Towards Solving the Mysteries of Pion and Kaon Mass
Quantum Chromo Dynamics

Meson

Pion
Goldstone boson should be massless.

Measured mass < mass of constituent quarks.

98% of ALL matter comes from interaction between quarks and massless gluons.
Electron Ion Collider

Electron + Proton → Pion + Neutrino

“giant microscope” beams

Process Behind Probing Mass
Monte Carlo Simulation

- Input given values (proton+ electron beam)
- Random numbers are generated
- Kinematic quantities calculated
- The events that fall outside range
- Graph Data
Variables

\( X_{\text{bj}} = \text{fractional momentum carried by the partons} \)

\( Q^2 = \text{Energy (GeV)} \)

\( F2k/F2n = \text{structure function} \)

Mass is calculated from this

\( i = \text{cuts made on } X_{\text{bj}} \)

\( t_{pi} = \text{4-momentum transfer} \)
Initial Feasibility

Proton beam: 50 GeV/c
Electron beam: 5 GeV/c

Forbidden Region

Wider range of accessible kinematics

Proton beam: 100 GeV/c
Electron beam: 5 GeV/c
Feasibility Studies

*Simulated running the experiment for a year
Proton beam: 100 GeV/c
Electron beam: 10 GeV/c

Proton beam: 100 GeV/c
Electron beam: 50 GeV/c

Proton beam: 100 GeV/c
Electron beam: 5 GeV/c
Confirmation of Virtual Pion
Looking ahead

- Complete study of virtual pion
- Determine more accuracy efficiency of detector
  - Currently assume 50%
- Optimization of detector design
- Run simulations for Kaons
THANKS

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