Equation (2b) is just a slightly generalized form of the f sum rule for metals. Suppose that the potential is very weak and that n denotes the lowest energy band. Then there is only one important term in each of the sums (2), *viz.*, the term in which n' denotes the first excited band. In this case one easily obtains from Eqs. (2)

$$2|p_{nn'}{}^x|^2=m[E_{n'}-E_n](1-\alpha_{xx}{}^{(n)}), \quad (3a)$$

$$2|p_{nn'}{}^y|^2=m[E_{n'}-E_n](1-\alpha_{yy}{}^{(n)}), \quad (3b)$$

$$2p_{nn'}{}^xp_{n'n}{}^y=2p_{nn'}{}^yp_{n'n}{}^x=-m[E_{n'}-E_n]\alpha_{xy}{}^{(n)}. \quad (3c)$$

Multiplying (3a) by (3b) one gets the square of (3c) or

$$[\alpha_{xy}{}^{(n)}]^2=(1-\alpha_{xx}{}^{(n)})(1-\alpha_{yy}{}^{(n)}). \quad (4)$$

From (4)

$$\alpha_{xx}\alpha_{yy}-\alpha_{xy}{}^2=\alpha_{xx}+\alpha_{yy}-1. \quad (5)$$

The left-hand side of Eq. (5) is just the quantity which occurs in the angular brackets of Eq. (1). It is clear from Eqs. (3) that if α_{xx} and α_{yy} are to have magnitudes much greater than unity, they must be negative numbers. In that case, however, the right-hand side of Eq. (5) is surely negative. It follows that Eq. (1) gives a paramagnetic and not a diamagnetic susceptibility.

The outcome of the argument is not changed if one takes into account the fact that the band in question is not the lowest band, on account of there being inner shell bands. One needs only to modify Eq. (4) by adding to each unity occurring therein an appropriate positive number of order of magnitude unity. The key point is that almost all of the contribution to the f sum comes from the term with the small energy denominator. Since the electron-phonon interaction is very much weaker than the interaction which binds the electron in the lattice, the energy denominator for a transition between two electron-phonon bands will be many orders of magnitude smaller than for a transitions between two normal lattice bands and the contribution to the f sum correspondingly larger. Thus the only important point for the argument is that the superconducting electrons occupy the lowest electron-phonon band.

In Bardeen's discussion of the susceptibility there is an indication[5] that perhaps his model requires very many electron-phonon bands to be occupied. In such a case the argument given above would not be relevant to Bardeen's theory. A careful examination of the papers[1,2] shows that Bardeen did not adopt this feature for his model but made all calculations on the assumption that the superconducting electrons are in a single band. It is concluded, therefore, that the calculations presented here do apply to Bardeen's theory and constitute a serious objection to the theory in its present form.

[1] J. Bardeen, Phys. Rev. **81**, 829 (1951).
[2] J. Bardeen, Phys. Rev. **80**, 567 (1950).
[3] R. Peierls, Z. Physik **80**, 763 (1933).
[4] E. N. Adams, II, Phys. Rev. **85**, 41 (1952). Equation (2b) above follows at once from Eq. (45a) of the reference.
[5] The remark referred to here follows Eq. (2.5) of reference 1.

Magnetic Moment of Se^{77}*

S. S. Dharmatti and H. E. Weaver, Jr.
Stanford University, Stanford, California
(Received February 29, 1952)

EMPLOYING a new nuclear induction apparatus which has higher sensitivity and stability than the one used in previous measurements and which will be described later, signals of Se^{77} were detected in a 12-molar solution of H_2SeO_3. Resonances of Se^{77} with an amplitude approximately seventy times that of the random noise were observed in SeO_2 and H_2SeO_3 dissolved in water without the addition of paramagnetic ions.

