

Executive Officers

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

Join GHP by following a link on the lower-right of our web page; namely, from:
<http://www.aps.org/units/ghp/>.

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1 Open letter from the Chair

A Message from the GHP Chair, Ramona Vogt.

Elections for open positions in the executive will soon be upon us. The Nominating Committee and their charge are announced below. An EMail seeking input from GHP’s membership has already been circulated. At this point, for myself and the whole of GHP, I’d like to thank Ron Gilman, Past Chair and Chair of the Nominating Committee; Craig Roberts, Secretary/Treasurer and also a Past Chair of GHP; and Volker Crede, Member-at-Large, who have each served the GHP well and faithfully during their time in office.

As previous editions of this newsletter have reiterated many times, a strong GHP is in the interest of everyone doing hadronic physics, an area with strong overlap with both DNP and DPF, as is evident from our membership. As a unit, the GHP has a potential for raising the profile of hadronic physics in the APS as well as for community action. It all depends on the membership, both in terms of numbers – so please encourage your colleagues and students to join GHP – and in the level of activity of the Executive Committee.

I have now been on the Executive Committee for five years, two as Member-at-Large and now three in the Chair line, and during that time I have been impressed to see the membership increase by around 50%. We have raised the number of Fellows we can nominate to two regular nominations; and we have also played a bigger role in the APS April meeting, with two invited sessions as well as contributed sessions, which not only increases the awareness of our activities at the April meeting but also brings us a larger share of the meeting income. Our biennial meeting, held before the April meeting, has garnered around 100 participants with a diverse representation of interests. Finally, we have endowed the GHP Dissertation Award. All that has happened because of our overall increase in membership coupled with the efforts of the Executive.

I am very proud to serve the GHP with the other members of the Executive who have been generous of their time and abilities on behalf of the GHP. To keep the GHP strong, however, it is essential that the nominees for office are willing to keep donating their time to further expand and enhance the GHP. As the February 2012 newsletter stated “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,

which exhibits quantum fluctuations.)” It is in the best interest of the GHP if those fluctuations can be smoothed out and the energy of the Executive maintained at a high level.

If the Nominating Committee invites a GHP member to run for the Executive, the member should carefully weigh whether they have the time to actively serve in the office for which they are nominated. Say “yes” because you genuinely want to serve the members of the GHP and are willing to take the time to do so. The same is true for membership in the various GHP committees which are shorter term but still require commitment. The Executive is very grateful to GHP members willing to share in our service to the community through these committees.

Finally, I’d like to use this opportunity to suggest that, in this time of difficult funding, we support each other’s research efforts. While none of us want to see our funding diminish, we need to support all areas of hadronic physics, and more generally physics and science research, not just the part upon which we work ourselves. We also need to remember that part of our role is to educate the public, already generally enthusiastic about science. The greater good is ultimately served by continued education and funding for science, not just for our own career goals but for a new generation of competitive innovators and critical thinkers. We already know how to speak to our colleagues and to our students. We should not hesitate to speak to the general public about our work when given the chance. Take advantage of the opportunities you have to talk to the public about your work. (Yes, the person next to you on the flight might not have a real clue about the Standard Model but even though they garble everything, they should be encouraged so as to maintain their excitement.) Show your enthusiasm but also make them feel like they have a stake in it. If they think it’s all about you, they will never feel invested in it. However, if they care about it themselves, we all ultimately benefit.

2 Thesis Prize

The GHP Executive reiterates our call for nominations for the GHP’s newly endowed American Physical Society Dissertation Award in Hadronic Physics.

The first GHP Dissertation Award, \$1000 and a travel allowance of up to \$1500 to attend the biennial GHP meeting, will be presented in Denver, Colorado, at the
April 2013 GHP Meeting.

Nominations should be sent to Ramona Vogt, Chair of GHP, by

October 8, 2012.

If you know of a deserving student, who has or will graduate in the 2 year period preceding the nomination deadline, please see

<http://www.aps.org/programs/honors/dissertation/hadronic.cfm>

This link provides details about eligibility and the material that should be included in the nomination.

As chair of GHP, Ramona Vogt will lead the Dissertation Award Committee, whose full composition is:

Volker Crede	Mike Leitch	Wally Melnitchouk	Jianwei Qiu	Ramona Vogt
FSU	LANL	JLab	BNL	LLNL & UCD
crede@fsu.edu	leitch@rcf.rhic.bnl.gov	wmelnitc@jlab.org	jqiu@bnl.gov	rlvogt@lbl.gov

The dissertations will be evaluated based on: the quality of the written dissertation (40%), the contribution of the student to the research (30%), the impact of the work (15%), and the broader involvement of the student in the community (15%).

The GHP Dissertation Award was made possible by significant contributions from Brookhaven Science Associates (the management contractor for the Brookhaven National Laboratory), Jefferson Science Associates, LLC (the management contractor for Jefferson Lab), Universities Research Association (the management contractor for Fermi National Accelerator Lab) and personal contributions from some of our members.

In order to maintain the endowment and, perhaps, to expand the Award, the Executive encourages our members to donate to the award fund. For information on how to proceed, please see: <https://www.aps.org/memb-sec/profile/DonationFunds.cfm>

3 Pre-Town Meetings at DNP Fall Meeting

(Communicated by S. Kuhn – kuhn@jlab.org.)

At the upcoming DNP Fall Meeting (October 24-27, Newport Beach, CA) there will be a Town Meeting on Friday evening, with discussion of the activities of the NSAC subcommittee chaired by Bob Tribble.

During the preceding evening (Thursday 10/25, 6 - 10 p.m.) there will be four parallel “pre-”town meetings held in preparation for this event, focusing on different subfields of nuclear physics.

In particular, there is one town meeting on hadronic physics organized by S. Kuhn. More information and the agenda can be found at <https://www.jlab.org/indico/conferenceDisplay.py?confId=21>.

The GHP Executive would like to strongly encourage GHP members to attend one of these town meetings, in order to ensure our broad community is represented.

In the hadronic physics meeting, there is a section where members of the community may present short comments (5 min. max, 3 slides max.) on any topic related to hadronic physics and the NSAC subcommittee. If you plan to make such a presentation, please contact S. Kuhn at the EMail address give above.

The “general audience” part of the town meeting will begin at 7:00pm (light refreshments will be served). It is preceded by a short Jefferson Lab Users Group Satellite meeting (6-7 pm) in the same room, with light dinner. GHP members are also invited to attend the satellite meeting.

