CONF-840945--6

DE84 017482

OPTICAL MODEL SCATTERING FUNCTIONS FOR LOW ENERGY NEUTRONS ON ^{86}Kr

R. F. Carlton
Middle Tennessee State University, Murfreesboro, TN 37312

J. A. Harvey and C. H. Johnson
Oak Ridge National Laboratory, Oak Ridge, TN 37831

ABSTRACT

Optical scattering functions are deduced from an R-matrix analysis and subsequent averaging of high resolution ^{86}Kr + n transmission data. These functions have been fitted by adjusting the well depths in an optical model with $r_0 = r_D = 1.21$ fm, $a_0 = 0.66$ fm and $a_D = 0.48$ fm. The well depths are $V_0 = 51.5$ MeV and $V_{SO} = 5.5$ MeV for $\ell=1$ and $V_0 = 48.5$ MeV for $\ell=0$. W_D is about 3.5 MeV for $s_{1/2}$, $p_{1/2}$ and $p_{3/2}$. Each well depth has an uncertainty of about ±1 MeV.

INTRODUCTION

Johnson, Larson, Mahaux and Winters[1] presented a method for deducing neutron optical scattering functions for individual partial waves from an R-matrix parametrization of high resolution total cross section data. Using that method we obtain scattering functions for ^{86}Kr and describe them with an optical model potential. (In Session V, Johnson compares our results with other nuclei.)

EXPERIMENTAL AND R-MATRIX ANALYSIS

Raman et al.[2] measured the transmission of a 99.5% enriched ^{86}Kr sample using the 80-m flight path at the ORELA facility. We repeated the measurement with the resolution of the 200-m flight path. The cross sections up to 400 keV are shown by points in Fig. 1. Between resonances the data are averaged over energy channels to reduce the fluctuations. These data permit J^π-assignments based upon the asymmetry produced by the resonance-potential interference. The curve is the multilevel R-matrix fit, which extends to 700 keV.

In Fig. 2 the staircase plots show the cumulative sums of p-wave reduced widths for a 6.4-fm boundary radius. The strength function, $\tilde{s}=\langle\gamma^2\rangle/D$, is 0.058 for $p_{1/2}$ and 0.22 for $p_{3/2}$. For s-waves it is 0.022. Of equal importance for the model analysis is the external R-function which accounts for all levels outside the region from $E_\ell = 0$ to $E_u = 700$ keV. For each partial wave it is parametrized by $R^{ext}(E) = \tilde{R}(E) - \tilde{s}\ \ell n\ [(E_u-E)/(E-E_\ell)]$ where $\tilde{R} = a+b(E-E_m)$ and E_m is the midpoint of the measurements. The fitted (a,b) with b in MeV^{-1} are (-0.13,0.15), (0.60,0.14) and (0.58,1.74) for $s_{1/2}$, $p_{1/2}$ and $p_{3/2}$.

Research sponsored by the Division of Basic Energy Sciences, USDOE under Contract Nos. DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc. and DE-AS05-80ER10710 with MTSU.

DISCUSSION

We averaged the scattering functions for each partial wave using the analytical approximation[1] with a width 2I=200 keV. For p-waves the resulting compound cross section divided by g_J is about 2.5 times larger for $p_{3/2}$ than $p_{1/2}$ and the shape elastic is about 6 times larger for $p_{3/2}$ than $p_{1/2}$. We fit these by adjusting the well depths in a model with Woods-Saxon real well and surface-derivative spin-orbit and imaginary terms. (See abstract for geometric parameters.) The resulting model has V_0 = 48.5 MeV and W_D = 3.5 MeV for s-waves, and V_0 = 51.5, V_{SO} = 5.5, W_D = 3.5 MeV for p-waves. The uncertainties are each about ±1 MeV.

The spin-orbit term, which is required to fit the differences between $p_{1/2}$ and $p_{3/2}$, is consistent with other spin-orbit potentials of other nuclei. It places ^{86}Kr closer to the $3p_{3/2}$ size resonance than to $3p_{1/2}$ and it may explain why the $p_{3/2}$ strength function from Fig. 2 appears to be increasing in our region. The fact that the V_0 are about 3 MeV smaller than for some lighter nuclei is consistent with the N-Z difference for ^{86}Kr. The difference in V_0 between s-waves and p-waves suggests an ℓ-dependence consistent with results from other lighter nuclei.

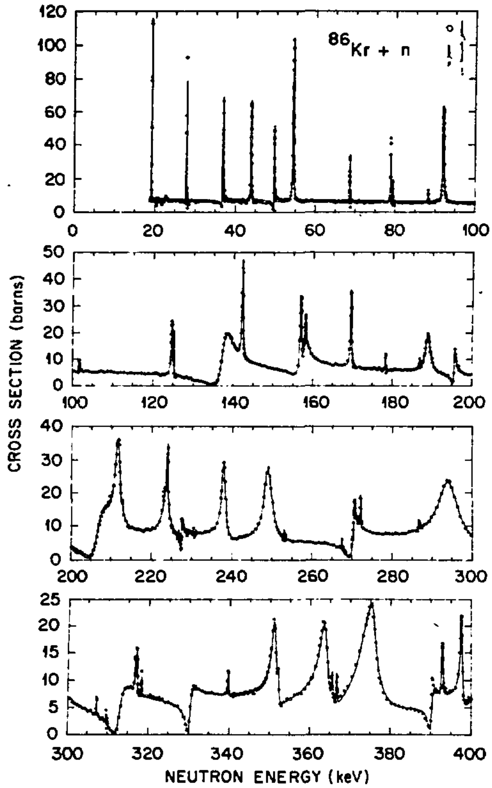

Fig. 1. Total cross section.

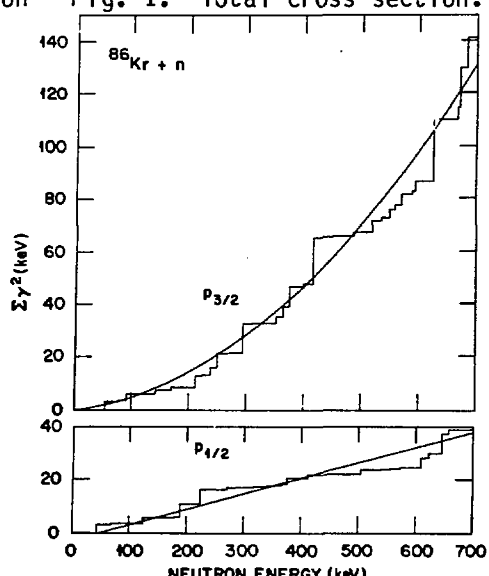

Fig. 2. Cumulative p-wave reduced widths.

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1. C. H. Johnson, N. M. Larson, C. Mahaux, and R. R. Winters, Phys. Rev. C 27, 1913 (1983).
2. S. Raman, B. Fogelberg, J. A. Harvey, R. L. Macklin, P. H. Stelson, A. Schröder, and K.-L. Kratz, Phys. Rev. C 28, 603 (1983).

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