Light-front quantization

From the White Paper by the Board of Directors of ILCAC, Inc.

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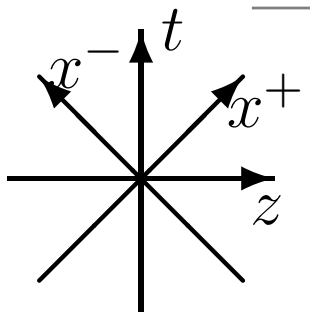
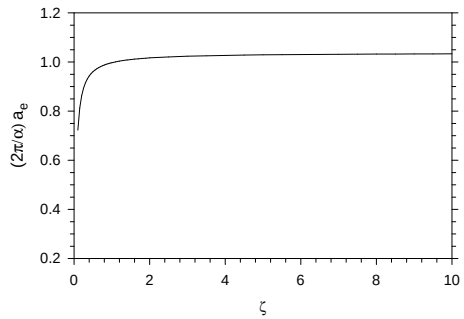
Light-front Quantization

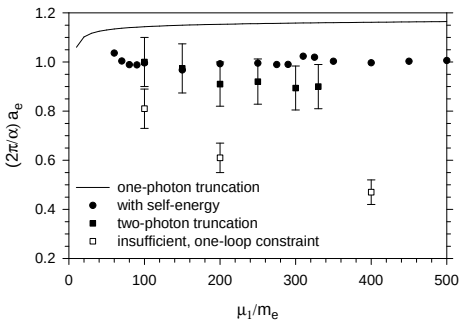


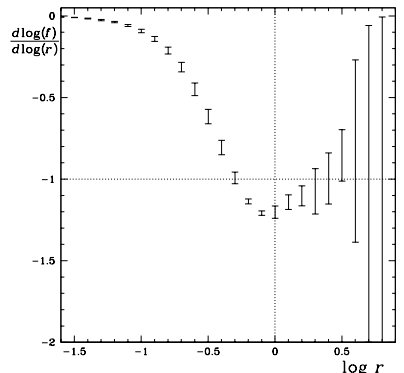
- ILCAC, Inc. URL: http://www.ilcacinc.org/
- framework for analysis of hadrons in QCD:
  $x^+ = t + z$, $x^- = t - z$, $p^- = E - p_z$, $p^+ = E + p_z$
- nonperturbative Hamiltonian eigenvalue problem:
  $\mathcal{P}^-|P^+, \vec{P}_\perp\rangle = \frac{M^2+P_\perp^2}{P^+}|P^+, \vec{P}_\perp\rangle$
- well-defined Fock-state expansion:
  $|\text{proton}\rangle = \psi_{uud}|uud\rangle + \psi_{uudg}|uudg\rangle + \psi_{uudq\bar{q}}|uudq\bar{q}\rangle + \cdots$
- boost-invariant & process-independent wave functions
  - free of vacuum contributions
- Minkowski space: time-like *and* space-like processes
- no fermion doubling
- no formulation-specific light-quark problem

Progress & Successes

- direct evidence for a Maldacena duality conjecture
  –SDLCQ Collaboration (Pinsky, jrh, et al.)
- massively parallel Lanczos code –Vary et al.
- nonperturbative QED in an arbitrary covariant gauge
  –Chabysheva and jrh
- relativistic quark models based on light-front holography
  –Brodsky and De Téramond
- effective-particle representation via renormalization gp
  –Wilson and Głazek
- methods for finite-temperature calculations
  –SDLCQ Collaboration, Beyer and Strauss

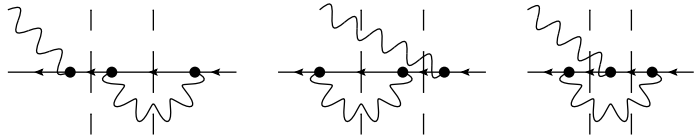






Goals & Challenges

- calculation of hadron masses, wave functions, form factors, GPDs,...
  - light-front coupled-cluster method



- analysis of hadronic and nuclear phenomenology
  - at zero and finite temperature
- understanding of vacuum structure
  - zero modes, effective interactions
- construction of nonperturbative regularization
  - St Petersburg group (Paston et al.)
- classification of total angular momentum eigenstates
  - rotations about x and y are dynamical
- physics of intense laser fields
  - nonperturbative strong-field QED