GHP Newsletter February 2010

American Physical Society Topical Group on Hadron Physics

http://www.aps.org/units/ghp/

Executive Officers

Chair	*Chair-Elect*	*Vice-Chair*
Stanley Brodsky sjbth@slac.stanford.edu	Ron Gilman rgilman@physics.rutgers.edu	Ramona Vogt RLVogt@lbl.gov

Past-Chair	*Secretary/Treasurer*	*Members at Large*	
Winston Roberts wroberts@fsu.edu	Craig Roberts cdroberts@anl.gov	Robert Edwards edwards@jlab.org	Sebastian Kuhn kuhn@jlab.org

NB. EMail addressed to ghpexec@anl.gov will reach all members of the Executive.

Contents

1 Talking Chair

A Message from the GHP Chair, Stan Brodsky.

Hadron physics is a core subject for both nuclear and particle physics. It is a field driven both by experiment and fundamental theory, with the driving objective to understand the spectra, structure, and dynamics of hadrons and nuclei in terms of their fundamental quark and gluon constituents.

The quantum field theory of the strong interactions, quantum chromodynamics (QCD), is believed to be the underlying theory of hadron and nuclear physics in the same sense that quantum electrodynamics underlies all of atomic physics and chemistry. Despite the simple form of the QCD Lagrangian, the range of QCD phenomena is extraordinary, including exotic hadronic states, the quark gluon plasma in heavy ion collisions, dynamical chiral symmetry breaking, instanton and axion effects, time-reversal-odd single-spin asymmetries, hard diffraction phenomena, hidden-color effects in nuclei, novel heavy quark phenomena, etc. Fundamental questions such as the mechanisms for color confinement, jet hadronization, and CP invariance still remain. Hadron physics has critical impact in astrophysics, cosmology, and as backgrounds in the search for physics beyond the standard model.

We are very fortunate to have laboratories in the US intensively devoted to pushing the boundaries of hadron physics, such as the Relativistic Heavy Ion Collider (RHIC) at Brookhaven Laboratory and the continuous electron beam facilities at Jefferson Laboratory, now being upgraded to 12 GeV. Electron-positron collider experiments such as Belle at KEK and BaBar at SLAC test central issues in QCD. The Tevatron antiproton-proton collider at FermiLab and the LHC at CERN now test the limits of QCD at TeV energies. There are now intensive studies in the US for a new electron-ion collider. New hadron facilities are also being developed worldwide, such as GSI-FAIR in Germany, and KEK in Japan as well as new high energy electron-positron colliders.

On the theory side, hadron physics is being developed intensively using QCD lattice gauge theory, Dyson-Schwinger/Bethe Salpeter methods, light-front Hamiltonian techniques, effective field theory methods, new higher loop and renormalization methods, and higher dimension techniques initiated by string theory such as AdS/QCD.

The Hadron Physics Group of the American Physical Society is dedicated to advancing our field, particularly by supporting our members through APS Fellowship recognition and organizing hadron physics sections and special meetings. In many cases we have been able to award travel fellowships to graduate students and other scholars. We also help promote new experimental and theoretical initiatives and facilitate connections between laboratories. I hope you will continue to support the GHP and encourage other hadron and nuclear physicists to join the GHP.

I have been very fortunate to have the outstanding assistance from the other officers of the GHP executive committee. We all owe a great debt of gratitude to our past-chair, Winston Roberts, for all of his efforts on behalf of the GHP. I especially thank Craig Roberts for organizing this newsletter.

2 Elections

Elections for three posts in the GHP Executive closed at the turn of the year. The new Executive Committee is listed at the top of this newsletter.

On behalf of GHP, the Executive thanks the people who entered their names on the ballots.

In addition, we thank Curtis Meyer and Wally Melnitchouk for their service to GHP.

Elections will open again this year in early-November. We will fill two positions on GHP's Executive Committee:

- Vice-Chair (Ron Gilman will become Chair and Ramona Vogt will become Chair-Elect, leaving the position of Vice-Chair vacant. Naturally, Stan Brodsky will become Past-Chair and Winston Roberts will pass gracefully into retirement.)
- and one Member-at-Large (Sebastian Kuhn will by then have completed his stint.)

It is planned that in October, 2010, the Nominating Committee will solicit input from the GHP membership. The nomination of candidates will likely close on Fri. 29 October and an electronic ballot will subsequently be held over a four week period: 8 November – 6 December.

Our rules state that: the Committee shall nominate at least two candidates for the office of Vice-Chair and for the open position of Member-at-Large; the slate of candidates will be balanced as much as possible to ensure wide representation amongst the various fields of physics included in the GHP's membership; the Nominating Committee shall be chaired by the immediate past Chair, which is

Winston Roberts (wroberts@fsu.edu)

this year; and shall include three members in addition to its Chair, one of whom shall be appointed by the APS.

We urge GHP members now to begin considering whom they would like to see filling the two open positions in 2010 and encourage members with ideas to contact the *Chair of the Nominating Committee* and pass on their suggestions. There is strength in diversity and so the Executive would like to see nominations from across the entire spectrum of GHP's membership.