4 GHP 2013: 5th Workshop of the GHP

The Executive has begun planning for the Fifth Meeting of the APS Topical Group on Hadron Physics. It will take place over 2.5 days:

10-12 April 2013

GHP13
Fifth Workshop of the APS Topical Group on Hadronic Physics
 April 10-12
 Denver, CO

The workshop immediately precedes the 2013 April APS meeting and will take place at the same venue, the Sheraton Denver Downtown Hotel, on the downtown pedestrian mall and near several museums. The GHP workshop provides a great opportunity for nuclear and particle physicists to meet and discuss their common interests in hadronic interactions.

Topics to be discussed:

- Light and heavy quark mesons and baryons
- Exotic hadrons
- Nucleon spin physics and hadronic structure
- AdS/QFT, novel phenomena
- Future facilities
- Lattice QCD
- Physics of the quark-gluon plasma
- Physics of gluon saturation

Organizing committee: John Arrington (ANL, co-chair), Matthias Burkhardt (New Mexico State, co-chair), Ramona Vogt (LLNL and UC Davis), Peter Petreczky (BNL), Craig Roberts (ANL), Matthias Grosse Perdekamp (UIUC), Susan Schadmand (FZ-Juelich), Jianwei Qiu (BNL), Mike Leitch (LANL), Volker Crede (Florida State), Wally Menitchouk (Jlab), Peter Tandy (Kent State).

*Workshop website: <https://sites.google.com/site/ghpworkshop/>
 Workshop email: ghpworkshops@gmail.com
 Workshop Hotel: Sheraton Denver Downtown Hotel, 1550 Court Place, Denver, CO
<http://www.sheratondenverdowntown.com>*

i.e., just before the APS April Meeting, being held at the same hotel in Denver, CO.

John Arrington and Matthias Burkhardt are co-chairing the Organising Committee, which will be constituted from the entire Executive and selected members of GHP.

Topics to be discussed include:

- Light and heavy quark mesons and baryons
- Exotic hadrons
- Nucleon spin physics and hadronic structure
- AdS/QFT, novel phenomena
- Future facilities
- Lattice QCD
- Physics of the quark gluon plasma
- Physics of gluon saturation

As past meetings have demonstrated, the GHP workshop offers a very good opportunity for nuclear and particle physicists to meet and discuss their common interests in hadronic interactions. So please mark these dates and the location in your calendar, and plan on attending.

5 Membership

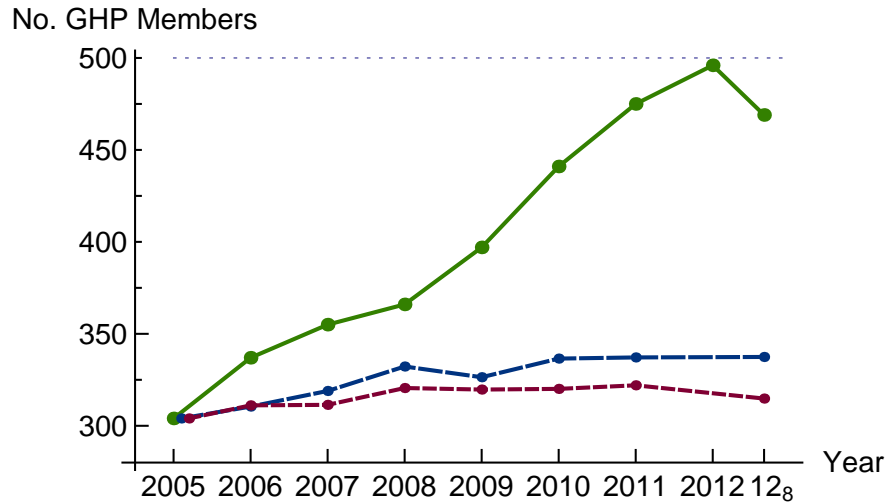


Figure 1: *Solid line* – GHP membership, as at August 2012; *long-dashed* – DNP membership normalized to GHP’s value in 2005 (2401 \rightarrow 304); and *short-dashed* – DPF membership normalized to GHP’s value in 2005 (3291 \rightarrow 304).

As of August, 2012, the GHP had 469 members, which represents 0.94% of APS membership.

However, As Fig. 1 shows, this is a **5.4% decline** in membership, from 496 in December 2012, and the first fall in our membership since the GHP was formed. Perhaps this should have been expected in an off-meeting year? It’s difficult to say because membership declined in ten-from-twelve of the American Physical Society’s Topical Groups by an average of $4.3 \pm 1.2\%$. Hopefully, membership will rebound in the lead-up to GHP2013.

Amongst the twelve Topical Groups, GHP is the 8th largest – we’ve dropped one place – and although membership in ten topical groups fell, as a percentage, GHP’s decline was second-largest. Only membership in the Topical Group on Shock Compression fell further.

It is important to bear in mind that the GHP must maintain membership close to 500 in order to continue making two Regular-fellowship nominations each year. The election of Fellows under the GHP banner provides a significant boost in the visibility of hadron physics.

As noted in Ramona Vogt’s message, 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. The Executive urges existing

members to encourage their colleagues to join us. We know there are absent-minded people who have overlooked the opportunity to join GHP but many will react positively to a little gentle prodding.

Membership is only \$8. 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.

Hence, if you are reading this newsletter but are not a member of GHP, please join. On the other hand, if you're already a member, please circulate this newsletter to your colleagues and encourage them to join.

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>.

6 Elections

Elections are approaching for posts in the GHP Executive. We need to fill three positions:

- Vice-Chair (Ramona Vogt will become *Past-Chair*, John Arrington will become *Chair* and Matthias Burkardt will become *Chair-Elect*, leaving the position of *Vice-Chair* vacant. Ron Gilman will leave the Executive, after four very active years.)
- Secretary/Treasurer (Craig Roberts' three-year term ends this year.)
- and one Member-at-Large (Volker Crede will by then have completed his stint.)

