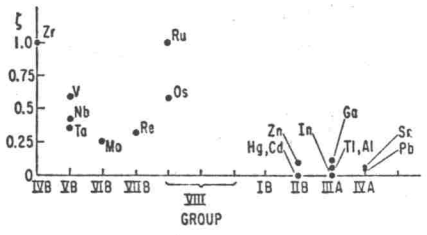

FIG. 4. The variation of ζ with position in the periodic system.

workers[18–21] have made extensive studies of the correlation between φ and the isotopic mass dependence of T_c. In the BCS formalism the role of the phonon spectrum in the attractive interaction leads to a mass dependence of $M^{-0.5}$. This has been termed the "normal isotope effect." Now deviations from a coefficient of 0.5 may be written as $0.5(1-\zeta)$, where ζ is taken as a measure of the departure from the "normal isotope effect." The largest values of ζ have been observed in the transition metal superconductors.[22] Swihart,[23] Morel and Anderson[24] and Garland[22] have been able to explain these deviations by using a more realistic value for the cutoff energy of the Coulomb interaction than that employed in the BCS formalism.

The theory of Morel and Anderson[24] leads to the simple expression,

$$\zeta=(K_c^*/(K_p-K_c^*))^2, \tag{8}$$

where $K_p-K_c^*$ replaces the $N(0)V$ of the BCS relationship; K_p and K_c^* representing the phonon and screened Coulomb interactions, respectively. For the nontransition metal superconductors ζ is almost zero and it follows, therefore, from (8) that K_c^* must be very small compared to K_p. The importance of K_c^* in the transition metal superconductors may be inferred from the larger values of ζ observed.[22] It has been suggested by Bucher, Müller, Olsen, and Palmy[19] that the disappearence of superconductivity at each end of the transition series is due to the rapid increase in K_c^*. Values of ζ for all of the superconducting elements, shown plotted in Fig. 4 as a function of position in the periodic table, support this suggestion. Estimates of ζ for V, Ta, Nb, Re, Ga, and Al, for which no direct isotope measurements are available, were made from φ using the empirical relationship of Bucher *et al.*[19] It is concluded, therefore, that the increased influence of K_c^* upon the superconducting transition temperatures of Zr and V results in the observed sign of the pressure dependence of T_c. Such an explanation is also undoubtedly applicable for the dramatic pressure dependence of T_c observed for La[13] and U,[14] but here the situation is complicated by the presence of f character in the electron wave functions at the Fermi surface.

It is interesting to make a comparison, in Fig. 4, of ζ for V, Nb, and Ta in group VB and Ru and Os in group VIII. This would indicate a decrease in the influence of K_c^* in going from the $3d$ to the $5d$ elements. This may be associated with the increasing width of the d band of the later transition metals.

We can see a definite need for further investigation of the pressure dependence and the isotope effect on the superconducting transition temperature of the remaining transition metal superconductors. Unfortunately, the experimental difficulties involved are quite considerable.

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