

Science Overview and the Experimental Program

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The Structure of the Science Presentations

Overview of the Experimental Program – Scientific Motivation and Progress (LSC)

Detailed Talks on Three Cross-Cutting Efforts in the JLab

“Campaigns” to understand Hadronic and Nuclear Structure:

- The Shape and Structure of the Nucleon (Volker Burkert)
- The Parton-Hadron Transition in Structure Functions and Moments (Rolf Ent)
- From Nucleons and Mesons to Quarks and Gluons (Kees de Jager)

Details on the Hall Research Programs and Technical Developments (Dennis Skopik)

Theory (Rocco Schiavilla)

Progress and Plans for Nuclear Physics Research at 12 GeV and Beyond (LSC)

JLab's Scientific Mission

- How are the hadrons constructed from the quarks and gluons of QCD?
- What is the QCD basis for the nucleon-nucleon force?
- Where are the limits of our understanding of nuclear structure?
 - To what precision can we describe nuclei?
 - To what distance scale can we describe nuclei?
 - Where does the transition from the nucleon-meson to the QCD description occur?

To make progress toward these research goals we must address critical issues in “strong QCD”:

- What is the mechanism of confinement?
- Where does the dynamics of the q-q interaction make a transition from the strong (confinement) to the perturbative . . . -like) QCD regime?
- How does Chiral symmetry breaking occur?

Nuclear Physics: The Core of Matter, The Fuel of Stars

(NAS/NRC Report, 1999)

Science Chapter Headings:

The Structure of the Nuclear Building Blocks

The Structure of Nuclei

Matter at Extreme Densities

The Nuclear Physics of the Universe

Symmetry Tests in Nuclear Physics

JLab Scientific “Campaigns”

The Structure of the Nuclear Building Blocks

1. How are the nucleons made from quarks and gluons?
2. How does QCD work in the ‘strong’ (confinement) regime?
3. How does the NN Force arise from the underlying quark and gluon structure of hadronic matter?

{ Voller’s and
Rolf’s talks

The Structure of Nuclei

4. What is the structure of nuclear matter?
5. At what distance and energy scale does the underlying quark and gluon structure of nuclear matter become evident?

Kees ...

Symmetry Tests in Nuclear Physics

6. Is the “Standard Model” complete? What are the values of its fr

How are the nucleons made from quarks and gluons?

Why are nucleons interacting via V_{NN} such a good approximation to nature?

How do we understand QCD in the confinement regime?

1. **What are the spatial distributions of u, d, and s quarks in the hadrons?**

G_E^p/G_M^p , w/ Super-Rosenbluth coming
 G_E^n (2 expts in Hall C) G_M^n (Hall A; CLAS to high Q^2)
HAPPEX, w/ G0 & HAPPEX II coming
 F_π , w/ Higher Q^2 extension coming (6, then 12 GeV)

2. **What is the excited state spectrum of the hadrons, and what does it reveal about the underlying degrees of freedom?**

$N \rightarrow \Delta$ (All three halls)
Higher resonances (CLAS e1: η , π^0 , π^\pm production)
Missing resonance search (CLAS e1 and g1: ρ , ω production)
VCS in the resonance region (Hall A)

3. **What is the QCD basis for the spin structure of the hadrons?**

Q^2 evolution of GDH integral and integrand for:
proton (CLAS) and neutron (Hall A) (w/ low Q^2 extension coming for neutron)
 A_1^n , g_2^n w/ 12 GeV follow-on (Hall A)
 A_1^p (Hall C, CLAS)

4. **What can other hadron properties tell us about 'strong' QCD?**

VCS (Hall A) Separated Structure Functions (Hall C)
DVCS (CLAS, Hall A & CLAS coming) Single Spin Asymmetries (CLAS, Hall A coming)
Compton Scattering (Hall A)

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RoF (2002)

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Voller (2003)
Bernhard (2002)

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Nucleon and dPion Form Factors

- Fundamental ingredients in “Classical” nuclear theory

and gluons .

- Experimental insights into nucleon structure from the flavor decomposition of the nucleon form factors

PRECISION

$$\left. \begin{array}{ccc} G_E^n & G_E^{p,Z} & \\ G_M^p & G_M^n & G_M^{p,Z} \end{array} \right\} \quad \begin{array}{c} G_E^d \\ G_M^d \end{array}$$

- Additional insights from the measurement of the form factors of nucleons embedded in the nuclear medium
 - implications for binding, equation of state, EMC...
 - precursor to QGP



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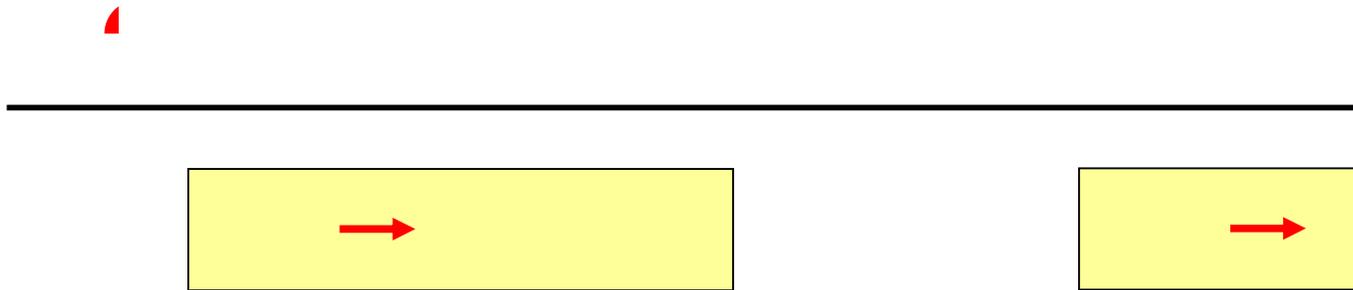
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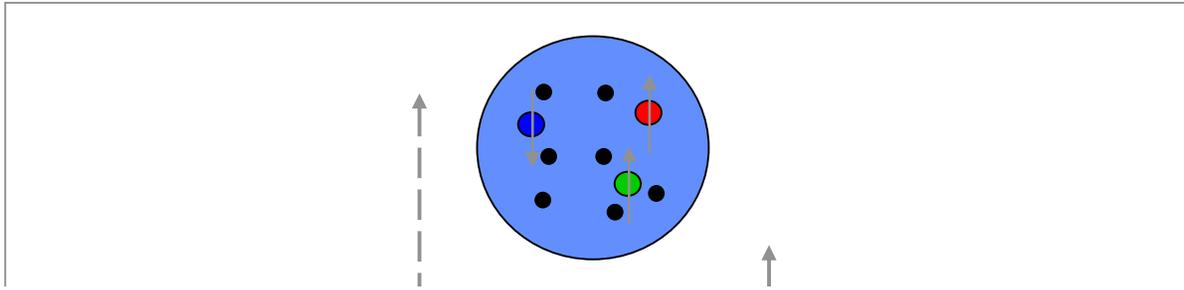
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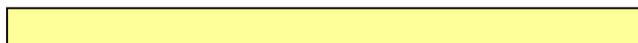
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