You will already have received an Email from the Nominating Committee, soliciting input from the GHP membership. The nomination of candidates will close on Mon. 8 October and an electronic ballot will subsequently be held over a four week period:

22 October – 19 November.

Our rules state that: *the Nominating Committee shall nominate at least two candidates for the office of Vice-Chair, for Secretary-Treasurer during the final year of the term of the current Secretary-Treasurer, and for open positions of Members-at-Large of the Executive Committee; 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*

Ron Gilman (rgilman@physics.rutgers.edu)

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

The Committee is now formed:

2012 Nominating Committee

Carl Gagliardi cgggroup@comp.tamu.edu TAMU	Ron Gilman (Chair) rgilman@physics.rutgers.edu Rutgers	Kawtar Hafidi kawtar@anl.gov ANL	Peter Tandy tandy@kent.edu Kent State U.
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7 APS April Meeting, 2013

A topical group is invited to participate in planning the program of major APS meetings. In 2013 there will be 2 sessions of invited talks sponsored by the GHP at the April meeting in Denver, Colorado:

13 – 16 April 2013

<http://www.aps.org/meetings/april/>

In this connection, the Executive encourages GHP members to submit suggestions to the Program Committee, which is

GHP Program Committee, preparing for April 2013

John Arrington, ANL johna@anl.gov	Peter Tandy, KSU tandy@kent.edu	Matthias Grosse Perdekamp, UIUC mgp@illinois.edu
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John Arrington is Chair.

To be of most assistance, a nomination should be EMail-ed to the program committee [chair](#) and provide (it should all fit within a $\frac{1}{2}$ -page)

- Topic (title and short description)
- Rationale as to why the topic is timely
- Speaker (Name and qualifications)

Given the deadline for submission of GHP Invited Session Programs to the APS, the Executive requests that you provide input to our Committee by

8th October, 2012.

Abstract Submission for April 2013

On a related matter, please recall that the GHP now has sorting categories of our own. There are four:

- light mesons and baryons
- heavy flavor hadrons
- spin structure of the nucleon
- QCD effects in medium

These categories are rather broad and should be interpreted as covering both theory and experiment. The first two can be interpreted as covering production, spectroscopy, decay, lattice simulations, exotics, and effective theories, at least. Spin structure includes measurements of parton densities, polarized measurements, experiments at JLab, RHIC and elsewhere, and future studies such as at the EIC. The last category includes lattice studies at finite temperature and density, gluon saturation at small x in protons and nuclei, cold nuclear

effects on quarkonium, energy loss in Drell-Yan production and other many-body effects in QCD.

When submitting abstracts to the April 2013 meeting, please consider choosing one of these categories. GHP's portion of the proceeds from the Meeting increase in proportion to the number of abstracts submitted to its categories.

8 Convocation

8.1 Unit Convocation

The APS Convocation is the gathering of Unit Officers of the Society. It provides for their familiarization with the ways of the APS, and is also an excellent opportunity for unit officers to learn from each other. The 2012 APS Unit Convocation took place at the American Center for Physics (APS Headquarters) in College Park, Maryland, on Friday, April 20. There are now 42 APS Units, including new Forums on Outreach & Engaging the Public. This year, three members of the GHP's Executive took part: John Arrington, Matthias Burkardt, and Jianwei Qiu.

The Convocation began with a brief welcome address by Robert Byer, Vice President of the APS, and an overview of the Structure of the APS and its Executive Office, delivered by Kate Kirby, Executive Officer of the APS. It was followed by two shorter overviews: one was on APS finances, presented by Joseph Serene, the APS treasurer, and the other was on APS publications by Gene Sprouse, the APS Editor-in-Chief. Following the overviews, there were presentations on APS programs, such as International Affairs, Public Affairs, Education, and Outreach, and presentations on APS support services available for APS Units, including Information Technology, Meeting Support, etc. In addition, there was a special Presidential Presentation of the APS Strategic Plan (2013-2017) by Robert Byer, followed by informal discussions about the Strategic Plan monitored by Byer and Kirby.

The five year Strategic Plan for 2013-2017 was developed by its leadership following an extensive survey on the trends in physics and science in general, the strengths and opportunities of the APS, and discussions amongst APS governance and staff. The Plan sets forth a series of goals for the Society over the next half-decade, and provides a roadmap for ensuring the Society will continue to be a highly valued membership organization for physicists in the US and around the world, a global resource for physics information, a strong and visible advocate for the discipline of physics and key communicator about physics to the community and general public, and a recognized leader in designing educational programs to serve the next generation of physicists as well as a more science-literate citizenry.

Following the presentation by Byer, there was an active and extensive discussion on the goals and objectives in the Plan. The Plan is now available on the APS website with the following link: <http://www.aps.org/publications/apsnews/201205/fiveyearplan.cfm>.

The Society's finance is supported mainly by its endowment, membership dues, and APS journals. Although the US and the world in general have experienced financial hardship in last few years, the finance of the Society is strong and healthy as assured by Serene, the APS treasurer.

In his overview, Sprouse, the APS Editor-in-Chief, summarized the current status of APS

journal publications and potential improvements to better serve the community. He pointed out that the largest number of accepted papers now come from Western Europe, rather than the US, and there is a steady growth of papers from Asia. The majority of referees are also from institutions outside the US. Sprouse also emphasized that the APS journals have the lowest publication-cost per article among all major science publications in the world. Nevertheless, the APS journals still provide the bulk of APS income, the largest fraction of which comes from non-member subscriptions. The APS journals are truly world journals serving the physics community around the globe.

Theodore Hodapp, the Director of Education and Diversity of the APS, presented a talk on APS Education and Diversity Programs. The APS Department of Education and Diversity runs programs that advocate issues relevant to minorities and women, and in areas of education and careers, and many bridge programs such as New Faculty Workshops, Graduate Education Conference, Professional Development Workshops, etc. Hodapp and the department also lead a large NSF and APS-funded national effort, known as the PhysTEC project or Physics Teacher Education Coalition. The project seeks to improve the quality of physics and physical science K-12 teachers. Hodapp showed a steady and healthy growth in the number of high school students studying physics since 1990.

Hodapp also talked about the APS Bridge Program, which was created to increase the number of physics PhDs granted to under-represented minorities. It has been well recognized that the under-represented minority groups received far less Physics PhDs after being normalized by the groups' population, although the number has been improved from 90% less in the early-90's to the current number at almost 80% less. The APS Dept. of Education and Diversity aims to bring minority PhD graduation rate into parity with bachelor rate (roughly double) in 10 years, and makes an effort to spawn sustainable bridge programs, to spread good practice and workable ideas, to build collaborative partnerships to change physics department culture to improve graduate education for all students, etc. The APS provides Childcare Grants for young physicists to attend meetings, and organizes Career Fair, Graduate Recruiting Fair, Teachers' Days, Mentoring Workshops, and other programs to get more young people, in particular, those from the minority groups, to be interested in pursuing a career in physics. Hodapp showed a rebound of Physics Bachelor's Degrees since 2000, and a steady growth of the percentage for women in physics, especially, in Doctorate and Post-doctorate.