---

3 Membership

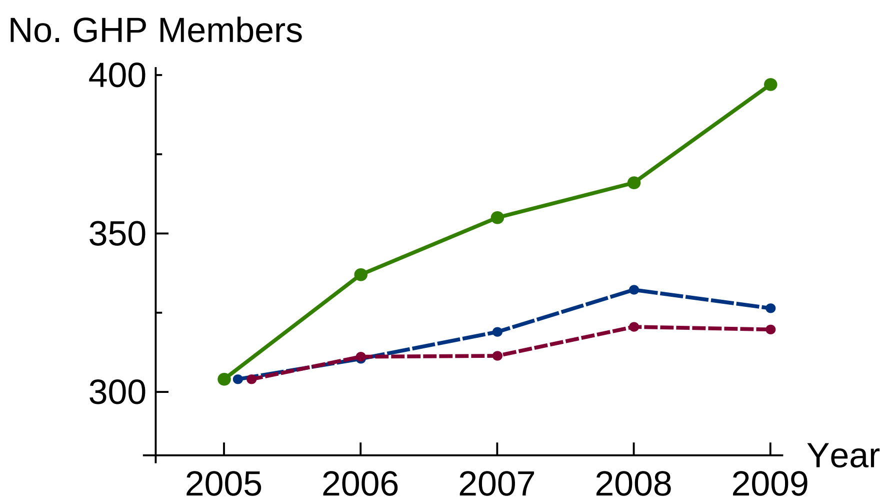


Figure 1: *Solid line* – GHP membership, true value; *long-dashed* – DNP membership normalized to GHP's value in 2005 (2401 → 304); and *short-dashed* – DPF membership normalized to GHP's value in 2005 (3291 → 304).

As of December, 2009, the GHP had 397 members, which represents 0.84% of APS membership. Of these people, 225 are also in DNP (Division of Nuclear Physics) and 229 are in DPF (Division of Particles and Fields). However, DNP has a total of 2578 members and DPF has 3461. Hence, it is likely that there are many Hadron Physics researchers who are not involved with GHP. On the other hand, as the figure here shows, GHP membership is growing strongly whilst that of DNP and DPF has actually declined from 2008 to 2009.

Indeed, there are ten Topical Groups, of which the GHP is 7th largest. However, in comparing 2008 membership with that in 2009, in relative terms, the GHP grew 8.5%, almost twice the rate of the second fastest growing Group (Quantum Information, 4.9%). Membership in six Groups declined. In the Executive's view, at least part of this growth owes to the organization and conduct of successful *Meetings of the GHP*, such as GHP09 (see below).

Membership in a strong GHP brings many benefits. A vital GHP

- establishes and raises the profile of Hadron Physics in the broader physics community, e.g., by nominating members
  - to APS governance committees,
  - to APS prize and award selection committees,
  - for election to Fellowship in the APS
- has a greater role in planning the program for major APS meetings;
- and provides a vehicle for community action on topics that affect the way research is conducted and funded.

Whether one considers the APS alone, or takes a broader perspective, the impact GHP can have is primarily determined by the number of members. (It is also influenced by the energy of the Executive.) The Executive urges existing members to encourage their colleagues to join us.

Membership is only $7. Of this, GHP receives $5 from the APS. (The remainder stays with the APS and covers the many services they provide.) With this support we can be an active force for Hadron Physics. The money can be used, for example, to assist with: the organization of meetings; the preparation of publications that support and promote the GHP's activities; and participation in those fora that affect and decide the direction of basic research.

Current APS members can add units online through the APS secure server by following a link on the lower-right of our web page; namely, http://www.aps.org/units/ghp/index.cfm.

---

4 Unit Convocation

The Convocation is the gathering of unit officers. It provides for their familiarization with the ways of the APS, and is also an excellent opportunity for unit officers learn from each other. Normally, this meeting is held in the middle of February, but this year, the date is changed because the "April Meeting in February" falls on the usual Unit Convocation weekend. As a result, the 2010 APS Unit Convocation will now take place at the American Center for Physics (APS Headquarters) in College Park, Maryland on Friday, April 30. The Convocation will be much larger than usual this year because an invitation is being extended to all of the APS Committee Chairs. There are 21 standing committees of the APS and often these committees operate quite independently from one another. The APS Executive Board feels it is important for APS Committees to develop a sense of the larger APS picture.

This year three members of the GHP's Executive are volunteering their time and will take part: Robert Edwards, Ron Gilman and Craig Roberts.

An important adjunct to the Unit Convocation is the participants' pre-convocation visits to Capitol Hill in order to meet their Congressional representatives and discuss the contributions that physics and physical science make to the nation. The APS Public Affairs office does a terrific job coordinating this, including providing briefing material, helping to set up appointments and initiating those first time participants.

Jian-Peng Chen (right) after being presented with his Certificate of Fellowship during the reception at GHP09 by Winston Roberts (then Chair of the GHP).

5 Fellowship

We take this opportunity to congratulate Jian-Ping Chen (JLab) and Bogdan Wojtsekhowski (JLab), both of whom have recently been elected to Fellowship in the APS under the auspices of the GHP:
Jian-Ping, in 2008, "For his contributions to understanding the spin structure of the neutron, through the use of a polarized Helium-3 target;"
and Bogdan, in 2009, "For outstanding contributions to instrumentation at Jefferson Lab and his leadership role in studies of nucleon structure, particularly real Compton scattering on the proton and the neutron charge form factor."

