Diversity in nuclear physics: does it really matter?

Paul Guèye
Disclosure

The content of this presentation is solely mine and is not the position of FRIB, NSCL, MSU or Jlab ...
Outline

- Framework
- Nuclear physics & Diversity in the US: NuHEP story
- Focus: Minority Serving Institutions
- MSI and NSF
- MSI and DoE
- Research at FRIB
- Another Future Duality: FRIB & Jlab
- Summary & Final thoughts
Color Transparency

h-N interactions vanish @ high energy transfer

“Daddy: She is Black!”
Yannick Guèye, Age: 5
Black hair = people are Blacks!

Credit: J. Griffin (Jefferson Lab)
www.jlab.org

http://clipart-library.com
The Senegalese Beaches & Lakes ...

Pre-College Years: Tourists vs. Locals

Yoff

Retba (Pink) Lake

Gorée Island (point of no return)

Ngor
Highly successful! – Critical Mass established!

Hampton University Nuclear and High-Energy Physics (NuHEP) Center

- Funding
  - Amount: $1M/year.

- Taking full advantage of proximity of Jefferson Lab.

- Crucial Outreach Program

- Some highlights (~2000)
  - Experimental Group meetings of 3.5 faculty, ~3 postdocs, ~8 students, ~10 undergrads, in a corridor (ex-laundry building!) with portable screen and projector. ~2/3 of the group was Afro-American, ~10% was African.
  - 15 years after establishment, the HU program graduated over half of the doctoral degrees awarded to African-Americans annually.
  - At one time, the group led two experiments simultaneous in Halls A and C. Still, the Hampton group covered 1/4 and 1/3 of all shifts, respectively!

Highly successful! – Critical Mass established!
Strangeness Production at JLab

1st JLab strangeness experiment (e93-018, K. Baker)

G. Niculescu et al.
PRL 81, 1805 (1998)

L. Teodorescu et al.

1st JLab hypernuclei experiment (e91-016, L. Tang)

Feasibility study of Λ and Σ hypernuclei @ JLab

B. Pandey et al., PRC 105, L051001 (2022)


L. Tang, JLab/e1217003
(last strangeness experiment so far)
Λ nn resonance [neutron-stars]
Hall A/C Collaboration: January 2022

Facility for Rare Isotope Beams
U.S. Department of Energy Office of Science
Michigan State University

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Polarized Positron Beams – 20 years later!
(... possible scheme for the EIC)

Polarized Electrons for Polarized Positrons
D. Abbott et al., PRL 116, 214801 (2016)

- Experiment in the CEBAF injector
- Highly polarized positrons
- 80% @ 6.5 MeV
- R&D for EIC
- Last PhD @ HU (A. Adeyemi, 2016)
(Some) NuHEP Impacts

Hidden stories of NP: from [??] to professionals

FRIB
Facility for Rare Isotope Beams
U.S. Department of Energy Office of Science
Michigan State University

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Minority Serving Institutions

“MSIs are institutions of higher education that serve minority populations … Some are only a few decades old, whereas others, have been striving for more than a century to give their constituents the social and educational skills needed to overcome racial discrimination and limited economic opportunities.”

<table>
<thead>
<tr>
<th>U.S. DoEd</th>
<th>Physical Sciences: 1,476</th>
</tr>
</thead>
<tbody>
<tr>
<td>7,175 institutions</td>
<td>2,033 [MS/PhD]; 797 [BS]</td>
</tr>
<tr>
<td></td>
<td>2,305 [AD]; 1,566 [CD]; 474 [ND]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Historically Black Colleges &amp; Universities</th>
<th>Physics Departments: 33 (33/444 ≈ 7%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>102 institutions</td>
<td>MS: 13</td>
</tr>
<tr>
<td></td>
<td>PhD: 5 (Howard, Hampton, FAMU, DESU, AAMU)</td>
</tr>
<tr>
<td></td>
<td>MS/PhD in nuclear physics: 3 (Hampton, Howard, FAMU)</td>
</tr>
</tbody>
</table>
Focus: Minority Serving Institutions

Some Graphs

<table>
<thead>
<tr>
<th>Focus</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historically Black Colleges and Universities (HBCUs)</td>
<td>African-Americans</td>
</tr>
<tr>
<td>Hispanic Serving Institutions (HSIs)</td>
<td>Hispanics</td>
</tr>
<tr>
<td>Tribal Colleges and Universities (TCUs)</td>
<td>Native Americans</td>
</tr>
</tbody>
</table>

Need a critical mass = pipeline from Pre-College to Professionals!
Dedicated MSI Programs @ FRIB

Physicists Inspiring the Next Generation
Campus Research + Professional Physics Societies Meetings

Student Training and Engagement Program for Undergraduates in Physics (STEP-UP)

Institute for Nuclear Science to Inspire the next Generation of a Highly Trained workforce (INSIGHT)

(Note: website coming soon …)
One-person Impact & Sustainability?