Examples of APS outreach efforts were advertised at the convocation, including PhysicsCentral, which was launched with the goal of communicating the excitement and importance of physics to everyone. One of their products is a physics cartoon character (Spectra) written and drawn by APS staff members. The cartoons are aimed at sparking the excitement for physics/science in middle school students. More details can be found at <http://www.physicscentral.com>.

8.2 Capitol Hill

The APS continued its tradition of organizing Congressional Visits for interested Convocation participants on the day preceding the Unit Convocation. John Arrington and Matthias Burkardt participated on behalf of GHP this year.

John was accompanied by four other Illinois delegates and visited several Illinois representatives:

1. Representative Randall Hultgren (IL-14), speaking with the Congressman himself and

- Mischa Fisher, his Legislative director;
2. Senator Richard Durbin, speaking with Legislative Assistant Jasmine Hunt;
 3. Senator Mark Kirk, speaking with Legislative Assistant Sarah Walter and Legislative Correspondant Gretchan Blum;
 4. Representative Judy Biggert (IL-13), speaking with Legislative Director Cade Clurman;
 5. and Representative Bobby Rush (IL-1), speaking with Legislative Assistant Nishith Pandya

Matthias toured the Hill with four other New Mexico delegates, all from the Topical Group on “Shock Compression of Condensed Matter,” and visited the following New Mexico representatives:

1. Representative Martin Heinrich (NM-1), speaking with Elizabeth Hill, his Legislative Assistant for Education;
2. Representative Ben Ray Lujan (NM-3), speaking with David Schmidt, his Legislative Assistant for Education;
3. Representative Stevan Pearce (NM-4), speaking with Patrick Cuff, his Legislative Assistant for Science/Technology;
4. Senator Jeff Bingaman, speaking with one of his Legislative Assistants;
5. and Senator Tom Udall, speaking with Legislative Correspondents Stephanie Kuo and Anna Vavruska.

The APS Office of Public Affairs (OPA) did a wonderful job of coordinating these visits, helping John and Matthias to arrange the meetings, and providing guidance for the visits. This included a pre-meeting briefing, providing detailed materials that all participants could use in their discussions, and a post-meeting dinner at the National Press Club, where the Illinois and New Mexico groups could compare notes with the other delegations. The assistance provided by the APS helped make the meetings productive and the entire process went very smoothly. The people our delegates met with were all supportive of science and their request for robust funding of science.

During these meetings, all APS delegates expressed our Community’s deep concerns about the dire impact of the looming budget sequestration, not only on fundamental science but, as a longer term consequence, also on the economy and national security.

While the people John and Matthias spoke with were all aware of the important role of scientific research and the impact of institutions such as Argonne National Laboratory and Fermilab, Los Alamos and Sandia National Laboratories, and the strong private and public universities in each state, it is important that they and the many Senators and Representatives who are not as focused on science are made aware of the importance of funding a wide range of cutting-edge research. We encourage anyone who is interested to arrange a meeting with your congressional representatives or their staff in order to discuss the importance of science. Note that the OPA is available to provide information and assistance for APS members who are interested in contacting their elected officials in support of science and science funding.

9 Fellowship

Each year the APS allocates a number of Fellowship Nominations to a Topical Group (and to Units in general). That number is based primarily on membership. A strong GHP can nominate more of our members for Fellowship.

In 2012, owing to our level of membership at the beginning of the year, we were again allocated two Regular nominations. As noted above, however, in order to maintain this level we must work to expand our membership beyond 500. We are not on track to achieve this in 2012.

In the Executive's view, the election of Fellows under GHP's banner helps materially in raising the profile of hadron physics. Moreover, with so many excellent hadron physicists, a limitation to anything less than two nominations places stresses on our Fellowship Committee.

This year's Committee was

2012 GHP Fellowship Committee

Les Bland bland@bnl.gov	Matthias Burkardt (Chair) mburkardt@physics.nmsu.edu	Eric Swanson swansone@pitt.edu
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We thank them for their efforts, the fruits of which will be announced by the APS in December 2012.

The 2013 Fellowship Committee will be formed after results of our forthcoming elections are known, and will be chaired by the incoming Vice-Chair.

The Executive urges members of GHP to be prepared in 2013 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 deadline for nominations will be announced

5th April 2013

and 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 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 APS subsequently forwards the Nominations to the GHP's Fellowship Committee.

10 Meeting Summaries

A comprehensive list of meetings that are relevant to GHP members is available at <http://cmr2.kent.edu/manley/BRAGmeetings.html>.

10.1 Confined to JLab

(Communicated by M.R. Pennington – michaelp@jlab.org.)

In the week 12-15 March 2012, experimentalists and theorists from Europe, Latin America and the USA met at Jefferson Lab for the “14th Joint JLab/INT workshop.”

Entitled “Twin approaches to confinement physics: experiment and strong QCD”, the workshop brought together theorists expert on strong coupling QCD, both continuum and lattice methods, and their experimentalist partners to discuss problems in hadron spectroscopy and dynamics as routes to a detailed understanding of confinement physics and dynamical chiral symmetry breaking.

The program is available at <http://www.jlab.org/conferences/confinement/program.html> and includes links to the presentations.

While considerable progress has been made in probing physics at the fermi-scale, experiments at JLab with the 12 GeV upgrade will, over the next decade, allow the internal structure of the nucleon to be charted to an extent and in ways hitherto impossible. Much of excitement and novelty is expected to be revealed. These discoveries, together with experimental and theoretical efforts aimed at exposing the role played by gluonic excitations in forming the hadron spectrum, will hopefully lead to a veracious understanding of the manner by which the dynamics of confinement works in real-world QCD and also how confinement is connected with dynamical chiral symmetry breaking.

A follow-on workshop is being planned for fall 2013.

10.2 Precision data require precision analyses

(Communicated by M.R. Pennington – michaelp@jlab.org.)

Twenty-first century technology is enabling (and will continue to enable) data with unprecedented statistics to be taken in a whole series of spectroscopy experiments at B-factories, e.g., BESIII, LHCb, COMPASS, PANDA, and with the CLAS12 and GlueX detectors at JLab. In order to analyze data in channels with as many as 10^8 events and extract physical insight, a new generation of phenomenologists, theorists and experimentalists is required, physicists who are well versed in analysis of the precision data required to identify small signals that reveal the fine workings of confinement, whether through the dynamics of well-known hadrons, or the discovery of exotic states.

During the period 30 May – 13 June 2012, the Jefferson Lab Advanced Study Institute on “Extracting Physics from Precision Experiments: Techniques for Amplitude Analysis” was held at the College of William & Mary, as part of the training necessary for future JLab, BES,

FAIR and COMPASS analyses. Nine courses were presented during the two weeks of lectures, covering basics of S-matrix theory and spin formalisms, partial wave analyses, reaction mechanisms, coupled channel analyses, applications of chiral perturbation theory, results of lattice-QCD, CP violation studies and general Dalitz plot analyses.

