

High-Momentum Protons in ^{208}Pb

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High-momentum components of proton momentum distributions in ^{208}Pb have been studied from 300 to 500 MeV/c with the $(e, e'p)$ reaction. Cross sections were measured with 180 keV excitation-energy resolution for transitions to the low-lying $\frac{1}{2}^+$, $\frac{3}{2}^+$, $\frac{11}{2}^-$, $\frac{5}{2}^+$, and $\frac{7}{2}^+$ states in ^{207}Tl . The data are compared to distorted-wave impulse-approximation calculations with mean-field wave functions and with wave functions that include nucleon-nucleon correlations. The data are substantially larger than mean-field predictions. The observed excess strength at low excitation energy appears to be mainly due to long-range correlations and not to short-range and tensor correlations.

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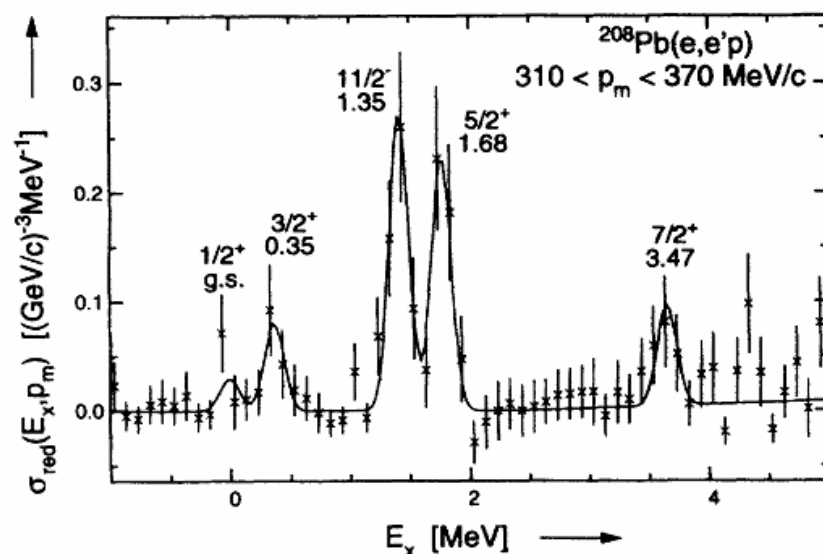


FIG. 1. The reduced cross section of the reaction $^{208}\text{Pb}(e, e'p)$ at an average missing momentum of 340 MeV/c, showing the knock out of valence protons to discrete states in ^{207}Tl , labeled by their spin, parity, and excitation energy. The solid curve is the result of a fit to the spectrum.

EXPERIMENT

The experiment was carried out with the electron beam from the Amsterdam Pulse-Stretcher facility (AmPS) at NIKHEF-K [13] at an energy of 487.3 ± 0.5 MeV. The duty factor and the average current of the beam amounted to about 50% and $1.5 \mu\text{A}$, respectively. The scattered electron and knocked-out proton were detected in coincidence by two high-resolution magnetic spectrometers [14].

KINEMATICS

The present data between 300 and 500 MeV/ c were measured under kinematical conditions where the center of the acceptance corresponded to fixed values of the three-momentum transfer ($q = 221$ MeV/ c), the energy transfer ($\omega = 110$ MeV), and the proton kinetic energy ($T_{p'} = 100$ MeV, corresponding to a proton momentum of $p' = 444.6$ MeV/ c). The angle of the proton spectrometer was set at 99.17° , 112.18° , and 139.11° to obtain a missing momentum of 340, 400, and 500 MeV/ c in the center of the acceptance, respectively. At each setting the covered missing momentum range is ± 30 MeV/ c . The experimental

TARGET

The target consisted of two enriched (abundance 99%) ^{208}Pb foils separated by 5 mm and mounted in a water-cooled frame. With the double-foil construction the luminosity could be doubled while maintaining the excitation-energy resolution at 180 keV by separating the events from the foils through vertex reconstruction and subsequently accounting for position dependent energy loss in the target. The total target thickness of 87.4 ± 2.8 mg/cm² has been determined by comparing the measured cross section for elastic electron scattering with the calculated cross section from known Fourier-Bessel coefficients [15]. The total systematic uncertainty in the cross sections is 6%.

