which have been obtained so far for both Fe and Ni, as given in Table I.

TABLE I. The pressure coefficient $\sigma_s^{-1}(\Delta\sigma_s/\Delta p)$ for Fe and Ni at room temperature.

Observers	Fe [10^{-7} (kg/cm^2)$^{-1}$]	Ni [10^{-7} (kg/cm^2)$^{-1}$]
Ebert and Kussman[a]	-6	-2.8
Kouvel and Wilson[b,c]	-2.69	1.27[d]
The authors	-3.04	-2.38

[a] H. Ebert and A. Kussman, Z. Physik. **38**, 437 (1937).
[b] J. S. Kouvel and R. H. Wilson, J. Appl. Phys. **32**, 435 (1961).
[c] They listed their results in units of atm^{-1}. Here, these values are converted into units of (kg/cm^2)$^{-1}$.
[d] Dr. Kouvel obtained later a negative value (of about the same magnitude). [General Electric Report No. 61-RL-2731M, May 1961 (unpublished)].

For Co, the same measurement was not applicable because a field sufficient to saturate had not been obtained with the present electromagnet. However, the measurement might be applicable if the sample is a single-crystal rod cut parallel to the easy axis. Preparation of such a single-crystal rod is now in progress.

The authors are much indebted to K. Kusumoto, manager of the machinery division of the Toyo Kogyo Co., Ltd., for preparing several kinds of pressure cylinders.

[3] For example, E. I. Kondorskii and V. L. Sedov, Soviet Phys.—JETP **11**, 561 (1960).

[4] R. M. Bozorth and D. M. Chapin, J. Appl. Phys. **13**, 352 (1942).