The lectures can be found at www.jlab.org/conferences/asi2012/program.html.

This Study Institute follows a related one-week school at Bad Honnef in 2011; and a similar school is being planned in Germany for 2013. The next Advanced Study Institute will then be held in the US in 2014. These meetings are critical to the process of developing expertise in analysis that is equal to the quality of data to come.

10.3 EmNN* 2012 at USC

(Communicated by R. Gothe – gothe@sc.edu and V. Mokeev – mokeev@jlab.org.)

The latest workshop in the series “Nucleon Resonance Structure in Exclusive Electroproduction at High Photon Virtualities” was held at the University of South Carolina during the period 13-15 August 2012, following directly upon a first-of-its-kind three-week graduate-student summer-school on “Dyson-Schwinger Equations (DSEs): tackling non-perturbative physics, their applications in Quantum Chromodynamics (QCD) and condensed matter physics, and their mathematical connection to Hopf algebras.” (The lectures given at the school are available at <http://www.physics.sc.edu/gothe/summer-school-12/schedule.html>.)

The three-day EmNN* workshop united experimentalists and theorists from labs and universities, both national and international, in their common effort to find reliable approaches to measure, extract, and describe the structure of nucleon resonances, and reveal therefrom aspects of the transition from the confinement to the perturbative domain of QCD. The experimental coverage of this transition area will be extended for the first time up to photon virtualities of 12 GeV^2 by the approved JLab experiment E12-09-003 on N^* studies in exclusive meson electroproduction from protons with the CLAS12 detector.

EmNN*2012 provided extended opportunities to discuss preliminary results in depth, future developments, and potential problems. The discussions were lively and constructive, and the heat generated a good deal of crucial new information and understanding.

A wide range of themes within the nucleon resonance program were canvassed; e.g.,

- evaluation of $\gamma_v NN^*$ electrocouplings from exclusive meson electroproduction data measured with the CLAS detector and plans for experimental studies of N^* structure at high photon virtualities with the CLAS12 detector;
- phenomenological reaction models for the extraction of the $\gamma_v NN^*$ electrocouplings in single and double meson electroproduction up to high W and Q^2 ;
- and theoretical interpretation of the measured $\gamma_v NN^*$ electrocouplings from first-principles QCD and within the framework of QCD-motivated models of baryon structure.

The program and all presentations are available at <http://www.physics.sc.edu/gothe/summer-school-12/program.html>.

The approaches explained and discussed during the workshop are essential to the process of unfolding the nature of gluon and light-quark confinement, dynamical chiral symmetry breaking, their role in the hadron spectrum, and their emergence from QCD. These are some of the most challenging and important problems in hadron physics.

10.4 Photonuclear Gordon Conference

(Communicated by R. Gilman – gilman@jlab.org.)

The Gordon Research Conference (GRC) on Photonuclear Reactions covers recent advances in nuclear and particle physics. “Photonuclear Reactions” has been going on since 1959, with the most recent conference held at the Holderness School in Holderness, NH, from 5-10 August 2012. The 2012 Conference was supported by Gordon Research Conferences with additional support from Florida International University; Jefferson Science Associates, LLC; and the National Science Foundation.

There were 108 participants, drawn from Europe, Japan and the U.S. Misak Sargsian (FIU) chaired the meeting, with assistance from co-chairs Ron Gilman (Rutgers) and Ulrike Thoma (Bonn).

The program of the meeting can be found at <http://www.grc.org/programs.aspx?year=2012&program=photonuc>.

Topics included recent advances in many areas of hadronic physics, such as the quark/gluon structure and excitation spectrum of nucleons, the spectroscopy of exotic hadrons, and hadrons in the nuclear medium. Other areas covered included nuclear structure at short distances and its quark-gluon dynamics, the structure of few-body and hyper nuclei, and astrophysical implications of photonuclear studies.

The next Photonuclear Reactions GRC is expected to be held at the Holderness School in early August, 2014. The meeting will be chaired by Ron Gilman (Rutgers) with assistance from co-chairs Alberto Accardi (Hampton University and JLab) and Lothar Tiator (Mainz).

At the 2012 meeting there was interest in also holding a 2014 Gordon Research Seminar. The seminar is a meeting that is run by and for the graduate students and postdocs, held at the same location as the GRC on the Saturday and Sunday just before the start of the GRC. Erin Seder (U Conn) and Wim Cosyn (Ghent) were elected to lead the GRS effort.

10.5 Quark Matter

(Communicated by R. Vogt – vogt@lbl.gov and Jianwei Qiu – jquiu@bnl.gov.)

The Quark Matter 2012 conference was held in Washington, DC, 13-18 August. Quark Matter 2012 was the twenty-third in the series, held at approximately 18 month intervals since 1982. The conferences aims to unite international specialists in the fields of experimental and theoretical high energy heavy-ion physics. Other recent editions have taken place in Shanghai, China (2006); Jaipur, India (2008); Knoxville, TN, USA (2009); and Annecy, France (2011).

Some of the main physics topics covered at the conference include: global and collective dynamics; hadron thermodynamics and chemistry; jets; heavy flavor and quarkonium; electroweak probes; correlations and fluctuations; QCD at finite temperature and density; exploring the QCD phase diagram; pre-equilibrium and initial state dynamics; new theoretical developments; and experiment upgrades, new facilities and instrumentation.

In 2012, results were presented from the second LHC Pb+Pb run at $\sqrt{s} = 2.76$ TeV, including suppression of identified D and B mesons by, respectively, reconstruction of hadronic decays and indirectly through $B \rightarrow J/\psi X$ decays; strong suppression of the $\Upsilon(3S)$ state; as well as high p_T hadron suppression up to $p_T \sim 100$ GeV. The recently installed PHENIX silicon tracker at RHIC yielded some intriguing results on the relative suppression of electrons from charm and bottom decays in Au+Au collisions. STAR presented reconstructed D meson measurements in pp collisions at 500 GeV. In addition, results from the very successful RHIC beam energy scan were reported.

