a finite energy width of the central peak which would give direct support to these ideas. Since a small static distortion and thermodynamic fluctuations also correspond to the same structure factor, intensity measurements around different reciprocal lattice points do not help to clarify the nature (static or dynamic) of the $2k_F$ quasielastic scattering. It is therefore impossible to conclude whether the true Peierls transition in KCP occurs at low temperature and coincides with the 3D local ordering (dynamical interpretation of the quasielastic scattering), or if the Peierls distortion already exists at room temperature (static interpretation of the quasielastic scattering). It should be emphasized that a small Peierls gap at high temperature would make only very small changes in the electrical properties as well as in the phonon spectrum at room temperature.[7]

We expect a more precise answer to this question from the measurements of the temperature dependence of the truly inelastic part of the $2k_F$ anomaly in the phonon spectrum. If, for instance, the phonon frequencies in the range of the Kohn anomaly increase with decreasing temperature, this would prove the existence of a Peierls distortion already at room temperature.

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p-^{4}He Elastic Scattering at 1.05 GeV

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The angular distribution of the elastic-scattering differential cross section of 1.05-GeV protons by ^{4}He has been measured from 3 to 47° lab. The main features of this measurement are that the first minimum is much less deep than previously measured and that, at the point where a second minimum is predicted by calculations, there is just a slight change of slope.

Since the appearance of the first experimental results on 1-GeV proton scattering from nuclei,[1] considerable theoretical effort[1-4] has been focused on an explanation of p-^{4}He elastic-scattering differential cross section data. In particular, Lambert and Fesbach[3] studied the influence of short-range correlations and Ikeda[4] the effects of N^* production during the multiple scattering process. The theories show how cross sections are quite sensitive to those aspects, but more precise data were necessary, particularly in the region of the first minimum and maximum. The purpose of this Letter is to present new data, taken at Saclay, on the elastic scattering of 1.05-GeV protons by ^{4}He. We find that our angular distribution is similar to that of Ref. 1 but is in rather serious disagreement in the region of the first minimum, which in our result is largely "filled in." Other apparent differences may be due to the slightly different energies of the two experiments and to the rather arbitrary absolute normalization adopted by us.

The apparatus used to obtain the data is the magnetic spectrometer facility SPES I at the Saclay synchrotron Saturne. A description of the system is reported elsewhere,[5] but we include here a few details which we consider particularly significant. The ^{4}He target was a liquid layer, 20 cm in diameter and 1 cm thick, maintained perpendicular to the beam between Mylar sheets in a thin-walled Dewar system. The spectrometer system operated in an energy-loss mode in which the dispersion and focusing properties of the beam-analyzing magnet system as well as the effects of scattering kinematics were matched to the properties of the spectrometer magnet system. In this way a resolution ranging from 300 keV to 2 MeV full width at half-maximum (FWHM), depending on the scattering angle, for the elastic scattering peak was obtained in the focal plane of the spectrometer. There is a correspondence between the angle of emission of the particles at the target and the direction of the trajectories at the exit of the spectrometer. Those directions were measured as described below, and permitted an angular resolution much smaller than the angular opening (2.85° maximum) of the spectrometer. This opening was divided into five 0.5° adjacent angular bins (Fig. 1) of which the relative values were independent of the beam monitoring and target thickness. The shape of the curves (extent and edges) has been checked for various openings of the spectrometer entrance slits. By closing the slits to an opening of 0.25°, for example, the measurements were in agreement with those of the corresponding angular range when taken with full aperture.

To calculate the angular resolution, we have taken into account all significant sources of uncertainties on the scattering angle, which are (a) beam emittance, i.e., spot size and beam convergence; (b) the angular variation due to the energy spread of the beam; (c) defocusing of the incident beam after the target for kinematical compensation purposes; (d) 2-mrad-rms precision of the angular resolution with which the trajectories were measured at the focal plane; (e) multiple scattering in the target and the Dewar walls; and (f) geometrical effects due to the target thickness.