This is a good time to remind the GHP that each year the APS allocates a number of Fellowship Nominations to a Topical Group. That number is based primarily on membership. A strong GHP can nominate more of our members for Fellowship. This year we are allocated ONE Regular nomination and ONE Alternate, for a total of TWO nominations.

The Executive urges members of GHP to be prepared in 2010 to nominate colleagues who have made advances in knowledge through original research and publication or made significant and innovative contributions in the application of physics to science and technology. They may also have made significant contributions to the teaching of physics or service and participation in the activities of the Society.

The instructions for nomination may be found at
http://www.aps.org/programs/honors/fellowships/nominations.cfm
The entire process is now performed on-line.

A few things to know before proceeding, however. One must

- Ensure the nominee is a member of the Society in good standing. The on-line site will do this for you but it's best to check beforehand, to save yourself time or get your nominee to join APS and/or GHP.
- A nomination requires a sponsor and a co-sponsor. During the on-line nomination

Bogdan Wojtsekhowski (center) receiving his Certificate of Fellowship from Robert Edwards (left, GHP Member-at-Large) as Hugh Montgomery (Director, JLab) looks on cheerfully. The presentation took place during PAC35 at JLab.

process, you will be required to provide details for a co-sponsor. After you complete a nomination, the co-sponsor will be notified by EMail. It would be best to coordinate with the co-sponsor beforehand.

- You will require supporting letters, that will need to be up-loaded to the APS web site. Two letters of support are sufficient. Individuals providing letters of support do not have to be members of the APS, however, it is preferable in practice that sponsors be APS Fellows.
- The nomination process should be complete prior to GHP's deadline:
  1st April 2010

The APS will subsequently forward the Nominations to the GHP Fellowship Committee, which this year is

2010 GHP Fellowship Committee

Robert Edwards edwards@jlab.org	Carl Gagliardi gagliard@physics.tamu.edu	Ramona Vogt RLVogt@lbl.gov

Ramona Vogt is Chair. Do not hesitate to contact her or her colleagues on the committee if you have questions.

The Executive urges members of GHP to react quickly to this call for nominations.

---

6 APS April Meeting, 2010

A topical group is invited to participate in planning the program of major APS meetings. This year there will be two sessions of invited talks sponsored by the GHP at the April meeting, which is actually taking place 13-16 February in Washington, DC.

Session 1 – “New Directions in Hadron Dynamics”
Sunday, February 14, 2010, 10:45-12:33. Chair: Les Bland, Brookhaven National Laboratory

- 10:45-11:21: Pawel Nadel-Turonski – *Physics for Future Facilities for QCD*
- 11:21-11:57: Anne Sickles – *Baryons and Evidence for Direct Hadron Production in Heavy Ion Collisions*
- 11:57-12:33: Akio Ogawa – *Forward particle production in d+Au collisions*

Session 2 – “QCD Structure of the Nucleon”
Monday, February 15, 2010, 10:45-12:33. Chair: Ron Gilman, Rutgers University

- 10:45-11:21: Patricia Solvignon – *New measurement of the EMC effect in light nuclei*
- 11:21-11:57: Fatiha Benmokhtar – *Strange sea contribution to the ground state charge and magnetization of the nucleon*
- 11:57-12:33: Vina Punjabi – *Novel Features of Hadronic Form Factors*

These sessions were arranged by our 2009 Program Committee; namely, Stanley Brodsky (Chair), James Vary (Member), Les Bland (Member), Ron Gilman (Consultant), Wally Melnitchouk (Consultant), Winston Roberts (Consultant), Matthias Burkardt (Consultant).

Ron Gilman will serve as Chair of the GHP's 2011 Program Committee, which will be constituted within approximately one month. The 2011 April Meeting is scheduled for

April 30-May 3, 2011 – Anaheim, CA.

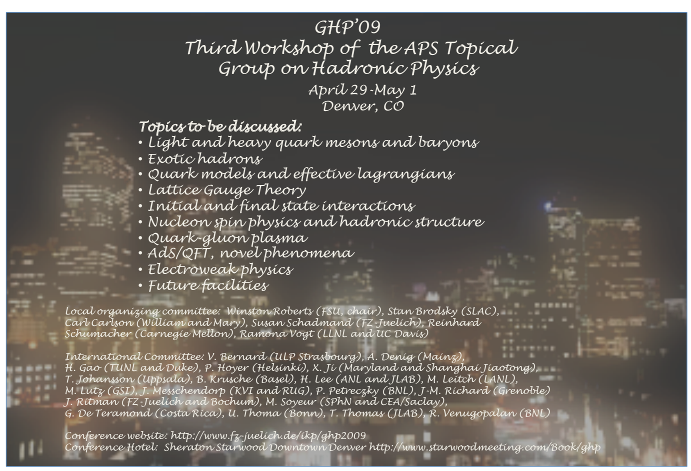
http://www.aps.org/meetings/meeting.cfm?name=APR11

---

7 Meeting Summaries

7.1 GHP09

(An overview contributed by Ramona Vogt, currently GHP Vice-Chair.)



The third GHP workshop, GHP09, took place from April 29-May 1 in Denver, CO, just before the April APS meeting, and consisted of 7 plenary and 15 parallel sessions. It was supported mainly by GHP membership fees but JLab also provided a material contribution.