Now, for a little more detail:

1. Initial-state color charge fluctuation – In this talk, Bjorn Schenke demonstrated that the observed flow anisotropies in relativistic heavy ion collisions at RHIC and the LHC can be closely related to the color charge fluctuation in the colliding heavy ions. By accounting for sub-nucleon color charge fluctuations on scales $1/Q_S$ (where Q_S characterizes the “lumpiness” of the medium) in the incoming nuclear wavefunctions, event-by-event; solving the corresponding Yang-Mills equations in the presence of these light-cone color sources in the forward light-cone; and matching that event-by-event pattern to viscous hydrodynamics, Schenke *et al.* are able to describe data (in particular from ATLAS) on up to the 6th moment (v_6) of the measured flow anisotropies. Schenke was awarded the NPA Young Scientist award for best theory talk in the parallel sessions at QM2012. This work was highlighted in both the opening broad overview talk by Wiedemann and the closing rapporteur talk by Hippolyte/Rischke.

In his plenary talk, Kevin Dusling discussed various approaches to a longstanding problem in the relativistic heavy ion physics: how the initial gauge fields - classical non-equilibrated Yang-Mills solutions - thermalize and subsequently match to viscous (i.e. close to equilibrium) fluid dynamics. The instability-amplified quantum fluctuations appear to play a big role in the equilibration of Yang-Mills solutions.

These two examples highlight one of the important insights of the QM meeting: the initial state fluctuations are imprinted and they are not eliminated in the subsequent flow inferred from the measurements.

2. Equation of State (EOS) – Progress was made in determining the equation of state in heavy ion collisions. Various groups are converging on the EOS, and are in agreement on the determination of the critical temperature. However, the discussion continues on the QCD critical point and the determination of η/s .
3. “Re-discovery” of nuclear suppression – High p_T particle and jet production are also suppressed in relativistic heavy ion collisions at the LHC. All theoretical calculations, which were tuned to fit RHIC data, describe qualitatively the trend of the LHC data but fail in quantitative comparisons. The challenge to theory is: can these differences be fixed with small re-tuning or do we simply not yet understand the energy-loss mechanism in the hot and dense medium? And why are the b -jets suppressed like inclusive jets?
4. Color screening in hot, dense medium – Progress was made in lattice-QCD calculations of the effective heavy-quark potential in a hot medium, indicating that charmonium and $\Upsilon(2S)$ dissolve for $T > 245$ MeV, and $\Upsilon(1S)$ dissolves for $T > 450$ MeV. The centrality and p_T dependence of the J/ψ suppression pattern at RHIC and the LHC are consistent with the competition of recombination and color screening. The $\Upsilon(2S)$ is strongly suppressed, and $\Upsilon(3S)$ is completely melted. However, a theoretical calculation consistent with the observed suppression pattern of heavy quarkonia is still lacking.

All the talks are available from the meeting website, <http://qm2012.bnl.gov>, either via slides or live video of both plenary and parallel talks under the session recordings link. Given the location of the conference, there was also considerable press coverage. Links to some of the articles can also be found on the homepage.

Quark Matter 2012 was jointly chaired by John Harris (Yale), Dmitri Kharzeev (Stony Brook and Brookhaven) and Thomas Ullrich (Brookhaven and Yale). A pre-conference student and teacher day was held on 12 August and was well attended. During the conference itself, a total of 689 registered participants filled the Regency ballroom at the Omni Shoreham Hotel for the plenary sessions and were offered a choice of four parallel sessions. There was also a well-organized poster session, with more than 200 posters available for viewing. A poster committee judged the posters and selected eight for 8 minute flash talks on the last day of the conference.

The GHP's own Peter Petreczky (BNL) was presented with the 2nd *Zimanyi Award*, founded by the family of a pioneer in the theory of heavy-ion physics, Prof. Josef Zimanyi of Budapest, in a special session.

Other events included opening remarks by former Tennessee representative Bart Gordon, a reception at the National Portrait Gallery, a talk by Prof. Wolfgang Bauer (MSU) on "Energy for the 21st Century World Economy: Problems and Opportunities," and an after dinner speech "Death from the Skies!" by Dr. Phil Plait, focusing on one of the more likely doomsday scenarios from his recent book.

The conference was followed by several satellite meetings: Jet Physics – Wayne State University; Extreme QCD – George Washington University; POETIC, the International Workshop on Physics Opportunities at an Electron Ion Collider – Indiana University; and a Town Meeting for Heavy-Ion Physics, immediately following the end of Quark Matter at the Omni Shoreham.

The next meeting in the Quark Matter series will be hosted by GSI and TU Darmstadt, in Darmstadt, Germany, 19-24 May 2014.

11 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.

11.1 Highlights from COSY

(Communicated by S. Schadmand – s.schadmand@fz-juelich.de)

A main focus of the Institut für Kernphysik (IKP) at Forschungszentrum Jülich (FZJ) is the design and construction of the High Energy Storage Ring (HESR) for the Facility for Antiproton and Ion Research (FAIR), which is being built in Darmstadt, Germany. A corresponding contract between the FAIR company and FZJ was signed in 2011 and 65-MEuros have been assigned for this purpose. An international consortium, comprising IKP as the leading institution, the Zentralinstitut für Technologie (ZAT) at Jülich, the

Helmholtzzentrum für Schwerionenforschung (GSI), the Helmholtzinstitut Mainz (HIM), and the National Institute for R&D in Electrical Engineering (ICPE-CA), Bucharest, will build the HESR in the years up to 2018 and commission it afterwards.

IKP is contributing to the design and construction of the PANDA detector at HESR: after the decision of the PANDA collaboration to use a straw-tube tracker (STT) as the central tracking detector, a cooperation of IKP, Frascati, Pavia and Ferrara (Italy), Cracow (Poland) and Bucharest (Romania) will build the STT and later install it in PANDA. IKP is making essential contributions to the Micro-Vertex-Detector (MVD), as well as conceiving a day-one experiment for PANDA; and is also involved in the PANDA pellet target development, together with IHEP (Moscow). In 2011 the Technical Design Reports were finalized and approved by PANDA to be submitted to FAIR for these three detectors components (MVD, STT, target).

The IKP is presently hosting test beam times for various detector components for FAIR collaborations. An exciting prospect is the PANDA preassembly to be taking place at COSY. Here, the mechanical preassembly as well as a functional preassembly of PANDA detectors with complete system tests at an external beam line is envisaged.

IKP is conducting a feasibility study in connection with a search for electric dipole moments (EDM) of charged particles in storage rings. For this purpose, the JEDI-collaboration (Jülich Electric Dipole moment Investigations) has been formed as a study group, together with RWTH Aachen, Ferrara (Italy), BNL, Cornell and Indiana (USA), and HEPI-TSU (Georgia) to (i) perform test measurements at COSY (together with colleagues from the BNL-EDM collaboration), (ii) devise a precursor experiment for pEDM and dEDM using COSY, and (iii) design a dedicated EDM storage ring for a high-precision search with a sensitivity up to 10^{-29} e cm.

