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ELASTIC ALPHA-ALPHA SCATTERING NEAR 40 MeV

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ABSTRACT

In order to investigate suggested rapid energy variation of the s,d and g-wave phase shifts near 40 MeV, we have measured differential cross sections for alpha-alpha scattering over center-of-mass angles from 16 to 100 degrees at nine energies between 37 and 43 MeV. Analysis of these data is underway and is directed toward determining whether resonances corresponding to states in Be^8 or threshold effects of opening reaction channels are responsible for the indicated behavior of the phase shifts.

ELASTIC ALPHA-ALPHA SCATTERING NEAR 40 MeV

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A recent phase shift analysis [1] of the alpha-alpha elastic scattering data available between 23 and 47 MeV [2,3] has indicated a rapid energy variation of the s,d and g-wave phase shifts near 40 MeV. This behavior contrasts markedly with their otherwise rather smooth dependence on energy from 23 to 120 MeV [1,2,4], and might be interpreted as evidence for resonances corresponding to 0+, 2+, and 4+ states of Be^8 (with appreciable reduced widths for decaying to two alpha particles). However, since the threshold energy for the first reaction channel ($He^4 + He^4 \rightarrow Li^7 + p$) is 34.7 MeV and several other reaction channels open near 40 MeV, the possibility exists that threshold effects may be responsible for the suggested behavior of these phase shifts. It is apparent that analyses of data more closely spaced in energy are needed before this question can be resolved.

The variable-energy feature of the Berkeley 88-inch cyclotron has simplified considerably just such an experimental investigation. Thus, we have measured differential cross sections for alpha-alpha scattering over center-of-mass angles from 16 to 100 degrees at nine energies between 37 and 43 MeV. The energy resolution was better than 200 keV, and the angular resolution was approximately 0.25 degree. Angular distributions determined at 39, 40, and 41 MeV are shown in Fig. 1, where they demonstrate the very rapid variation with energy previously seen in less detail [3]. The insert in Fig. 1 shows the excitation curve for alpha-alpha scattering at the center-of-mass angle $\theta = 56^\circ$ ($\theta_{lab} = 28^\circ$), which is near the position of the first zero of the Legendre polynomial $P_2(\cos\theta)$. This is clear evidence for rapid changes in the g and/or s-wave phase shifts in the energy interval shown.

A phase shift analysis of these data is presently underway, the results of which will be reported in the near future.

We are deeply indebted to A. T. Berztiss for communicating to us the results of his phase-shift analyses prior to publication and, thus, calling to our attention the rather unexpected behavior of the phase shifts near 40 MeV. We are also grateful to P. Darriulat, H. D. Holmgren, G. Igo, and H. G. Pugh for discussions concerning their results before publication.

REFERENCES

*Permanent address: Physics Department, Osaka University, Osaka, Japan.

[1] A. T. Berztiss, University of Melbourne (private communication).

[2] E_α = 23 to 38 MeV: D. J. Bredin, W. E. Burcham, D. Evans, W. M. Gibson, J. B. C. McKee, D. J. Prowse, J. Rotblat, and J. H. Snyder, Proc. Roy. Soc. (London) A251, 143 (1959).

[3] E_α = 37 to 47 MeV: H. E. Conzett, G. Igo, H. C. Shaw, and R. J. Slobodrian, Phys. Rev. 117, 1075 (1960).

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FIGURE CAPTION

Fig. 1. Center-of-mass differential cross sections for indicated laboratory energies. The insert shows the excitation curve for the center-of-mass angle, $\theta = 56^{\circ}$.

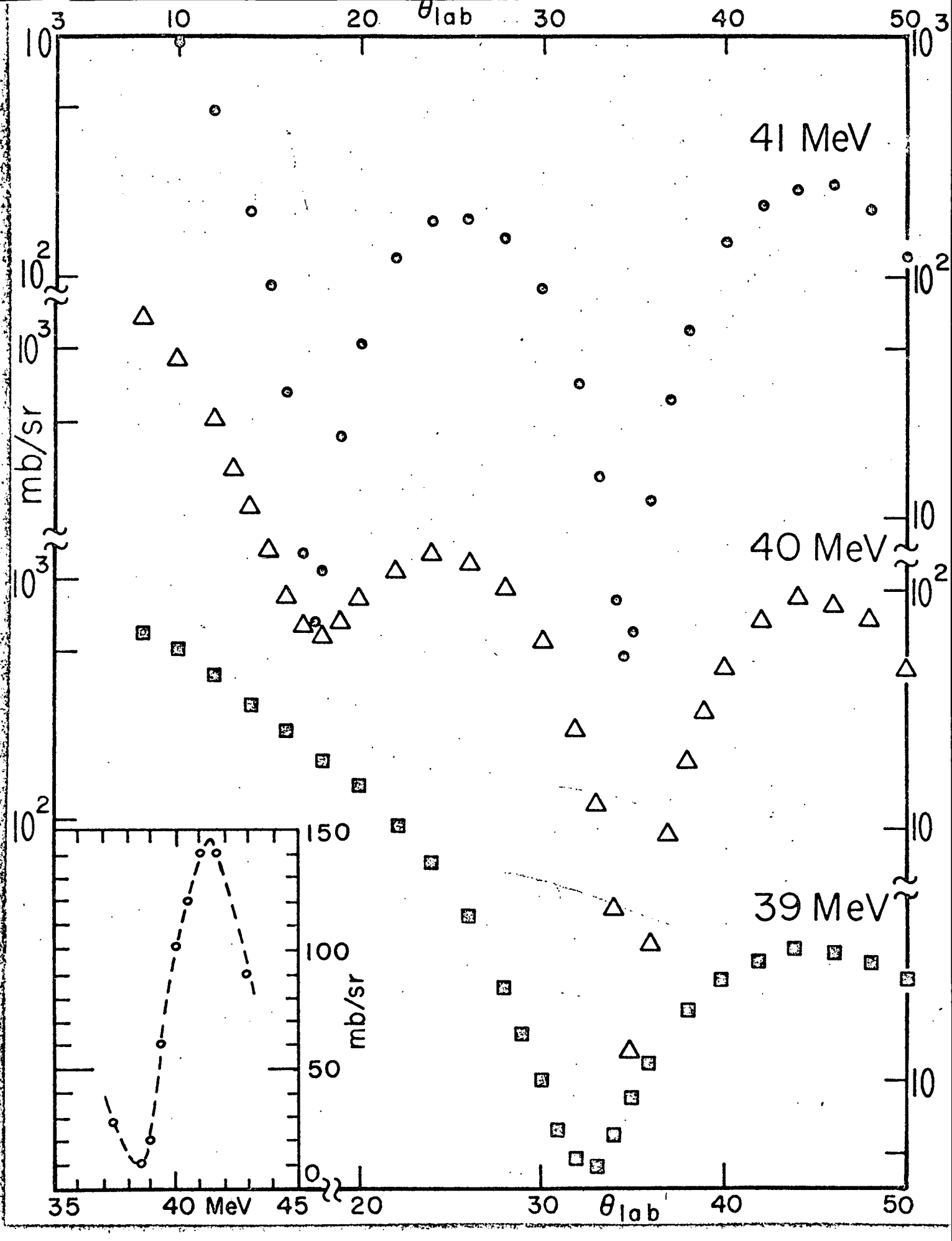
10
20
θlab
30
40
50
10³
10²
41 MeV
mb/sr
10³
10²
40 MeV
10²
10
10
39 MeV
10
150
100
50
0
mb/sr
35
40 MeV
45
20
30
θlab
40
50

Fig. 1

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