At the reception on April 29, Jian-Ping Chen was awarded his APS fellowship certificate by Winston Roberts, GHP chair and chair of the GHP09 organizing committee. The other members of the organizing committee were Stan Brodsky (SLAC), Carl Carlson (William and Mary), Susan Schadmand (Jülich), Reinhard Schumacher (Carnegie Mellon) and Ramona

Vogt (LLNL and UC Davis). The program, with links to the abstracts and talks, can be found on the workshop web page, http://www.fz-juelich.de/ikp/ghp2009, ably maintained by Susan Schadmand.

Plenary talks on nucleon structure included the 12 GeV upgrade at JLab (Sebastien Procureur) and spin and nucleon structure (Xiangdong Ji). Several parallel talks emphasized nucleon structure theory, including talks by Carola Berger, Stan Brodsky, Dennis Sivers, Adam Szczepaniak and Feng Yuan Other talks focused on spin sum rules, spin structure functions, form factors and dipole moments. Nuclear structure talks included measurements of the deuteron structure function at JLab, KN and KA interactions, and nuclear modifications of generalized parton distributions. Jorge Morfin discussed nucleon and nuclear structure measurements with neutrinos. Measurements of structure functions and parton densities at JLab, together with results from the RHIC spin program, help provide a complete picture of the internal structure of both the free nucleon and nucleons in nuclei.

Several talks were devoted to exotics and resonances. CLAS results on resonances studies were presented by Victor Mokeev, exotic meson searches in the 3π system were discussed by Craig Bookwalter, and John Price covered cascade experiments. Paul Eugenio covered light hybrid mesons and Ryan Mitchel presented recent exotic meson searches.

A number of plenary talks were devoted to RHIC-related topics including talks by Anne Sickles (baryon production), Paul Sorenson (scaling of multiplicity moments), Ludmila Levkova (finite-temperature QCD), Agnes Mocsy (quarkonia in hot, dense media), Astrid Morreale (spin physics) and Ramona Vogt (quarkonia production mechanisms). There were two parallel sessions on heavy-ion collisions with speakers from STAR (Haidong Liu on quarkonium measurements) and PHENIX (Mikhail Stephanov on using azimuthal angle correlations of forward rapidity muons to study charm, Xiaorong Wang on heavy flavor measurements and Hugo Pereira da Costa on quarkonium). The heavy-ion programs of the LHC were also represented by Rene Bellwied (ALICE), Alexandre Lebedev (ATLAS), and Camelia Mironov (CMS). Alberto Accardi spoke about in-medium hadronization. In addition, Ralf Seidl (PHENIX) and Robert Fersch (STAR) spoke about RHIC spin results.

A wide range of theoretical topics were canvassed. Lattice results were covered in talks on form factors (Jurgen Rohrwild) and nucleon resonances (Robert Edwards); Simon Capstick presented cascade baryon studies using a constituent quark model; Craig Roberts described the use of QCD's Dyson-Schwinger equations as a tool to obtain information about the long-range interaction between light-quarks from experiment; several talks discussed hadron spectroscopy within the context of effective field theories; and Hovhannes Grigoryan described results on hadron form factors within the context of AdS/QCD models.

Several sessions, both plenary and parallel, were devoted to heavy flavor physics, an important topic in the entire hadronic physics community. Recent heavy flavor results were presented by SELEX, BaBar, Belle, and Cleo-c while future heavy flavor programs at PANDA and LHCb were described. Finally, the view of hadronic physics in the NSAC Long Range Plan and at the NSF was provided by Zein-Eddine Meziani and Brad Keister respectively.

GHP09 was the largest GHP workshop so far, with more than 90 participants and 80 talks. The Executive anticipates that our Topical Group's success in organizing stimulating meetings will promote additional growth of the GHP.

7.2 Hadron 2009

(An overview contributed by Eric Swanson, 2004 GHP Chair.)

The thirteenth of the biennial series of Hadron conferences, initiated by David Peaslee in 1985, was held in Tallahassee, Florida, Nov 29 - Dec 4. The conference featured 35 plenary talks and 8 parallel sessions and was attended by approximately 250 physicists. It was sponsored by Florida State University, Jefferson Science Associates, Southeastern Universities Research Association, Thomas Jefferson National Accelerator Facility, Fermi National Accelerator Laboratory, U. S. Department of Energy, the International Society of Technical Environmental Professionals, and the European Physical Journal.
Perspectives on the theoretical and experimental status of mesons were presented by a number of speakers, starting with Ted Barnes, who highlighted recent work by Close and Downum showing that the low energy $^3P_0$ model does not describe e^+e^- double charmonium production well. Barnes and C. Thomas also described the JLab lattice group effort on charmonium spectroscopy and radiative transitions, noting that a large charmonium hybrid photoproduction amplitude is predicted. Other theory reviews were delivered by Mike Pennington (scalar mesons) and Jose Pelaez (chiral dynamics).

Amongst the recent experimental results were the CLEO observation of η_c' in $\gamma\gamma$ fusion, confirmation of the η_b, and the first observation of a meson decaying into three photons, $J/\psi \to \gamma\gamma\gamma$. Yanjun Ma of BES (Beijing Spectrometer) reported a confirmation of the $X(1835)$ $p\bar{p}$ threshold enhancement and the first observation of $\chi_{cJ} \to \varphi\varphi$ and $\omega\varphi$. In an interesting test of low energy decay models, Olsen reported a large D_2D decay mode for the $\psi(4415)$. Similarly, BaBar has observed that the $^3P_0$ model fails to describe branching ratios of $\psi(4040)$ decay modes. Finally, CDF and D0 have measured Υ polarization in $p\bar{p}$ production, precise B_c and B^{**} meson masses, and note a threshold enhancement in $B \to J/\psi\varphi K$, which they call the $Y(4140)$.

