from several diffusion mechanisms which employ a defect mechanism of mass transport. If volume diffusion is not predominant in establishing the fillet, then the value of D_{885} corresponding to volume diffusion must be even smaller than that given in the paper, thus increasing the discrepancy between D_{885} determined from sintering data and the corresponding value determined from tracer data. This strengthens the main argument, namely, that different mechanisms of diffusion are dominant in α-Fe and γ-Fe.

From the preceding discussion and the fact that D_{935} from sintering data is in good agreement with the tracer data, it is concluded that (*a*) the sintered fillets in the fcc structure were established by volume self-diffusion via a defect mechanism, presumably vacancies, and (*b*) a diffusion mechanism which does not involve lattice defects is primarily responsible for volume diffusion in bcc iron. This latter mechanism is presumed to be a ring mechanism such as proposed by Zener, where two or more neighboring atoms exchange positions simultaneously. The contribution from a four-atom ring seems most favorable from theoretical energy considerations.[7] Therefore, it is concluded that the large change in D, which occurs when iron is heated through the alpha-gamma critical temperature, is caused by a change in the dominant diffusion mechanism. It seems most likely that this change is from a four-atom ring mechanism in bcc iron to a vacancy mechanism in fcc iron. This conclusion is further substantiated by recent diffusion studies on α-iron in a high-temperature gradient,[8] and is direct experimental support for the theoretical treatment of Le Claire[9] on diffusion mechanisms in bcc metals.

[†] This work was performed under contract with the U. S. Atomic Energy Commission.

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SHELL EFFECTS IN THE OPTICAL POTENTIAL

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There are a few qualitative disagreements between the observed low-energy neutron scattering data (the strength function $\langle \Gamma^0/D \rangle$ and the scattering length R') and the predictions from the conventional optical potential whose imaginary part (W) is independent of the mass number A. (1) The observed $\langle \Gamma^0/D \rangle$ is too small around $A \sim 100$,[1] that is, W should be smaller than usual in this region. (2) The observed R' is too small around $A \sim 60$,[2] (Fig. 1), which means that W should be larger than usual in this region. (3) The observed $\langle \Gamma^0/D \rangle$ is too small around $A \sim 60$,[2] (Fig. 1), and this also indicates that W is larger than usual here.

Lane et al.[1] attributed the phenomenon (1) to the fact that for $A \sim 100$ either proton or neutron is near magic. This will not be the principal reason because for $A \sim 40$, where both proton and neutron are magic, the experiments agree fairly well with the theory (Fig. 1).[3] Phenomena (2) and (3) were attributed to the quadrupole deformation of the nucleus by Seth,[4] as was done for $A \sim 150$. This again is doubtful since, for $A \sim 60$, the quadrupole moments are not too large to be explained by configuration mixing and the low-lying levels are not of rotational type.

We propose to explain the above phenomena by the model of Lane and Wandel.[5] Usually this model is applied to an infinite medium. Now we apply it to a finite nucleus. The theoretical justification for this was given before.[6] What is the difference between the two? The difference appears in the conservation law for the scattering process leading to the absorption. For an

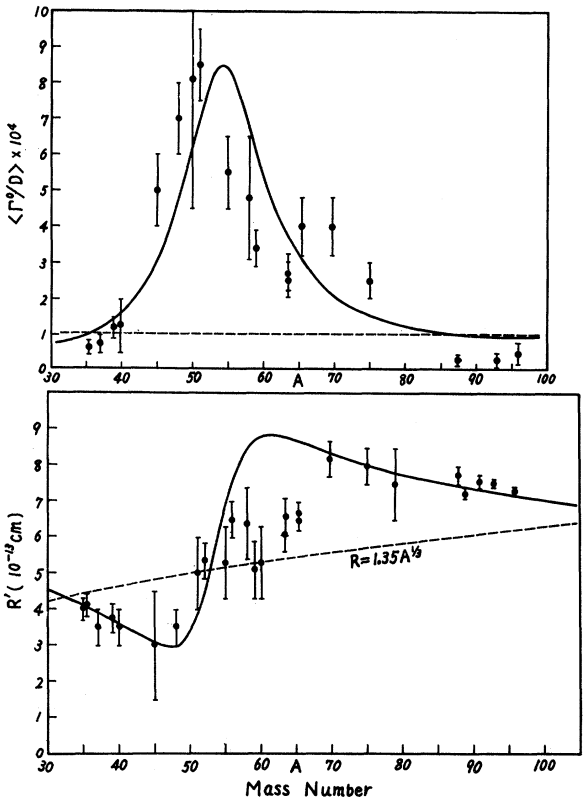

FIG. 1. The observed strength function $\langle\Gamma^0/D\rangle$ and the scattering length R'.[2] The solid curve is the prediction from the conventional optical potential [V. F. Weisskopf, Physica 18, 952 (1956)]. The dashed curve is the one from the black nucleus.