A comparison of the resonant frequency of Se^{77} with that of Na^{23} gave the result

$$\nu(Se^{77})/\nu(Na^{23})=0.72193\pm0.00002. \quad (1)$$

With the known[1] magnetic moment of Na^{23} and the fact that the spin of Se^{77} is $\frac{1}{2}$,[2] the sign and value of the magnetic moment were found to be

$$\mu(Se^{77})=+0.53326\pm0.00005. \quad (2)$$

The fact that nuclear induction resonances of selenium were observed in solutions not containing additional paramagnetic ions suggests the possibility of the existence of some monatomic selenium in acid solutions[3] in a manner similar to acid solutions of tellurium.[4] The relatively narrow observed lines can possibly be attributed to the slight catalytic action of such monatomic and paramagnetic atoms.

We would like to express our gratitude to Professor F. Bloch for his continued interest in our work.

* Assisted by the joint program of the AEC and ONR.

[1] F. Bitter, Phys. Rev. **75**, 1326 (1949).
[2] S. P. Davis and F. A. Jenkins, Phys. Rev. **83**, 1269 (1951).
[3] *Textbook of Inorganic Chemistry*, edited by J. Newton Friend (Charles Griffin and Company, Ltd., London, 1931), Vol. VII, Part II, p. 290.
[4] S. S. Dharmatti and H. E. Weaver, Phys. Rev. **84**, 843 (1951).

The Mass Difference $Mg^{23}-Na^{23}$

H. B. Willard, J. D. Kington, and J. K. Bair
Oak Ridge National Laboratory, Oak Ridge, Tennessee
(Received February 27, 1952)

PROTONS from the 5.5-Mev electrostatic accelerator at Oak Ridge were used to measure the $Na^{23}(p,n)Mg^{23}$ threshold. White, Delsasso, Fox, and Creutz report this to be 4.78 ± 0.3 Mev.[1]

A thin metallic layer of sodium was evaporated (in place) on the 15-mil sheet tantalum backing of a rotating target. The neutrons emitted in the forward direction were detected by a threshold counter similar to that described by Bonner and Butler.[2] The proton energy was determined from a magnet current calibration curve based on well-known[3–5] resonances in the gamma-ray yield of the proton bombardment of fluorine. This method, described elsewhere,[6] is believed accurate to 0.2 percent. As an additional check, the $B^{11}(p,n)C^{11}$ threshold at 3.015 ± 0.003 Mev[7] and the $F^{19}(p,n)Ne^{19}$ threshold at 4.253 ± 0.005 Mev[6] were measured in the same magnet cycle of one of the present runs.

Figure 1 shows the $Na^{23}(p,n)Mg^{23}$ yield in the forward direction (uncorrected for the response of the neutron counter). The average value of the threshold for six magnet cycles on two freshly evaporated sodium targets is 5.091 ± 0.010 Mev; therefore, the Q value is -4.88 Mev. Taking the $n-H^1$ mass difference to be

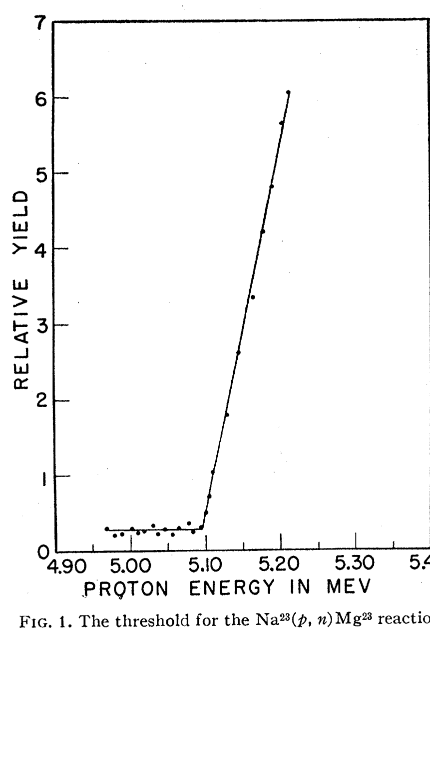

FIG. 1. The threshold for the $Na^{23}(p,n)Mg^{23}$ reaction.