- **PING: Exploring the Nuclear Matter (www.frib.msu.edu)**
  - 2019: 4 high school students + 2 undergraduate students
  - 2022: 20 high school students + 8 undergraduate students

- **PhD/Professionals @ FRIB/MSU**
  - 2018: 2 AA
  - 2022: +12

There are great people everywhere but not everyone looks like you and that is OK!
MSI and NSF

- NSF-PHY Program Managers
  - Special Thanks: Allena Opper

- Overlooking funding and logistics …
  - Focusing on students success = no time for grants
  - REALLY focusing on students success = NEED grants
Need dedicated team that can immersed itself within the targeted group

- STEP-UP Program: joint effort from FRIB & JLab
- The HU “behind the door” team: Carlane, Vevelyn … then … Monique, Edna …
INSIGHT: Institute for Nuclear Science to Inspire the next Generation of a Highly Trained workforce

Map of INSIGHT institutions in the United States:
- San Jose State University
- University of Texas at El Paso
- Texas Southern University
- Dillard University
- University of Arkansas at Pine Bluff
- Morgan State University
- Virginia State University
- Virginia Union University
- Howard University
- Old Dominion University
- Spelman College
- Morehouse College

DoE Award - DE-SC0022075

(Note: website coming soon …)
MSI and DoE

- DoE/SC Program Managers
  - Special Thanks: Paul Sorensen and Sharon Stephenson

- DoE/SC
  - Special Thanks: Tim Hallman

- Overlooking funding and logistics …
Facility for Rare Isotope Beams (www.frib.msu.edu; started: May 10, 2022)

- **NSCL**: ~100 MeV/u
- **Energy**: ~200 MeV/u
- **FRIB400**: ~400 MeV/u
Invariant Mass Technique

Beam + Target $\rightarrow$ Unbound($^*$) $\rightarrow$ Fragments + $[1..N_n]n$ ($[1..N_\gamma]\gamma$)

Invariant Mass Technique

Beam + Target $\rightarrow$ Unst. Isotope: $X[n$-rich$]$

$X[n$-rich$] \rightarrow$ Fragment + neutron(s)

$$E_U = E_F + E_n$$

$$P_U = P_F + P_n$$

$$M_U = \sqrt{E_U^2 - P_U^2}$$

$$E_{\text{decay}} = \sqrt{M_F^2 + M_n^2 + 2(E_F E_n - \vec{P}_F \cdot \vec{P}_n)} - (M_F + M_n)$$

**Three Body Decay Energy**

P. Gueye, in progress (2022)

T. Redpath et al, NIMA (2020)
The Facility for Rare Isotope Beams (and the MoNA-LISA System)

S2 Vault

2023

... and sweeperless mode

HRS Vault

~2030
Another Future Duality: FRIB & JLab

Jefferson Lab (electron beam)

FRIB (heavy ion beams)

Nucleons Structure
4 GeV → 6 GeV → 12 GeV

Nuclei Structure
100 MeV/u → 200 MeV/u → 400 MeV/u

... interface ...
Nuclear Radii

\[ \frac{d\sigma}{d\Omega} = \left( \frac{d\sigma}{d\Omega} \right)_{\text{Mott}} | F(Q^2) |^2 \]

\[ F_p(q^2) = \frac{1}{4\pi} \int d^3r j_0(qr) \rho_p(r) \]

\[ ZF_p = 4\pi \int_0^\infty \rho_p r^2 dr = \sum_{\nu=1}^\infty (-1)^{\nu+1} \frac{4\pi R_p}{q^2} a_\nu \]
Polarized $e^\pm$-RIBs

**RIBs Radii**
M. Wallach
- Nuclear charge distributions
- Bessel function parameterization
  - Extrapolation of Bessel coefficients
  - Expansion to unstable isotopes

Interpolation/extrapolation of Bessel $a_1$

**Compact $e^\pm$ linac/RIBs**
L. Harris, M. Wallach
- Polarized $e^\pm$ scattering off rare isotopes
- Coupling to storage ring FRIB project
- Nuclear radii, Born approximation

**Shel model**
Harmonic oscillator

**Extrapolation of Bessel coefficients**

**Expansion to unstable isotopes**

**5 MeV @ exit**

**0.1 MeV @ entrance**

**Had two brainstorming meetings**
03/25/22 & 04/01/22

**FRIB**
**Facility for Rare Isotope Beams**
U.S. Department of Energy Office of Science
Michigan State University

Paul Gueye - JLabUO (06/14/22) -23
Back to the Future

- American Association for Physicists in Medicine (AAPM)
  - Women and Minority Recruitment Sub-Committee (WMRSC)

