Nuclear theory research - W. Polyzou

- My primary interest is finding ways to understand hadronic structure and dynamics at distance scales that are a fraction of a proton radius.
- The most reliable way to get information about these systems is by scattering weak or electromagnetic probes from strongly interacting hadronic targets. This is because these weak interactions are understood, and can be treated using first-order perturbation theory.
- The quantities of interest are matrix elements of hadronic currents in hadronic states, where the momentum needed to be sensitive to physics at sub-nucleon distance scales means that the final hadronic state recoils with relativistic momentum.
- The required theoretical tools are relativistic quantum mechanics or relativistic quantum field theory. Non-perturbative methods are needed to understand the strong interaction dynamics and structure.

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Current research activities

- **Multi-scale discrete formulations of quantum field theory based on wavelets. This is an exact discrete formulation of quantum field theory. It is a useful representation for computations.**
- **Relativistic hadronic models based on locally gauge invariant degrees of freedom. These relate models of baryons exchanging mesons to quarks exchanging gluons. (With Siraj Kuthini Kunhammed)**
- **Calculations of scattering observables using real time Feynman path integrals. Uses a new method based on complex probabilities.**
- **Scattering in a Euclidean formulation of relativistic quantum mechanics. This method avoids analytic continuation. (With Gohin Samad)**
- **Studying the vacuum is light-front quantum field theory. This is the preferred framework for studying scattering by electroweak probes. (With M. Herrmann)**