Ab Initio No Core Shell Model - Recent Results and Future Prospects

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There has been significant recent progress in solving the long-standing problems of how nuclear shell structure and collective motion emerge from an underlying microscopic inter-nucleon interactions. These achievements are based on three major factors: 1. Newly derived interactions that accurately describe the two-nucleon and three-nucleon data; 2. Advances in computer algorithms to simulate the quantum many-body problem with strong interactions; and, 3. Continued rapid development of high-performance computers now capable of performing 20 x 10^{15} floating point operations per second.

I will present a review of recent results for light nuclei and neutron drops in external traps as well as outstanding challenges that lie ahead. These results include those with both chiral effective field theory nucleon-nucleon plus three-nucleon interactions as well as with the JISP16 nucleon-nucleon interaction. I will also present an overview of developments in high-performance computers that portend the route to exascale machines (10^{18} floating point operations per second) in the near future. Finally, I will outline the needs for multi-disciplinary teams of physicists, computational scientists and applied mathematicians to fully and efficiently exploit these new high-performance computers to maximize our potential for new discoveries in nuclear physics.