A perspective on the status of baryon spectroscopy and theory was provided by Eberhard Klempt, while Michael Peardon described progress being made in computing the baryon spectrum in lattice-QCD and Jose Goity reviewed the large-N_c formalism.

Studies of heavy baryons continue at the tevatron. Recent results reported at the conference include a measurement of the Ξ_b mass and a discrepancy between CDF and D0 concerning the mass of the Ω_b baryon. A new baryon, the $X(1500)$ is claimed by BaBar in B decays to $Dp\bar{p}\pi$. Work continues at Jefferson Lab and in Germany on the light baryon spectrum, with the theme of performing "complete" experiments with polarized targets and beams. Many measurements are in progress at CLAS, ELSA, MAMI and COSY. Recent highlights are a measurement of the $\Lambda(1405)$ mass distribution at CLAS, which lends some support to a picture of this state as a dynamically generated resonance, and evidence for an ηN quasibound state from MAMI.

Jean Marc Richard reviewed the theory of multiquark states. This was followed by many new experimental results on exotic states. Sadaharu Uehara reported that the B factories have found no mass splitting of the $X(3872)$ in the decays of differently charged B mesons. Also the $Z(3930)$ is confirmed by BaBar. COMPASS continue to analyze a new data set and report the observation of the $\pi_1(1600)$ light hybrid meson candidate. While dedicated searches for glueballs must await the GlueX and PANDA experiments, BES confirm an $X(1835)$ state in $J/\psi \to \gamma\pi^+\pi^-\eta'$, which they call a 0^{-+} glueball candidate. Finally, J. H. Lee reported that STAR at RHIC plans to search for glueballs in double pomeron exchange in polarized pp collisions.

The physics of hadrons in-medium was reviewed by Chaden Djalali. He reported that the only solid evidence for partial chiral restoration comes from pionic atom studies, that recent EMC measurement on light nuclei indicate the important role of clusters in nuclei, and that the jury is still out on Coulomb Sum rules.

Finally, future facilities were covered in a number of talks, including PANDA at FAIR (Concettina Sfienti), GlueX (Benedikt Zihlmann), CLAS-12 (Stepan Stepanyan), J-PARC (Shinya Sawada), and the super B factories (Riccardo de Sangro). Funding decisions on the latter are expected imminently.

It was evident that the field is vibrant and has a promising future. There are good reasons to look forward to Hadron 2011 in Munich!

---

8 State of the Laboratories

NB. We would be pleased to receive input from GHP membership, in particular from people at labs with hadron physics programs who are willing to prepare input and clear it with their labs leadership. The following contributions should serve as a template.

8.1 The Year at Jefferson Lab

(Communicated by Ronald Gilman EMail – rgilman@physics.rutgers.edu.)

Thomas Jefferson National Accelerator Facility (JLab) is maintaining an active physics program at 6 GeV, as construction has started on its 12 GeV upgrade. The 6 GeV program, originally begun in 1995 at 4 GeV, will continue for about 3 years, followed by a year-long shut down to upgrade the CEBAF accelerator, and the start of 12-GeV physics in late 2013. The ongoing physics program is very broad, and a few examples will be given below, followed by a description of some future plans. The selection of topics is biased towards hadronic physics.

Form Factors:
One focus of the JLab hadronic physics program has been the nucleon form factors: the form factors describe the charge and magetization distributions within the hadron. The Hall B CLAS collaboration published extensive measurements of the neutron magnetic form factor in 2009. The measurements, based on the ratio of the cross sections for the $d(e, e'n)p$ and $d(e, e'p)n$ reactions, covered the range $Q^2 \approx 1 \to 4$ GeV^2 with much greater precision than previous work. Over most of the Q^2 range, the CLAS data are very close to the dipole form.

Preliminary results have been shown at various conferences for two recent double polarization measurements of the proton and neutron electric form factors. The ratio of proton electric to proton magnetic form factors was determined up to 8.5 GeV^2, using a new recoil proton polarimeter in the Hall C HMS spectrometer; previous recoil polarization data from JLab used a polarimeter in the Hall A HRS spectrometers. The preliminary new data match the earlier measurements up to 5.7 GeV^2 for the form factor ratio $\mu_p G_E^p/G_M^p$, but might suggest that in the higher Q^2 range the falloff is less rapid than at lower Q^2. The electric form factor appears to remain positive in the measured range.

In concert with the proton form factor measurements, a two-photon-exchange test was done for polarization transfer. Measurements at the same momentum transfer across a broad range of angles all yielded consistent form factor ratios, limiting two-photon effects to be at the ≈1% level, somewhat smaller than competing hadronic and quark estimates that had predicted opposite signs for the corrections. This result yields further confidence in the observed difference between Rosenbluth separation and polarization transfer techniques being a result of two-photon corrections that largely affect the Rosenbluth technique. A number of other two-photon experiments are being planned.

