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Number of 3*d* Electrons in the Transition Metals*

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At a recent conference, values were presented for the number of 3*d* electrons in Cu, Ni, Co, Fe, and Cr,[1] in the solid state as obtained from absolute measurements of the scattering factor for x-rays. Inasmuch as the results differ considerably from the well-known atomic configurations, they occasion some curiosity, as the authors have remarked.[1] Furthermore, the configurations advocated in reference 1 are difficult to reconcile with self-consistent calculations for the valence band-wave functions of the transition elements.[2] The interpretation of the experiments by Weiss and DeMarco rest on two assumptions. First, it is assumed that the contribution to the scattering by the "argon core" electrons may be assessed by means of a self-consistent field calculation for the free atom. Next, it is assumed that the extent of the 3*d* wave functions is greatly exceeded by that of the 4*p* and 4*s* so that the latter may be neglected. It is then the case that the scattering in excess of that for the "argon core" is due only to the 3*d* electrons. The last assumption may possibly be questioned and it would seem desirable to obtain some independent information on the number of 3*d* electrons per atom in the transition elements in the solid state. It is the purpose of this note to point out that some such information exists already in the literature and tends to favor the conventional configurations assigned to the atoms in the metal over those suggested by Weiss and DeMarco.

Several years ago Nilsson[3] observed that the excitation function for *K* series characteristic x-radiation from the transition elements exhibited a region fairly rich in structural detail over a few tens of volts from the excitation potential. A particular feature of interest here was termed by Nilsson the "*h* structure." It gives the appearance of a partially resolved "line" occurring slightly below the Fermi energy as determined from the results of Beeman and Friedman.[4] Nilsson interpreted this line as due to ionizing transitions in which the electron final state lies in the unfilled part of the 3*d* band. Its intensity would then be expected to vary with the filling of the 3*d* band and Nilsson observed this to be the case, assuming conventional configurations appropriate to the atoms in the metal.

A specific example may be taken from a comparison of Co and Fe. According to the assignments of Weiss and DeMarco, the line would be expected to be about four times as intense in Fe as in Co. The observed factor is approximately $\frac{4}{3}$ which would have been expected on the basis of conventional atomic configurations in the metals.

It is suggested that since in the scattering experiments there are no selection rules effective in sorting states of a special symmetry, those experiments yield only some measure of the total extent of the electron cloud. Distinction among symmetry types is more properly sought in spectroscopic measurements.

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μ-Mesonic Molecular Ions and Nuclear Catalysis*

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THE experimental observation[1,2] of the catalysis of nuclear reactions by μ mesons in liquid hydrogen[3] created interest at a number of laboratories and led to several independent theoretical investigations of the processes involved.[4] Although it soon became clear that this phenomenon could not lead to the production of useful power, some of the estimates of particular reaction rates were in wide disagreement, primarily because of the gross approximations made. Because of the intrinsic interest in the effect, and in order to obtain a more satisfactory understanding of these processes, we have made a detailed investigation of the molecular systems involved in these reactions.

It is assumed that nuclear catalysis proceeds through the following processes:

(1) The μ meson is slowed down by collisions in the liquid hydrogen and captured by a proton, forming a $(p\mu)$ atom.

(2) The $(p\mu)$ atom migrates and encounters a deuteron which captures the meson by exchange. Owing to the difference in reduced mass, this process releases 135 ev to the system.

(3) The $(d\mu)$ atom slows down by collisions and forms a $(p\mu d)^+$ molecular ion by a process of electron ejection.

(4) The nuclear reaction $p+d\rightarrow He^3+\gamma$ (5.5 Mev) occurs. The γ ray may then eject the meson.