SPECTRUM

displayed at a mean momentum of 340 MeV/ c . Accidental coincidences have been subtracted, the phase space has been accounted for, and the spectrum has been unfolded for radiative processes [18]. The peaks in this excitation-energy spectrum are well separated. From the reduced

Search for nucleon-nucleon correlations in the proton spectral function of ^{208}Pb

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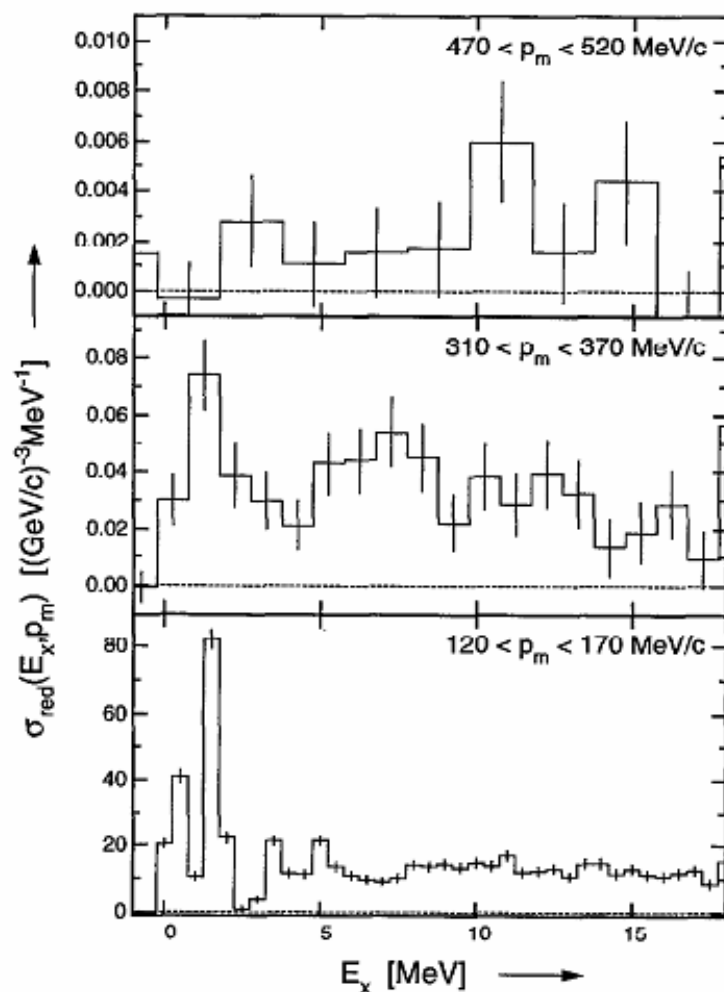


Fig. 1. Reduced cross section for the reaction $^{208}\text{Pb}(e, e'p)$ at average missing momenta of 145 MeV/c, 340 MeV/c and 495 MeV/c.

EXPERIMENT

matter [1,5]. In order to investigate the predicted binding-energy dependence of the high-momentum components of the spectral function we have measured the reaction $^{208}\text{Pb}(e,e'p)$ up to a proton binding energy of 26 MeV. The measurement was performed simultaneously with the one discussed in Ref. [3].

KINEMATICS

340, 400 and 495 MeV/c, where the acceptance covers a range of approximately 60 MeV/c. The data between 340 and 495 MeV/c were measured under kinematical conditions where the center of the acceptance corresponded to fixed values of the three-momentum transfer ($q=221$ MeV/c), energy transfer ($\omega=110$ MeV) and proton kinetic energy ($T_{p'}=100$ MeV). The acceptance in excitation energy (E_x) of the residual nucleus was 18 MeV. A double-foil ^{208}Pb target with a total thickness of 87.4 ± 2.8 mg/cm² was used to double the luminosity and simultaneously maintain the E_x resolution at 180 keV. The total systematic uncertainty in the cross sections amounts to 6 %.

SPECTRUM

Four experimental momentum distributions, $\rho(p_m, p')$, have been obtained by integrating σ_{red} over E_x in the ranges $[-0.75, 2.25]$, $[2.25, 7.25]$, $[7.25, 12.75]$ and $[12.75, 18.25]$ MeV. The boundary of 2.25 MeV represents the limit below which only discrete transitions to valence states in ^{207}Tl are observed, while the boundary of 7.25 MeV corresponds closely to the value of the two-nucleon emission thresholds ($E_x^{pp}=7.37$ MeV and $E_x^{pn}=6.84$ MeV). The third boundary of 12.75 MeV halves the remaining energy domain above E_x^{2N} . The momentum distri-