- American Physical Society (APS)
  - Medical Physics Section (initiated ~2005 under Bio, new option in 2009)

- American Association of Physics Teachers (AAPT)
  - Strategic Programs for Innovation in Undergraduate Physics (SPIN-UP)
  - SPIN-UP @ HBCUs (2001)

- American Institute of Physics (AIP)
  - Liaison Committee for Under-represented Minorities (LCURM): Chair for 2 terms
  - Task Force to Elevate African American Representation in Undergraduate Physics & Astronomy (TEAM-UP)

- National Radio Astronomy Observatory (NRAO)
  - National Astronomy Consortium (NAC)
  - Physicists Inspiring the Next Generation program (PING, http://nsbping.org)
Some (Personal) Thoughts

- People are good!
  - Negative attitudes = call for help

- Students
  - Engage your peers (one is enough!)
  - Find at least one person @ the lab to study, work, hang out …
  - In training to navigate life: you cannot do it on your own!
  - Racism is not acceptable but you also need to do your part
    ✓# Black scientists, people with different abilities … are dramatically low

- Postdocs
  - Engage your peers (one is enough!)
  - Find a senior person (faculty/scientist/engineer)

- MoNA-like Collaborations
  - Multi-institutions to tackle a common problem: team effort, networking …
## Research Group (Spring 2022)

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomas Baumann</td>
<td>MoNA device physicist&lt;br&gt;Experimental Physics (2020)</td>
</tr>
<tr>
<td>Thomas Redpath</td>
<td>MSU grad, 2019&lt;br&gt;MSI Fellow (2020)&lt;br&gt;Virginia State Ass. Prof. (2021)</td>
</tr>
<tr>
<td>Belen Monteagudo Godoy</td>
<td>Postdoc (2020)&lt;br&gt;Hope Faculty Fellow/FRIX&lt;br&gt;[Ass. Prof.] (2021)</td>
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</tbody>
</table>

## Graduate Students +2 (Fall 2022)

<table>
<thead>
<tr>
<th>Name</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dayah Chrisman</td>
<td>Graduated</td>
</tr>
<tr>
<td>Xinyi Wang</td>
<td>3rd year</td>
</tr>
<tr>
<td>Andrew Wantz</td>
<td>2nd year</td>
</tr>
<tr>
<td>Georgia Votta</td>
<td>1st year</td>
</tr>
<tr>
<td>Nicholas Mendez</td>
<td>1st year</td>
</tr>
<tr>
<td>Letrell Harris</td>
<td>1st year</td>
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</tbody>
</table>

## Other Professionals/Students

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sokhna Bineta Lo Amar</td>
<td>Postdoc, MSU/AAP&lt;br&gt;(2021)</td>
</tr>
<tr>
<td>Pierre Nzabahimana</td>
<td>4th year&lt;br&gt;Advisor: Pawel Danielewicz</td>
</tr>
<tr>
<td>Tracy Edwards</td>
<td>2nd year&lt;br&gt;Advisor: Greg Severin</td>
</tr>
<tr>
<td>Pierre Nzabahimana</td>
<td>4th year&lt;br&gt;Advisor: Pawel Danielewicz</td>
</tr>
<tr>
<td>Tracy Edwards</td>
<td>2nd year&lt;br&gt;Advisor: Greg Severin</td>
</tr>
<tr>
<td>Undergraduate/high school students</td>
<td><strong>MSU</strong>: Phuonganh Pham, Paige Lyons, Maya Wallach, Jared Bloch, Anna Brandl, Emily Holman, Emma Benedek, Tsuru Ariunbold, Justin Schmitz, Miles Klapthor, Sara Tatreau, Thomas Webb – <strong>MSF</strong>: Toni Trail, Isaiah Marshall, Joi Malone – <strong>Africa</strong>: Faith Cherop, Yoann Gueye, Ngono Afefa Reine De Lima (Lumière), Ange Ntivuguruzwa + NSF/DoE Programs (PING [NSF], INSIGHT [DoE] …)</td>
</tr>
</tbody>
</table>
Thank You!

Paul Guèye
T: 517-908-7481
E: gueye@frib.msu.edu

2022 Edward A. Bouchet Award Recipient

Paul L. J. Guèye
Facility for Rare Isotope Beams, Michigan State University
Citation:
"For many seminal experimental contributions to understanding the structure of nuclear particles and decades of service to physics outreach, diversity and inclusion, particularly throughout the African diaspora."