The cooler and storage ring, COSY, has been used continuously for hadron physics experiments with three major detector systems (ANKE and WASA inside COSY, TOF at the extracted COSY beam). Here are some of the highlights of the past twelve months:

- The WASA-at-COSY collaboration has achieved major milestones in the study of light meson decays. The results for decays from 3×10^7 η mesons produced in $pd \rightarrow {}^3\text{He}\eta$ reactions are being prepared for a benchmark publication. From part of this data set, the relevant kinematic spectra for the $\eta \rightarrow \pi^+\pi^-\gamma$ decay, proceeding via anomalous terms in QCD, have been published [Phys.Lett. B707 (2012) 243-249]. $5 - 10 \times 10^8$ η decays have been accumulated in $pp \rightarrow pp\eta$ reactions and are under analysis for high-precision results. The current studies of π^0 and ω decays are promising and experiments should be concluded in the next few years. The physics program is embedded in the European network 'MesonNet - Meson Physics in Low-Energy QCD', see <http://www2.fz-juelich.de/ikp/mesonnet/>.
- Evidence for a new isoscalar resonance in double-pionic fusion of a proton and a neutron to deuterium and two neutral pions has been found by the WASA-at-COSY collaboration. The structure in the excitation function is located about 80 MeV below the $\Delta\Delta$ -maximum and has a width of approximately 70 MeV; from differential distributions, the quantum numbers $I(J^P) = 0(3^+)$ could be deduced. [Phys.Rev.Lett. 106 (2011) 242302].
- The mass of the η -meson has been determined in the reaction deuteron (beam) plus proton (target) to ${}^3\text{He}$ and the η meson at the COSY-ANKE spectrometer. The result,

$m_\eta = (547.689 \pm 0.007 \pm 0.040)\text{MeV}/c^2$, is in excellent agreement with other recent measurements. [Phys.Rev. D85 (2012) 112011].

- In order to establish links between p-wave pion production in nucleon-nucleon collisions and low energy three-nucleon scattering, an extensive program of experiments on pion production is currently underway at COSY-ANKE. By using a deuterium target, data on the differential cross section and analyzing power of the quasi-free $\bar{p}n \rightarrow pp_s\pi^-$ reaction at 353 MeV have been obtained. The final state can be described in terms of s -, p -, and d -wave pion production amplitudes. Taken together with the analogous data on the $\bar{p}p \rightarrow pp_s\pi^0$ reaction, full partial wave decompositions of both processes were carried out. [PLB 712, 375-380 (2012), PLB 712, 370-374 (2012)]
- The transparency ratio for ϕ meson production in proton-nucleus (C, Cu, Ag, and Au) reactions was studied by the COSY-ANKE collaboration, first averaged over the accessible ϕ momentum region, and later also as a function of ϕ momentum. Indications for a significant momentum dependence and an effective ϕN absorption cross section were deduced. [Phys.Rev. C85 (2012) 035206].
- The PAX Collaboration performed a spin-filtering experiment with protons at the COSY ring. The spin-dependent cross section was measured at a beam energy of $T=49.3$ MeV. The experiment confirms that spin filtering is a viable technique to polarize a stored beam in-situ. The corresponding publication is in preparation.

Along with the current physics program at COSY, a major part of machine operation was scheduled for beam dynamic studies, HESR component tests and FAIR related activities. COSY also contributed its expertise in the context of EU projects and assisted the research of inside and outside users, for instance by performing irradiations at the cyclotron and at external detector areas.

A method for precise absolute luminosity determinations based on energy losses owing to the electromagnetic interaction during repeated passages of the beam through a thin target were developed by IKP-4 and the ANKE collaboration, and tested in elastic proton-proton scattering.

The 485th WE-Heraeus Seminar “Search for Electric Dipole Moments at Storage Rings,” organized by IKP, brought together experts in this field to assess its current status.

More detail about recent results and developments at COSY can be found on the public web pages of the Institut für Kernphysik in Jülich <http://www.fz-juelich.de/ikp/>.

11.2 Highlights from the COMPASS Hadron-Beam Program

(Communicated by B. Gruber – bgrube@tum.de)

The COMmon Muon and Proton Apparatus for Structure and Spectroscopy (COMPASS) is a fixed-target experiment at the CERN Super Proton Synchrotron (SPS). The main goal of the experiment is to study the non-perturbative regime of QCD by probing the structure and dynamics of hadrons in various reactions. The physics program makes use of the wide range of beams that are provided by the M2 beam line of the SPS. In addition to studies of the nucleon structure with muon beams, COMPASS has a broad measurement program using hadron beams. In these hadron-induced reactions *chiral dynamics* is probed at very low squared

four-momentum transfers ($\lesssim 10^{-3} \text{ GeV}^2/c^2$) while at intermediate momentum transfers ($\lesssim 1 \text{ GeV}^2/c^2$) the *spectrum of light-quark hadrons* is studied.

The experimental setup is a two-stage high-resolution spectrometer that covers a wide range of scattering angles and particle momenta [1]. It has an excellent acceptance for multi-particle final states. A Ring-Imaging Cherenkov detector (RICH) in the first spectrometer stage provides particle-ID information that can be used to separate pions and kaons up to momenta of $50 \text{ GeV}/c$. Two Cherenkov Differential counters with Achromatic Ring focus (CEDAR) upstream of the target are used to identify the incoming beam particles (π , K , p). In addition, the spectrometer is equipped with hadronic and electromagnetic calorimeters so that final states with charged as well as neutral particles can be reconstructed.

A central point of the COMPASS hadron-beam program is the search for hadrons beyond those of the constituent-quark model, which describes mesons as $|q\bar{q}\rangle$ and baryons as $|qqq\rangle$ states. Taking into account QCD, one expects to see also manifestations of the gluonic degrees of freedom. These could be realized in the form of so-called hybrids, where a color-octet $q\bar{q}$ pair and an excited gluon field form a color-neutral meson, or in the form of glueballs, which are characterized by valence glue. The search for these kind of objects has been one of the central goals of hadron spectroscopy during the last 20 years.

In addition to QCD-inspired models, numerical simulations of lattice-QCD have made progress in recent years by not only predicting masses, and in part widths of mesonic states, but also their dominant structure. Lattice-QCD results are now also in accord with various model predictions, which state that the lowest-lying non-strange hybrid state should have a mass around $2 \text{ GeV}/c^2$ and quantum numbers of $J^{PC} = 1^{-+}$, forbidden for $q\bar{q}$ pairs. The experimental observation of such mesonic states is therefore a test of our understanding of non-perturbative QCD and hence of the Standard Model.

