perature display a first-order transition in UO_2, but in the lattice properties, in contrast to Blume's hypothesis. This result would suggest a re-examination of the transition mechanism in UO_2. Part of the data on elastic constant versus temperature is in accord with the idea of a first-order phase change, but C_{44} versus temperature would seem to be quite anomalous and indicative of a considerable interaction between lattice and spins well above the transition.

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$\frac{3}{2}^-$ GROUND STATE OF V^{47} †

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Of those nuclei in the $1f_{7/2}$ shell which are readily accessible to experimental investigation, V^{47} is one of the least well studied. Thus, although in studies of the reactions $Cr^{50}(p, \alpha)$,[1] $Ti^{46}(p,\gamma)$,[2] and $Ti^{47}(p,n)$,[3] energy levels have been observed up to about 3 MeV in excitation, in no cases have spin-parity assignments been made. In particular, the assumed[4] $\frac{5}{2}^-$ character for the ground state of V^{47} has been based largely on its observed β^+ decay.

On the other hand, there are now extensive theoretical predictions concerning V^{47} as well as a wide range of other $1f_{7/2}$ nuclei. For example, within the framework of a pure $1f_{7/2}$ shell-model configuration, McCullen, Bayman, and Zamick[5] and Ginnochio[6] have successfully reproduced the excitation energies of the low-lying $\frac{7}{2}^-$ and $\frac{5}{2}^-$ states for many odd-A nuclei. However, their calculations generally predict the $\frac{3}{2}^-$ states arising from this configuration to be as much as 1 MeV higher in excitation than their observed locations. More recently, Federman and Talmi[7] have obtained good agreement for the low-lying states in the Ca isotopes by assuming a deformation of the $1f_{7/2}$ orbital. Malik and Scholz[8] have also shown that the level schemes for a number of odd-A nuclei in this shell can be rather well described in terms of the Nilsson model with Coriolis coupling. According to this model, the relative locations of the $\frac{7}{2}^-$, $\frac{5}{2}^-$, and $\frac{3}{2}^-$ states may be a sensitive measure of the deformations in these nuclei. In this communication we wish to report on a study of the low-lying $\frac{3}{2}^-$, $\frac{5}{2}^-$, and $\frac{7}{2}^-$ states in V^{47} arising from the $(1f_{7/2})^3$ proton configuration. Information concerning the locations of hole states is also presented.

Levels in V^{47} have been studied[9] by means of the reaction $Ti^{46}(He^3, d)$ using a 16.5-MeV He^3 beam from the University of Pennsylvania tandem accelerator. Deuteron spectra were recorded at angles ranging from 7° to 40° with a broad-range magnetic spectrograph and with an over-all resolution <20 keV. Figure 1 shows a partial deuteron spectrum measured at 30° for the transitions leading to the ground and first three excited states at 0.089, 0.147, and 0.258 MeV. The impurity group corresponding to the 1.663-MeV level in V^{49} arose because of the presence of 14.5% Ti^{48} in the target.

In Fig. 2, deuteron angular distributions corresponding to the ground and second excited states are shown. The curves shown were calculated from distorted-wave theory using the code JULIE. Of particular interest here is the unambiguous $l_p = 1$ assignment to the ground-

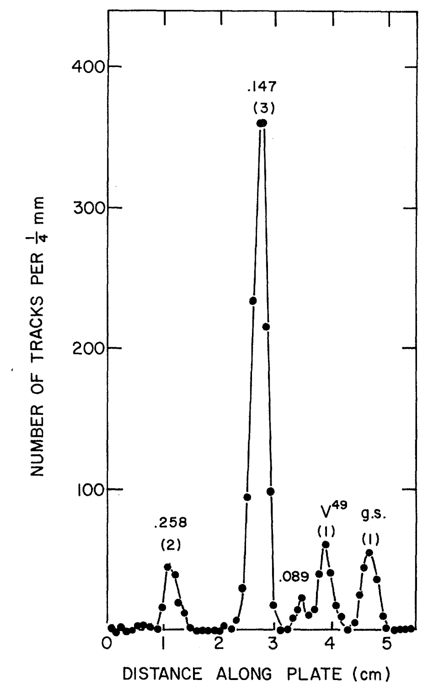

FIG. 1. Deuteron spectrum from the reaction $Ti^{46}(He^3, d)V^{47}$ measured at 30°. The numbers in parentheses are the values of the orbital angular momenta transferred in the reaction.

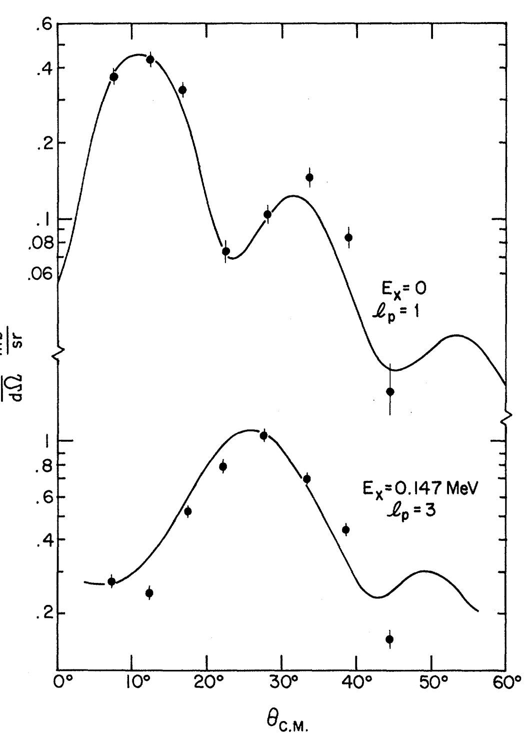

FIG. 2. Deuteron angular distributions corresponding to the ground state and 0.147-MeV state in V^{47}. The curves are the results of distorted-wave calculations.

state transition. This clearly rules out the earlier $\frac{5}{2}^-$ assignment for the ground state and limits the spin-parity to either $\frac{1}{2}^-$ or $\frac{3}{2}^-$. However, of these possibilities, only $\frac{3}{2}^-$ is consistent with the measured $\log ft = 4.9$ in the decay $V^{47}(\beta^+)Ti^{47}$.[4]

The intense ($S = 0.73$) $l_p = 3$ transition suggests a $\frac{7}{2}^-$ assignment for the level at 0.147 MeV. The $\frac{5}{2}^-$ state arising from the $(1f_{7/2})^3$ configuration is expected to lie close to this $\frac{7}{2}^-$ level[6,8] and should be only weakly excited since it cannot be formed by a first-order stripping mechanism. It is, therefore, reasonable to identify this state with the level at 0.089 MeV to which a relatively weak, nonstripping transition was observed. The level at 0.258 MeV was seen to be excited by a weak $l_p = 2$ transition, and this level can be identified as a $\frac{3}{2}^+$ hole state. Only one other low-lying even-parity state was seen in this study. This is the 1.664-MeV state to which a $l_p = 0$ transition was observed and which can, therefore, be identified as a $\frac{1}{2}^+$ hole state.

It is interesting to note that the Coriolis coupling model employed by Malik and Scholz[8] can successfully account for the $\frac{3}{2}^-$ ground state of V^{47} only if a deformation as large as either $\beta \approx -0.5$ or $\beta \approx +0.6$ is assumed. However, if the over-all agreement with the level schemes of neighboring $(1f_{7/2})^3$ nuclei is taken into account, their calculations tend to favor a negative deformation.

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