

Short-Range Correlations Introduction

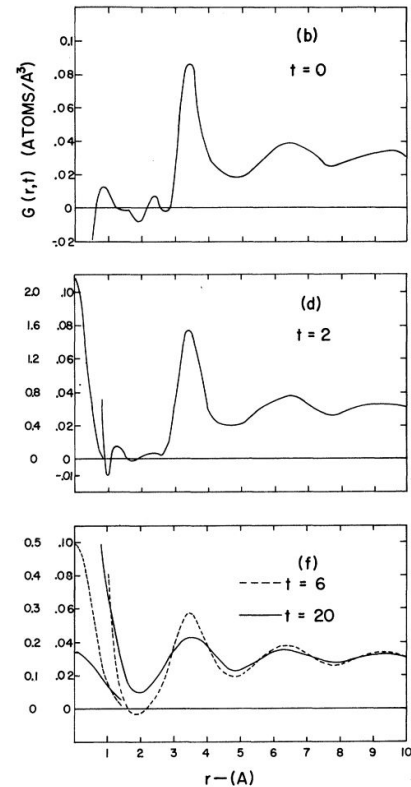
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Short-Distance Nuclear Structure and PDFs
ECT* workshop, July 2023



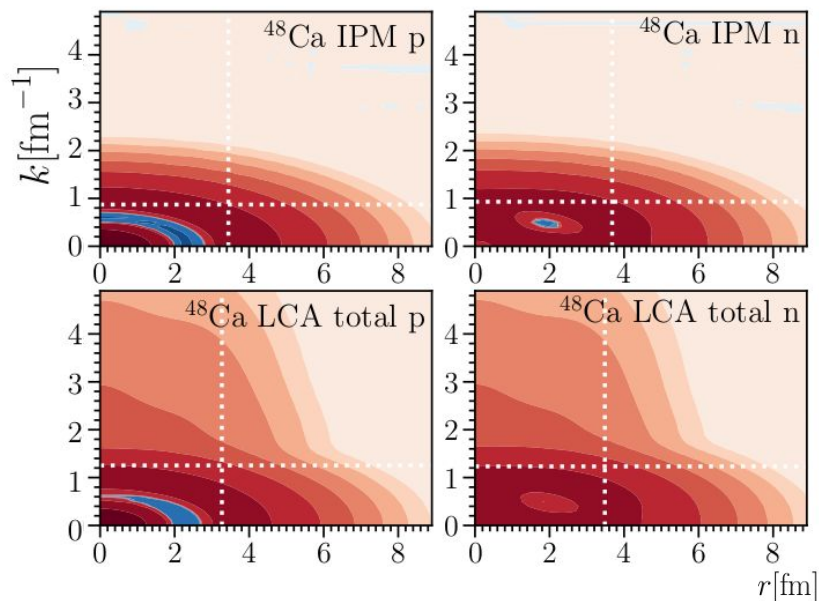
Correlations

- Well-defined concept in statistical mechanics
- Quantified in pair correlation function / radial distribution function
- Carry information about intra-particle interactions in many body system
- Measured using X-ray and neutron scattering (elastic/inelastic)
→ Fourier transforms



Nuclear correlations

- Reflect details of the NN interaction (\leftarrow QCD)
→ beyond mean-field shell model
- Long-range correlations: collective excitations
→ small excitation energies
- Short-range correlations
→ large excitation energies
→ “local” phenomenon
→ nuclear core [\[talk Sargsian\]](#)
→ tails in momentum distributions

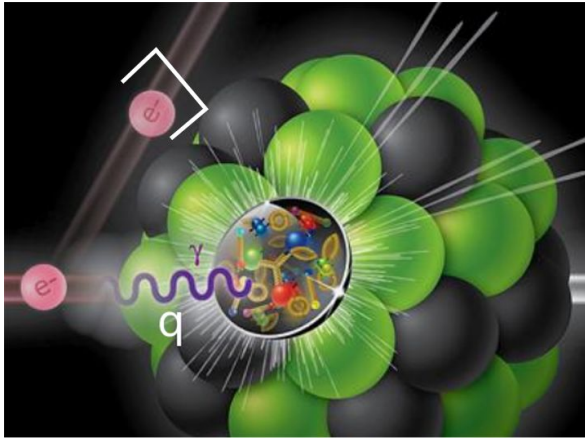


Short-range correlations (SRCs)

- Local phenomenon → Universality across nuclear chart?
- 2N SRCs [\[many talks today\]](#)
 - Abundance (“pair counting”)
 - Isospin composition (np/pp/nn)
 - tensor force dominance (→ deuteron)
 - momentum dependent (→ scalar)
 - Center of Mass motion
- Role of 3N SRCs [\[talk R. Weiss\]](#)
- Influence on nuclear properties
 - Kinetic energy [Hen, Sargsian et al. 2014]
 - Nuclear equation of state → neutron stars
- Connection with medium modifications of PDFs (etc.)
 - 2nd part of the week

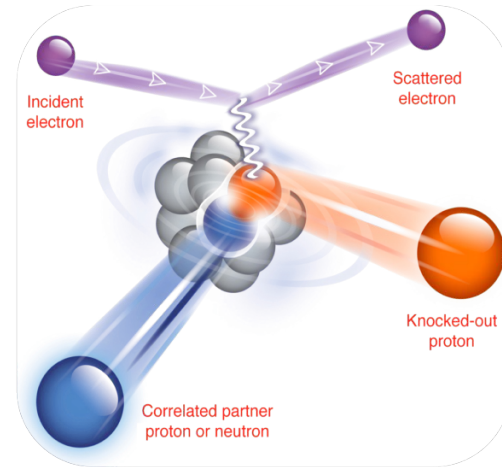
Measurements

Inclusive $A(e,e')$



- Detect scattered electron
- **Measure** of number of SRCs (as a function of Bjorken x)
- Mass; N/Z dependence

Exclusive $A(e,e'NN)$



- Additional detection of 2 nucleons
- Isospin information on 2N SRC
- Dependence on initial momenta of nucleons
- 2 small acceptance spectrometers OR large acceptance (4π) detector

SRCs: experiment and theory

- Many wonderful nuclear many-body techniques [\[talks tomorrow\]](#)
- Direct comparisons between exp and consistent calculations remains challenging
- Multi-scale problem
- In high-energy scattering with large excitation light-front is natural framework
→ off-shell effects remain finite
- Role of non-nucleonic degrees of freedom