The neutron electric form factor was determined up to 3.4 GeV^2, using polarized electrons scattering from a polarized ^{3}He target. Preliminary results tend to agree better with modern VMD fits and Dyson-Schwinger equation predictions, rather than constituent quark models. It remains an issue that we do not have a good description of all four nucleon form factors from a single theoretical approach over the entire accessible momentum domain.

Improved measurements of form factors at low Q^2 are also important for a variety of issues in proton structure. Preliminary high-precision JLab polarization transfer results, shown at GHP09, indicate that the proton electric form factor is a few percent smaller than generally determined by fits to previous data. These preliminary results are marginally in disagreement with recent Bates BLAST data. Along with a high precision Mainz cross-section experiment and double-spin asymmetry measurements planned for JLab Hall A in 2012, the low Q^2 proton form factors should be much improved in the next few years.

Strange quarks in the nucleon:
Since the early "spin crisis" data suggested a large role for strange quarks in carrying the nucleon spin, the contribution of strange quarks to the nucleon form factors has been a compelling issue. This topic has been investigated through parity-violating (PV) elastic electron scattering from protons and deuterons, at Bates, Mainz, and Jefferson Labs. The combination of electromagnetic scattering from protons and neutrons, along with the electroweak asymmetry from PV scattering, allows the strange quark contributions to be extracted, assuming there are only u, d, and s quarks in the nucleon. The latest results from the G0 backward-angle measurements have now been published. These data, combined with earlier forward-angle G0 results, allow a Rosenbluth separation to determine the electric and magnetic strange quark contributions to the form factor. Both are found to be less than ≈10%. An even higher-precision measurement from fall 2009 of the forward-angle PV asymmetry, HAPPEX-III, should be available as a preliminary result soon.

At even lower Q^2, where the strange quarks are expected to play a negligible role, PV can be used to measure the weak charge of the proton. As the standard model value is known, this can alternately be viewed as a measurement of the running of the Weinberg angle with momentum transfer or as a search for physics beyond the standard model. The experiment, Q_{weak}, the largest experiment at JLab to date, is scheduled to start two years of data taking in late 2010.

Nucleon spin structure:
All three experimental halls at JLab have had ongoing complementary programs studying the spin structure of protons and neutrons (in the deuteron or in ^{3}He) through scattering of polarized electron beams from polarized targets. The strength of the Hall B program has been its nearly 4π kinematic coverage, for longitudinally polarized proton and deuteron targets. The Hall A program has used a longitudinally and transverse polarized neutron (^{3}He) target. The Hall C program has used longitudinally and transverse polarized proton and neutron (^{2}H)

target.

Measurements have been made of spin structure functions and various sums and sum rules that can be determined from them. Examples include the Bjorken Sum Rule, Gerasimov-Drell-Hearn (GDH) sum, Burkhardt-Cottingham Sum Rule, d_2 matrix element, and spin polarizibilities. Examples of recent results include measurements of the very low-Q^2 neutron spin structure, to test chiral perturbation theory predictions for the spin polarizibilites and GDH sum, and investigations of duality in resonance-region spin structure functions. A major experiment on the proton in Hall C, SANE, along with a Hall A experiment on the neutron, both finished in early 2009, should give much improved determinations of d_2, which has been related to the color Lorentz force the struck quark in the nucleon experiences as it moves away from the recoiling diquark system.

Baryon Resonances:
Recent analyses of JLab data on pion electroproduction from protons have very significantly extended and improved our knowledge of resonance transition form factors for the $\Delta(1232)$ and the lowest isospin-1/2 states, the "Roper" resonance $P_{11}(1440)$ and the negative parity $D_{13}(1520)$ and $S_{11}(1535)$ states. For the first time, these fundamental quantities were determined over a wide range of $Q^2 < 6.0\,\mathrm{GeV}^2$, using dispersion relations and unitary isobar analysis techniques for the differential cross sections and polarization asymmetries. The single meson channels $\pi^+ n$, $\pi^0 p$ and ηp are particularly sensitive to these three states. The transverse electrocoupling of the Roper shows an unexpected sign-change near $Q^2 = 0.5\,\mathrm{GeV}^2$. This is the first nucleon form factor for which a zero-crossing in the transition amplitude has been observed. At high Q^2, the Roper is consistent with a radial excitation of the quark core, while, at lower Q^2, meson-baryon contributions are likely to contribute significantly to its properties. At low Q^2 the analysis of 2-pion electroproduction data give excellent agreement for the Roper amplitudes.

The $D_{13}(1520)$ resonance shows a very rapid change in the spin structure for the transition. At the real photon point the helicity-3/2 amplitude accounts for nearly the full resonance strength, which drops rapidly with increasing Q^2, whereas for $Q^2 > 1\,\mathrm{GeV}^2$, the helicity-1/2 is the dominant contribution. This behavior is qualitatively consistent with expectations based on the constituent quark model; and is consistent with quark structure dominating this state's properties.

Measurements of the transition form factors for the $S_{11}(1535)$ resonance were extended to $Q^2 = 7\,\mathrm{GeV}^2$. In the overlap region up to $4.5\,\mathrm{GeV}^2$, results from η and π production are consistent, and allow a precise determination of the respective branching ratios. The pion data afforded, for the first time, extraction of the longitudinal contribution to the $S_{11}(1535)$. The results compare well with a calculation using light-cone sum rules. The new transition amplitudes enable determination of the transverse transition charge densities for a series of resonances of different spin, parity and isospin, showing characteristic features of the spatial and spin structure. An extension of this work to higher-mass states is in preparation.