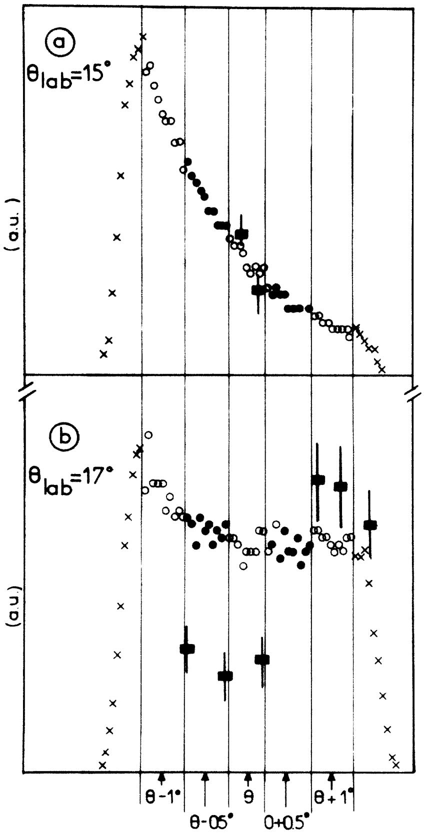

FIG. 1. (a) One of the three partial angular distributions measured at $\theta = 15°$ lab. (b) One of the four partial angular distributions measured at $\theta = 17°$ lab. Open and closed circles, 0.5° channels of adjacent bins in the same measurement. Closed squares, data of Ref. 1 with arbitrary normalization.

The beam emittance was defined by several sets of adjustable slits. The energy spread of the beam was surveyed by observing with a television system the displacement of the beam (due to the dispersion of the analyzing system) on a scintillating plate. The maximum displacement was smaller than ± 4 mm, corresponding to an angular variation of the incident beam smaller than ± 2 mrad.

The effects due to the uncertainties (a)-(d) on the angular resolution were calculated using simple well-known relationships[6] and confirmed by ray-tracing techniques based on accurate magnetic field measurements.

At scattering angles smaller than 26° lab, the angular resolution (FWHM) in the laboratory was approximately 9 mrad and increased monotically to 21 mrad at 44° lab.

Direct experimental evidence of this angular resolution is presented in Fig. 1 where partial angular distributions (2.85° angular range) are shown for positions of the spectrometer at 15 and 17° lab. At 15° a factor of 2.5 is observed between the forward and central bins. On the other hand, at 17° where, from the data of Ref. 1, a factor of 3 was expected between the backward and central bins, we observed a factor of only 1.08. The angular resolution of our system of 9 mrad cannot be responsible for this difference. We have checked this experimentally: First the angular resolution has been well illustrated by previous results of elastic and inelastic scattering on ^{208}Pb,[7] where very sharp minima were measured (i.e., a factor of 3.3 between two adjacent bins for the 3^-). The major difference with the ^{4}He case is in the kinematics for which a defocusing of the incident beam downstream from the target is needed. The effect of this defocusing has been tested with elastic scattering on carbon in the region of its minimum at 10° lab, using the same set of parameters for the various magnetic elements as was used for ^{4}He. The shape of the minimum did not change significantly, as expected from the calculations mentioned above. It should be noted that this minimum in ^{12}C is much sharper than the one in ^{4}He as described in Ref. 1.

The absolute value of the kinetic energy of the beam was determined to be 1.05 ± 0.005 GeV. The combination of energy and angular resolution provided effective discrimination against scattering from material in the target Dewar other than the layer of helium liquid, and except at the very forward and very backward angles, background subtractions were 10% or less. A secondary-electron beam monitor beyond the target provided a measurement of beam integration. The absolute thickness of the target could not be specified to better than about 50% and varied with the depth of liquid helium in the target because of boiling in the target as well as an uncertainty in the bulge of the Mylar walls of the target container. The depth of the helium, on the other hand, was continuously monitored, and the correlation with effective target thickness was reproducible. An independent check of the beam monitoring and, less sensitively, of the relative target thickness was provided by a fixed counter telescope which viewed reactions and scattering from the target assembly. Since a substantial amount of time will pass before an absolute measurement can be made, using, for example, a gas target, we report relative cross sections here.