Three experimental $J^{PC} = 1^{-+}$ candidates have been found so far, the $\pi_1(1400)$, $\pi_1(1600)$, and $\pi_1(2015)$, but their resonance interpretation is still controversial. One goal of the COMPASS hadron-beam program is to clarify this situation. To this end, we collected very large data samples of pion-beam induced diffractive dissociation reactions on hydrogen and various nuclear targets. These reactions, where the beam pion is excited to some intermediate state X via t -channel Reggeon exchange with the target, are known to exhibit a rich spectrum of produced intermediate states. Owing to the high beam energy (190 GeV), Pomeron exchange is dominant. The X decay into a n -body final states that are measured by the spectrometer.

A first analysis of 420 000 events of the $\pi^- \pi^+ \pi^-$ final state, taken during a pilot run, where a $190 \text{ GeV}/c$ π^- beam was scattered from a Pb target, shows a clear $J^{PC} = 1^{-+}$ signal in the $\rho\pi$ P -wave decay channel [2]. The signal intensity and the phase motion with respect to other partial waves is well described by a Breit-Wigner whose parameters are consistent with the $\pi_1(1600)$ seen by other experiments. In a dedicated measurement campaign, a much larger data set was taken with a hydrogen target. Approximately 10^8 events in the $\pi^- \pi^+ \pi^-$ channel have been analyzed in parallel with 2.4×10^6 events in the isospin partner channel $\pi^- \pi^0 \pi^0$. Similarly to the Pb data, a peak between 1.6 and $1.7 \text{ GeV}/c^2$ is seen in the $\rho\pi$ $J^{PC} = 1^{-+}$ partial wave, which also exhibits a rising phase motion with respect to the high-mass tail of the $a_1(1260)$ in the $\rho\pi$ $J^{PC} = 1^{++}$ partial wave, indicative of the resonant nature of the signal. The signal seems to be diluted by a sizable non-resonant background similar to the Deck effect. A more detailed analysis that takes into account these kinds of backgrounds is underway.

Spin-exotic $J^{PC} = 1^{-+}$ resonances were also claimed in the $\eta\pi^-$ and $\eta'\pi^-$ final states. COMPASS analyzed these decay channels in π^- diffractive dissociation reactions at 190 GeV beam energy using a hydrogen target. The fact that η and η' are related through meson

mixing could be confirmed in the $J^{PC} = 2^{++}$ and 4^{++} partial waves, which show very similar behavior, once phase-space factors are taken into account. The 1^{-+} wave, however, behaves differently and is relatively enhanced in the $\eta'\pi^-$ channel, which would be expected for an intermediate system with gluonic content. Similarly to the $\pi^-\pi^+\pi^-$ case, here, too, non-resonant contributions seem to play an important role.

In addition to the spin-exotic signals, the data show many interesting states with conventional J^{PC} quantum numbers, like, for example, the $\pi(1800)$ which is considered to be a hybrid candidate and is clearly seen in both, $\pi^-\pi^+\pi^-$ and $\pi^-\pi^0\pi^0$ final states. This resonance was also confirmed in a partial-wave analysis of the $\pi^-\pi^+\pi^-\pi^+\pi^-$ final state performed for the first time for diffractive production. Although the analysis is challenging, this channel is of particular interest because it allows access to heavier resonances, above $2 \text{ GeV}/c^2$.

Another goal of the COMPASS physics program is the search for glueballs in central-production reactions using pion and proton beams with a hydrogen target. Here the challenge is that the lightest glueballs are predicted to have ordinary quantum numbers, leading to strong mixing with normal $q\bar{q}$ mesons. In addition, at COMPASS energies the analyses have to cope with sizable diffractive backgrounds. Nonetheless, first partial-wave analyses of $\pi^+\pi^-$ and K^+K^- final states centrally produced by a proton beam show promising results.

The acquired proton-beam data also allow the study of vector-meson production in the reactions $pp \rightarrow p(\omega/\phi)p$. COMPASS measured violations of the OZI rule in ω and ϕ production with high precision, which, in combination with the measurement of the spin alignment of these vector mesons, gives important information about the production process. The spin-density matrix element ρ_{00} of the ω meson in its helicity frame depends strongly on Feynman x_F , whereas the ϕ is produced unpolarized. This is consistent with diffractive dissociation of the beam proton into an intermediate baryonic state in the case of ω production, while the ϕ production is consistent with a two-particle exchange process (central production).

Using the Pb target nuclei as a source of quasi-real virtual photons, COMPASS studied chiral dynamics in the photoproduction of $\pi^-\pi^+\pi^-$ at very small four-momentum transfer, below $10^{-3} \text{ GeV}^2/c^2$. Employing partial-wave analysis techniques, the contribution from photoproduction could be isolated from the diffractive background, so that the dependence of the $\pi^-\gamma \rightarrow \pi^-\pi^+\pi^-$ cross-section on the invariant three-pion mass could be measured for the first time in the region of $m_{3\pi} < 5m_\pi$ [3]. At leading order the result is in good agreement with predictions from chiral perturbation theory. In accord with recent findings from the CLAS experiment, however, there is no sign of a resonant signal in the $\rho\pi$ $J^{PC} = 1^{-+}$ partial wave around $1.7 \text{ GeV}/c^2$.

In addition to the study of photoproduction of multi-particle final states, chiral dynamics can also be tested by a measurement of the electromagnetic polarizabilities of the pion. Chiral perturbation theory makes precise predictions for these quantities, whereas the experimental situation is rather inconsistent. At COMPASS the polarizabilities are measured in the Primakoff reaction $\pi^- \text{Ni} \rightarrow \pi^- \gamma \text{Ni}$. Systematic effects that potentially lead to false polarizabilities are checked using a μ^- beam, which is a great advantage of COMPASS in comparison with previous measurements. First results based on data from a 10-day pilot run will be presented at the upcoming ‘‘Xth Conference on Quark Confinement and the Hadron Spectrum’’ in Munich. With additional data from the recently completed 2012 data taking campaign, COMPASS aims to provide the most precise experimental value for the pion as well as a first measurement of the kaon polarizabilities.

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3. C. Adolph *et al.*, Phys. Rev. Lett. **108**, 192001 (2012).

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THIS GHP NEWSLETTER WAS EDITED BY CRAIG ROBERTS FOR THE EXECUTIVE COMMITTEE.