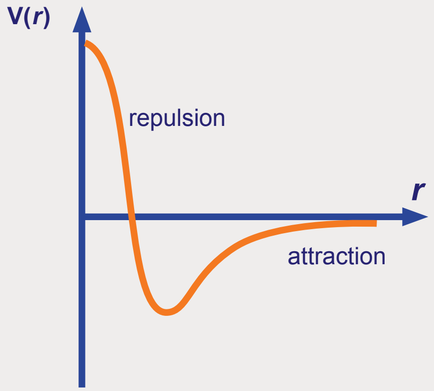
# Beyond the Shell Model
## Short Range Correlations in Nuclei

**Ran Shneor[1], Peter Monaghan[2] and Ramesh Subedi[3]**

1 Tel Aviv University, Tel Aviv, 69978, Israel
2 Massachusetts Institute of Technology, Cambridge, MA 02139, USA
3 Kent State University, Kent, Ohio, 44242, USA

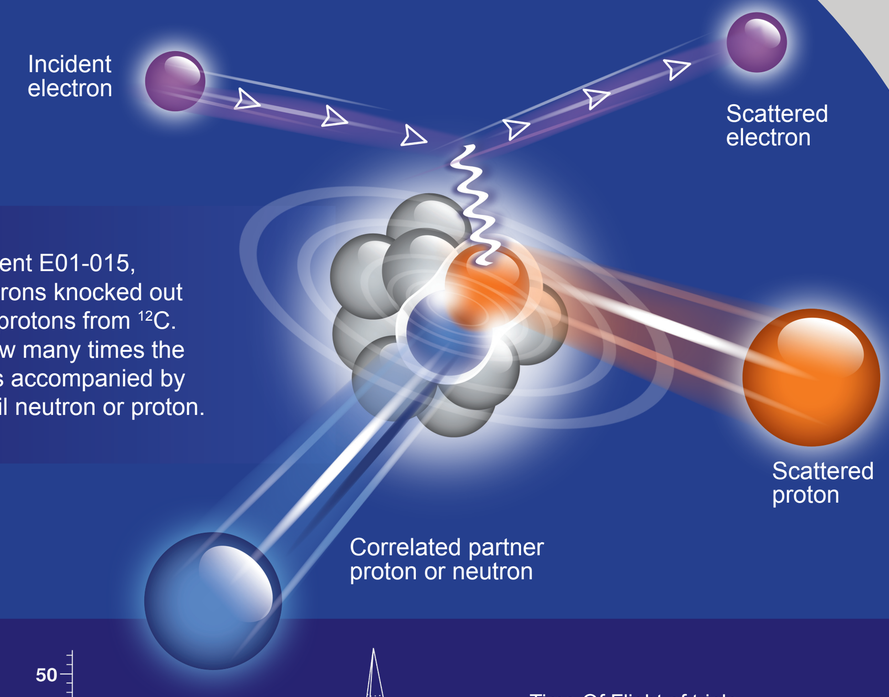
## Short Range Correlations

In the shell model, nucleons move independently in well-defined quantum "orbits" in the nuclear mean-field. The mean field is dominated by the long-range attractive part of the N-N interaction.

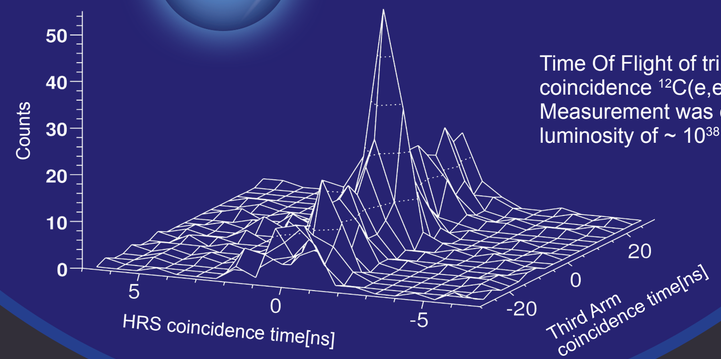



Due to the N-N interaction at short distances, a significant fraction (~20%) of nucleons form pairs instead of moving independently. The dominant repulsive part of the interaction at these distances, causes high relative momentum between the nucleons in the pair.

## The Experiment




In Hall-A experiment E01-015, high-energy electrons knocked out high-momentum protons from $^{12}$C. We measured how many times the struck proton was accompanied by a coincident recoil neutron or proton.

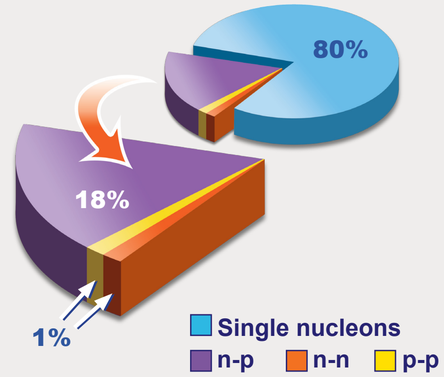



Time Of Flight of triple coincidence $^{12}$C(e,e'pp) events. Measurement was done at luminosity of ~ $10^{38}$ [cm$^{-2}$sec$^{-1}$]

## Results

We identified p-p and n-p short range correlated pairs in $^{12}$C and showed that :

- **Almost all nucleons with momentum above the Fermi momentum in $^{12}$C are paired.**
- **n-p pairs are nearly 20 times more prevalent than p-p pairs.**




The dominance of n-p over p-p SRC pairs is a clear fingerprint of the short-range N-N tensor force. This has far-reaching implications for modeling and understanding cold dense nuclear matter such as neutron stars.