The relative accuracy of the differential cross section at different angles was verified as follows. The entire angular range from 3 to 47° (lab) was covered in overlapping 2.85° slices by steps of 1° in spectrometer position (three overlapping bins of 0.5° between adjacent measurements) from 4 to 28° and by steps of 2° for the rest of the angular range (one overlapping bin of 0.5°). Most of the angular range was traversed more than once. The 92 partial angular distributions and their corresponding normalization factors (taking into account beam monitoring and relative target thickness) were treated together in a χ^2 minimization procedure and were found statistically consistent. In particular, the region of the first minimum and the following maximum was traversed several times with consistent results.

Figure 2 shows our results.[8] The errors, which include counting statistics and estimates of errors in beam monitoring, relative target thickness, and background subtraction, are smaller than the plotted points, except where shown. The agreement with the results of Ref. 1 is sat-

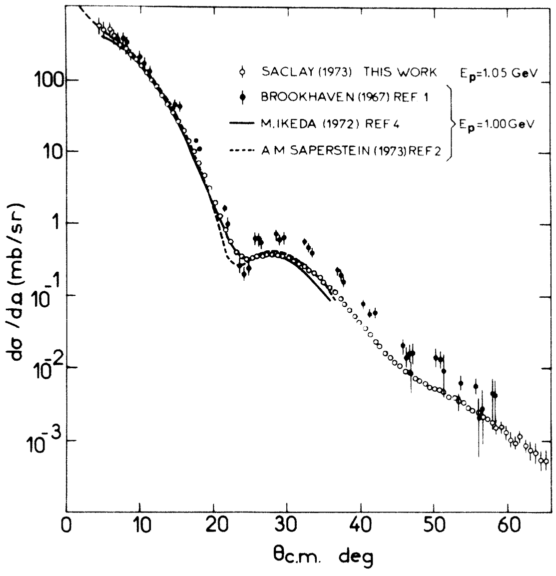

FIG. 2. Experimental results. The absolute normalization of this work has been arbitrarily fixed to $(d\sigma/d\Omega)_{\text{lab}} = 75$ mb/sr at 10° lab. Error bars, when not shown, are smaller than the points.

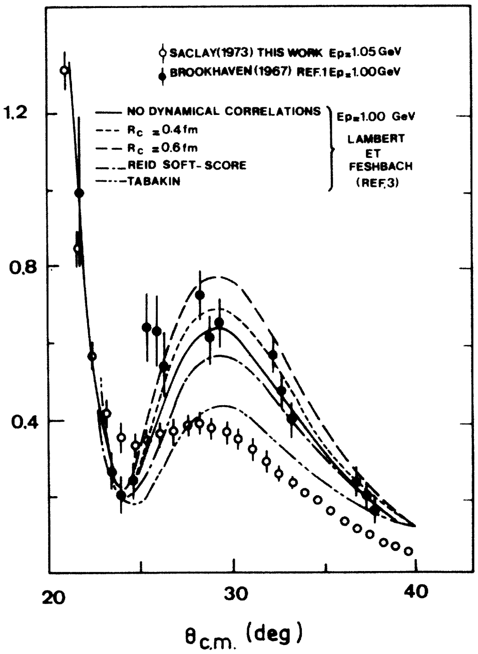

FIG. 3. Comparison between our measurements and the computations of Lambert and Feshbach.

isfactory in general but departs significantly in the region of the first minimum, which is not as pronounced as that of Ref. 1. The difference in the general slope and location of the first maximum may be due to the slightly different incident energies. The small amplitude of the oscillations in the angular distribution and, in particular, the difference with the results of Ref. 1 cannot be attributed to deficiencies in the angular resolution of the present experiment. We have also plotted in Fig. 2 a curve obtained by Ikeda[4] in a multiple-scattering Glauber-theory calculation including N^* production, which produces a very good fit to our data up to the maximum. A calculation published by Saperstein[2] based on an optical potential derived from electron scattering data on ^{4}He is also plotted in the same figure. We present also, in Fig. 3, separately for clarity, a comparison with the computations of Lambert and Feshbach.[3] It is interesting to note that the depth of the first minimum at 1.05 GeV is apparently less than that at 600 MeV.[9]

Finally, it may be added that at present the theoretical situation is not very decisive and one may think of a number of effects[2-4] which may be responsible for filling in the minimum.

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