Looking forward, one of the most compelling issues in the light quark sector is the quark-model prediction of many states that have not been found. Missing states could be an experimental problem, of broad resonances and a lack of sufficient precise polarization data to uniquely determine amplitudes, or a structure/theory problem, as some symmetry considerations or different dynamical formulations can both independently reduce the number of predicted states.

In this connection, on the theoretical side, JLab is devoting resources to the Excited Baryon Analysis Center (EBAC), aimed at better understanding the dynamical origin of the extracted nucleon resonance parameters. On the experimental side, major experiments are now underway in Hall B to, for the first time, uniquely determine (overdetermine in the case of Λ production) the reaction amplitudes in meson-baryon photoproduction from the proton and neutron. The experiments use the frozen-spin hydrogen target FROST as well as the HDICE target (Both FROST and HDICE use small magnetic holding fields, and can be used in CLAS with transverse polarization) to provide polarized protons and neutrons.

Imaging the proton:
New data have been obtained that address the extraction of generalized parton distributions (GPDs) from deeply virtual Compton scattering (DVCS). An experiment running with CLAS in Hall B measured the DVCS-BH asymmetry using a longitudinally polarized target. Earlier experiments in Hall A and Hall B measured the beam-helicity-dependent cross-section difference, which is sensitive to the two Compton Form Factors (CFFs) H and $\tilde{H}$. The target asymmetry has a different sensitivity to H and $\tilde{H}$, and together with the beam asymmetry enable a separation of the two contributions. An upcoming experiment in Hall A will examine DVCS contributions at leading- and higher-twist. The CFFs are related to the corresponding GPD's in leading-twist, which themselves can be used to get the first glimpse of a transverse spatial image of the proton's light-front quark- and spin-distributions. More detailed imaging will be possible with the 12 GeV upgrade.

12 GeV Upgrade:
The 12 GeV energy upgrade to the CEBAF accelerator includes beam line and detector upgrades to existing halls, and the construction of a new Hall D. The new Hall is focused on the search for exotic mesons, where "exotic" means states that are described by quantum numbers that cannot fit into a quantum mechanical constituent-quark model assignment.

Upgrades to existing Halls investigate a wide variety of issues mainly in nucleon structure. Several experiments concern long established physics issues. Form factor measurements will extend precision data to 10 GeV^2 for the neutron electric, and 15 – 20 GeV^2 for other form factors. The limit of the ratio of proton and neutron F_2 structure functions, or equivalently the u to d quark ratio, at high x has been unknown, with a variety of predictions, for 30 years. Experiments are planned using a variety of techniques (parity violation, ^{3}He/^{3}H comparisons, and spectator tagging) to reduce the uncertain nuclear corrections. Precision measurements of spin structure functions, for the nucleon and for the spin EMC effect, are planned.

Since Jefferson Lab turned on, theoretical advances have also led to the concepts of GPDs and transverse momentum distributions (TMDs). Initial measurements of these quantities have been performed by several experiments at JLab with 6 GeV beams in the past decade, as well as by the COMPASS (CERN) and HERMES (HERA) experiments. The existing JLab experiments typically have limited kinematic range and sometimes have questions about the interpretation of the data at low beam energies. The COMPASS and HERMES experiments have a broader kinematic range, but poor statistics, typically insufficient to allow binning against multiple kinematic quantities at the same time. A number of experiments are planned for the 12 GeV era to study various GPDs in reactions such as deep virtual Compton scattering and deep virtual meson production, and to study TMDs in semi-inclusive pion and kaon electroproduction. These experiments all aim at high statistics and simultaneous multidimensional binning, and should dramatically improve our knowledge of nucleon structure.

Ongoing construction activities are visible across the JLab site, for the 12 GeV project and also for the new Technology and Engineering Development Facility, a modernization and enlargement of the existing Test Lab building. A number of contracts have been awarded for major accelerator components, such as cryomodules, magnets, and cryogenics, and for major experimental equipment components, such as the Hall D barrel calorimeter, the CLAS torus and solenoid, and the SHMS Q1. Various detectors are also being built by university groups. In general the project remains on schedule and budget, with ongoing stress between staff and users supporting the ongoing 6-GeV program and working on 12 GeV.

The 12-GeV physics program continues to develop. The January 2010 Program Advisory Committee (PAC35) meeting is the 4^{th} PAC to review 12 GeV proposals, and the first to assign beam time and rate scientific priorities. PAC35 assigned beam time and priorities to approved experiments studying the transverse structure of hadrons – largely, form factors. Future PACs, focusing on specific physics topics, will assign beam time and scientific priorities to other already approved experiments.

Electron-Ion Collider: For over a decade, there has been discussion of an electron-ion collider as a future QCD machine. The HERA *ep* collider used high cm energy and moderate (10^{32}/cm^2/s) luminosity to study nucleon structure functions, diffractive processes and other physics. New features of the proposed machines include ion, as well as proton, beams, polarization of both electron and ion beams, higher luminosity, and different choices of beam energies. Various designs are being studied for FAIR, LHC (LHeC), RHIC (eRHIC), and JLab (mEIC,ELIC). The strengths of the initial JLab design include high luminosity (up to $\approx 10^{35}/cm^2/s$), four interaction regions (one for polarimetry, one for low energy, two for high energy), a figure-eight footprint to facilitate beam polarization, and use of the "existing" CEBAF 12 GeV machine as an electron injector, in parallel with an ongoing fixed target program.