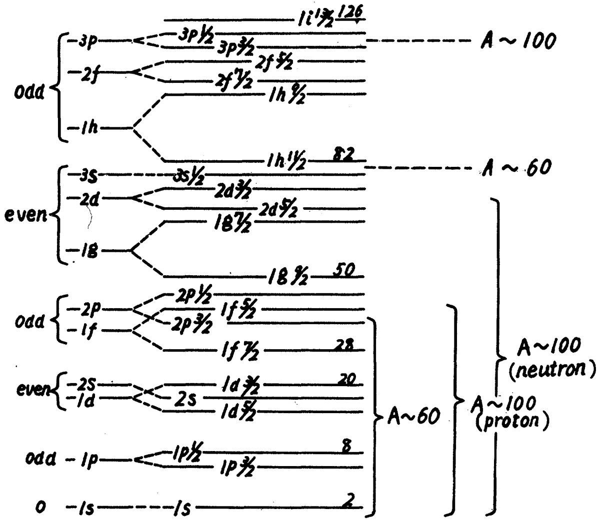

FIG. 2. The schematic single-particle levels.[7] The filled levels are indicated by curly brackets, and the positions of the zero-energy incident neutron are indicated by dashed lines for $A \sim 60$ and $A \sim 100$. For the latter, the top of the filled levels is different for protons and neutrons.

infinite nucleus, we calculate the effective two-body scattering cross section in the nuclear matter for which the momentum and energy are conserved. For a finite system, on the other hand, it is the angular momentum, parity, and energy which are to be conserved. The parity conservation is very important since, according to the shell model, the single-particle levels with the same parity are grouped together[7] (except for one level with the highest angular momentum) and the conservation law is either yes or no. The conservation of the angular momentum is not so restrictive because of its vectorial nature.

Figure 2 represents the schematic single-particle levels.[7] In the figure the filled levels are indicated by curly brackets and the positions of the zero-energy s-wave neutron are indicated by dashed lines for $A \sim 60$ and 100. For $A \sim 60$: (i) The incident s neutron can easily jump down to the $3s$ state just below and raise a nucleon in the target to a nearby state. (ii) If the incident neutron jumps down far below and the parity change is yes, a nucleon in the target is raised high so that the energy is conserved and the parity change is again yes. So we expect large W. For $A \sim 100$: (i) When the incident s neutron jumps down to the nearby states, the parity change is yes, but for the raised nucleon in the target the parity change is essentially no. (ii) If the incident neutron jumps down far below, the nucleon in the target is raised high and the parity law is again not satisfied. Thus we expect small W. In this way we can understand (1), (2), and (3) as the shell effect, but the meaning is quite different from that of Lane et al. The sharp rise of $\langle\Gamma^0/D\rangle$ and R' near $A = 70$ (Fig. 1) may be due to the filling of the minus parity levels.[8]

According to the present theory, W for the p state must be small for $A \sim 60$ and large for $A \sim 100$. There are no reliable data for W in the p state. Seth,[4] and also Lane et al.,[1] gave some experimental data indicating that W is small for $A \sim 100$ in contradiction to our theory, but these are not convincing. An exact analysis for W in the p state is highly desirable.

The surface absorption model[9] also makes $\langle\Gamma^0/D\rangle$ small for $A \sim 100$ but, according to our preliminary machine calculations, the reduction is not enough. Further, this model does not explain (2). The nonlocal nature[6] of the imaginary part may also be responsible for making the effective local W dependent on A and the incident angular momentum. This point has not been studied yet.

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[3] A. M. Lane et al. stated that W is small since the level density is small near magic. W depends, however, also on the nuclear matrix elements which will be large if the level density is small. Further, we do not observe large difference between $\langle \Gamma^0/D \rangle$ for the even nucleus and the odd nucleus although the level density differs by about a factor 2. This was pointed out to the author by V. F. Weisskopf.

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[8] From Fig. 1 we see a small discrepancy in $\langle \Gamma^0/D \rangle$ near $A \sim 50$ but, since R' is normal here, the theoretical R' and $\langle \Gamma^0/D \rangle$ will be fitted to the experiment by slightly changing the depth (or the radius) of the real part of the potential, leaving W near the normal value.

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FURTHER INTERPRETATION OF A MEDIUM ENERGY $(p, 2p)$ EXPERIMENT*

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In a previous publication,[1] the momentum transfer distribution observed in the 40-Mev $(p, 2p)$ angular correlation experiment of Griffiths and Eisberg[2] was interpreted as giving information about the momentum distribution of nucleons localized in the nuclear surface. After unfolding the momentum transfer distribution due to the optical potentials in the entrance and exit channels, it was found that momentum components corresponding to proton energies of about 1 Mev were most likely to be observed for the bound particle. It is the purpose of this Letter to point out some additional considerations which contribute to an understanding of the reaction.

A collision of a nucleon with a stationary free nucleon will result in an angle of 90° between the momenta of the particles in the final state. In reference 1, it is shown that the effect of the binding potential is to move the region of smallest momentum transfers to an angle less than 90°. If small momentum transfers are most probable, the result will be an angular correlation peaked at an angle less than 90° (depending on the binding and excitation energy) as is observed experimentally.

In reference 1, it was assumed that the momentum distribution was isotropic. The momentum components were estimated from the experiment. Essentially the peak in the experimental angular correlation is so narrow that only small momenta (~1 Mev) contribute. The relationship between the width of the angular correlation curve and the momentum of the struck particle is explained in reference 1.

It was also shown in reference 1 that the reactions are not isotropically distributed over the nuclear surface. They come predominantly from an equatorial belt on the surface with the incident direction as the north-south axis. Within the belt, the main contribution comes from regions A, Fig. 1, since, for one particle scattered to the left and the other to the right, one of the particles coming from region B is likely to be