It has to be pointed out that the above prescriptions, while being justified in the case of uniform nuclear matter, are questionable when applied to nuclei. In nuclear matter, due to translation invariance, the linear momentum is a good quantum number, that can be used to label single particle states. As a consequence, the momentum distribution also provides the occupation probability of the states. In finite nuclei, on the other hand, single particle states must be labeled according to the total angular momentum $\mathbf{J}$. In this case, for any given $\mathbf{p}$, $n(\mathbf{p})$ receives contributions from states of different $\mathbf{J}$, and may even exceed unity.

The available results of accurate nuclear matter calculations can be used to model the particle spectral function of finite nuclei within the framework of the local density approximation [5], i.e. using the definition of Eq. (14) with

$$\frac{4}{3}\pi p_F^3 n(\mathbf{p}) \to \int d^3r \, \frac{4}{3}\pi p_F^3 \, n_{NM}[\rho(r), \mathbf{p}] \, \rho_A(r) \ , \qquad (17)$$

where $\rho_A(r)$ is the nuclear density distribution, normalized to unity, and $n_{NM}[\rho(r), \mathbf{p}]$ is the momentum distribution of nuclear matter at uniform density $\rho(r)$. This procedure has been used in all calculations of nuclear cross sections discussed in this paper.

Within the nonrelativistic approximation, in which both the response and the hole spectral function can be evaluated using realistic nuclear Hamiltonians, the validity of the IA can be tested comparing $S(\mathbf{q}, \omega)$ of Eq. (10) to

$$S_{\rm PWIA}(\mathbf{q}, \omega) = \int d^3p \, dE \, P_h(\mathbf{p}, E) \left[1 - \frac{4\pi}{3} p_F^3 \, n(\mathbf{p}+\mathbf{q}) \right] \times \delta \left(\omega - E - \frac{|\mathbf{p}+\mathbf{q}|^2}{2M} \right) , \qquad (18)$$

for different values of the momentum transfer $\mathbf{q}$.

The nuclear matter $S(\mathbf{q}, \omega)$ at equilibrium density, $\rho_0 = 0.16$ fm^{-3} (corresponding to $p_F = 262.4$ MeV), has been recently computed using the correlated basis function formalism and an effective interaction derived from a state-of-the-art parametrization of the nucleon-nucleon potential [6]. To analyze the interplay between short- and long-range correlations, the response defined as in Eq. (10) has been evaluated in both the Hartree-Fock and Tamm-Dancoff approximations.

Figure 5 shows a comparison between the responses of Ref. [6], obtained using Eq. (10) and the correlated Hartree-Fock approximation, and those obtained from Eq. (18) using the nuclear matter hole spectral function of Ref. [7]. The main difference between the two calculations lies in the treatment of the target final state. In the IA scheme the state describing the struck particle is factored out, while in the approach of Ref. [6] the final A-nucleon state includes both statistical and dynamical correlations between the struck particle and the spectators.To make the comparison fully consistent, the PWIA response has been computed including only the contributions of one-hole final states to $P_h(\mathbf{p}, E)$. The results of the Fermi gas model with nonrelativistic kinetic energy spectrum are also displayed.

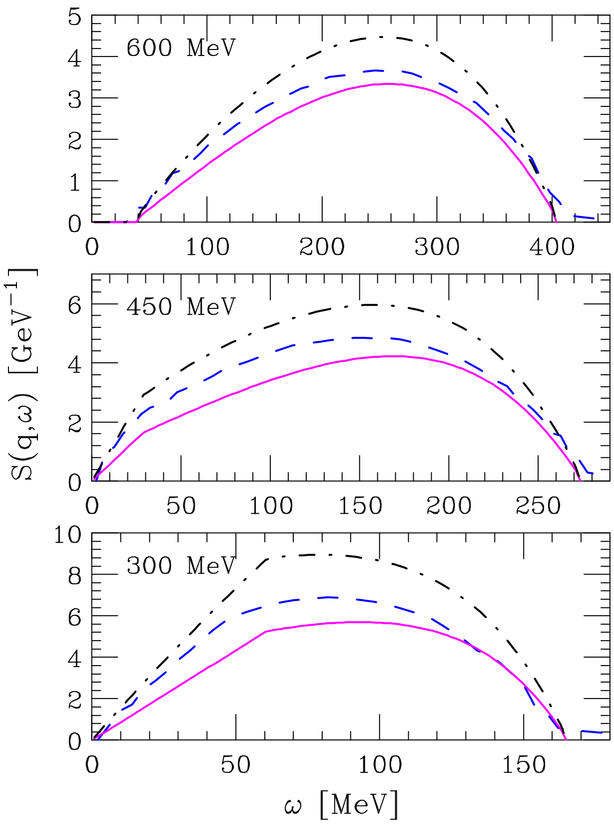

FIG. 5. Energy dependence of the nuclear matter response $S(\mathbf{q}, \omega)$. Solid lines: correlated Hartree-Fock approximation [6]. Dashed lines: PWIA results, obtained from Eq. (18) using the SF of Ref. [7]. Dot-dashed lines: results of the Fermi gas model (with nonrelativistic energies) at $k_F = 262.4$ MeV, corresponding to the equilibrium density of nuclear matter. The panels are labeled according to the value of $|\mathbf{q}|$.

The results of Fig. 5 clearly show that at $|\mathbf{q}| < 2p_F$ the response obtained from Eq. (18) does not exhibit the linear behavior at low ω resulting from the antisymmetrization of the final state. On the other hand, as the momentum transfer increases, the PWIA response draws closer to the one obtained in Ref. [6]. At $|\mathbf{q}| \sim 600$ MeV the results of the two approaches are within 10% of one another in the region of the maximum. Note that inclusion of dynamical FSI, e.g. according to the approach of Ref. [8], would produce a quenching of the PWIA response in the top panel of Fig. 5, thus bringing the solid and dashed lines in even better agreement. Theoretical studies of electron-nucleus scattering [15] suggest that at $|\mathbf{q}| \sim 600$ MeV, the FSI effect at the quasifree peak is $\sim$10 %.

The emerging pattern suggests that the assumptions underlying the IA are likely to be valid at momenta larger than $\sim 2p_F$, while at lower $|\mathbf{q}|$ factorization does not appear to provide an adequate description of the final state.