At this point, more effort in the U.S. has been devoted to the design and physics of an eRHIC machine at BNL than a mEIC/ELIC machine at JLab. The JLab Users Group is currently trying to broaden involvement in the study of physics possible with an mEIC/ELIC by hosting, in coordination with the laboratory, a series of workshops:

- Partonic Transverse Momentum in Hadrons: Quark Spin-Orbit Correlations and Quark-Gluon Interactions, Duke University, March 12-13, 2010, http://michael.tunl.duke.edu/workshop/index.php
- Electron-Nucleon Exclusive Reactions, Rutgers University, March 14-15, 2010, http://www.physics.rutgers.edu/np/2010rueic-home.html
- Nuclear Chromo-Dynamic Studies with a Future Electron Ion Collider, April 7-9, 2010, Argonne National Laboratory, http://www.phy.anl.gov/mep/EIC-NUC2010/
- Electroweak Reactions, expected May, 2010, University of Virginia.

8.2 The Year at RHIC

(Communicated by Brant Johnson – brant@bnl.gov.)

This is a year of past, present, and future at the Relativistic Heavy-Ion Collider (RHIC) and Alternating Gradient Synchrotron (AGS) complex at BNL. We are celebrating 50 years of AGS and 10 of RHIC operation; taking data near the mid-point of Run-10 with Au+Au at 200 GeV; commissioning ongoing accelerator improvements; and developing plans for the next decade and beyond.

From 1960 through the 1990s, AGS operation for particle physics produced three Nobel Prizes awarded in 1976, 1980, and 1988 for discoveries of the "*J*" particle, CP violation, and the muon-neutrino. The first decade of RHIC operations revealed that the hot, dense matter produced in heavy-ion collisions flows like a nearly perfect liquid and provided the first information from polarized $p + p$ collisions on how much the gluon spin contributes to the spin of the proton.

On Monday, February 15 in Washington, DC two more recent results from RHIC will be highlighted at the April APS Meeting. Namely, Yasuyuki Akiba from RIKEN will present PHENIX results on "Enhanced production of direct photons in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV and implications for the initial temperature" and Sergei Voloshin of Wayne State University will present STAR results on "Observation of charge-dependent azimuthal correlations and possible local strong parity violation in heavy-ion collisions."

Current activities and future plans for the RHIC & AGS complex are now being communicated in a successor to "RHIC News," called "Inside RHIC" http://www.bnl.gov/rhic/inside/default.asp.

The January 21 article on "News from Associate Laboratory Director, Steve Vigdor" http://www.bnl.gov/rhic/inside/news.asp?a=1587&t=today, details the "Revised Run-10 Plan" for 25 or 27 cryo weeks following the initial cooldown on December 1, 2009. While the bulk of the running time (10 weeks) will be devoted to Au+Au collisions at the full energy of 200 GeV, shorter runs are also planned, at 62.4, 39, 11.5, and 7.7 GeV, plus beam commissioning at 5 and 0.67 GeV. Vigdor also reports on a recent visit to BNL by Steve Koonin and an Electron-Ion Collider (EIC) Advisory Committee meeting at Jlab.

In "RHIC Run 10: The Push to Ultra-High 200 GeV Au Au Luminosity" (http://www.bnl.gov/rhic/inside/news.asp?a=1586&t=today) the collider Run-10 coordinator, Kevin Brown, describes the commissioning of "a number of new ideas that will lead to the highest luminosities ever. [...] The most significant improvement involves the implementation of bunched beam stochastic cooling, both longitudinal and transverse." The closing sentence conveys the sentiments of all staff members and scientists associated with RHIC, STAR, and PHENIX: "We are all looking forward to the next couple of months; with record breaking luminosities and new and interesting results coming out of RHIC."

In a third article, Evan Finch, Dima Kharzeev, Jack Sandweiss and Sergei Voloshin report on the recent STAR result: "Local Strong Parity Violation and New Perspectives In the Experimental Study of Non-Perturbative QCD" (http://www.bnl.gov/rhic/inside/news.asp?a=1588&t=today). The article concludes: "If established decisively, the local parity violation would constitute the first direct observation of a topological effect in non-Abelian gauge theories. This observation would have an effect reaching far beyond the physics of RHIC – it can modify our view of the early universe by providing; e.g., a possible primordial source for the magnetic helicity. In addition, it would improve understanding of the origin of baryon asymmetry, which is closely analogous to the chirality asymmetry possibly observed at RHIC."

The RHIC/AGS accelerator complex has been the home of significant past achievements, is now the test bed for promising accelerator developments, and will provide exciting scientific opportunities for the next decade and beyond. Further progress and future plans will be discussed at BNL during the *RHIC & AGS Annual Users Meeting*, from June 7-11, the first three days of which will be held jointly with the annual meeting of the National User Facility Organization (NUFO). All are most welcome to attend.

∗ Disclaimer ∗

This GHP Newsletter was edited by Craig Roberts for the Executive Committee.