- Problem of low diversity in STEM (Physics in particular)
- “MS-to-PhD” Bridge programs - effective way to address this
- How do bridge programs work?
- Results/impacts of OSU Bridge Program so far

The OSU Physics MS-to-PhD Bridge Program Team:
Jon Pelz, Jay Gupta (co-director), Chris Porter, Andrew Heckler, Zeke Johnston-Halperin, Chris Hammel, Michelle McCombs, Kris Dunlap, Crystal Moloney, C. Jayaprakash, Robert Perry, Bruce Patton, Michael Poirier, Mohit Randeria, …

Financial Support and Other Assistance:
American Physical Society (APS) Bridge Program
OSU Physics Department
OSU MRSEC: Center for Emergent Materials (CEM)
OSU Division of Natural and Mathematical Sciences / College of Arts & Sciences
OSU Graduate School
Lack of diversity in STEM spans many disciplines

Significant “leakage” in pipeline between BS & PhD
MS-to-PhD Bridge Programs work to plug this “pipeline leak”

Only 30 – 40 additional URM Physics PhDs per year needed to plug BS-to-PhD pipeline leak
Why not just admit more PhD students from underrepresented groups?

- There are very few “traditionally-qualified” URM grad school applicants in physics and other fields, and these are highly recruited by other universities.

- In the OSU Physics grad program, we would (prior to our Bridge Program) typically receive a handful of URM applicants each year, with perhaps 2 or 3 “traditionally-qualified,” who were also heavily recruited by other universities.

How can we increase the pool of qualified applicants?

- It was widely believed that when a student completes a BS/BA but is not prepared for graduate school, it is too late to intervene. - “Special programs that admit under-prepared students to grad school don’t work.”

- **UG-to-PhD Bridge Programs are different:** These programs are based on the premise that there are many underprepared underrepresented minority (URM) students who could thrive in PhD programs, provided they can be identified, they are provided financial support and effective mentoring in a one- or two-year post-baccalaureate program.

- The current numbers are so small that graduating even a few more PhDs/year could have a significant impact!
But is the Bridge Program Premise True?

Results from existing Fisk-Vanderbilt and Michigan Bridge Programs show that this approach can also work in Physics

Keys to student success:
* identify and recruit “Students with Promise”
* provide financial support
* frequent and intense mentoring (academic and other)
Main elements of Physics Bridge Programs at OSU (similar to other Bridge Programs)

(1) Recruiting
- OSU (and other APS-affiliated Bridge Programs) benefit greatly from APS Bridge Program as nationwide “applications central clearing house”
  - only consider applicants who are NOT accepted into graduate program as of April 15
- ~25 applications in 2013, increased to ~75 in 2016

(2) Making good admissions decisions
- use holistic criteria – Try to ignore GRE scores; emphasize “grit” and other so-called “non-cognitive” assessments of student ability and potential
- phone interviews with short-list of 6 - 10 applicants
- freely used and adapted “Tool Kit” from Fisk-Vanderbilt Bridge Program

(3) Program length and student financial support
- two-year program (PhD transition decisions made in fall or spring of 2\textsuperscript{nd} year)
- full fellowship in 1\textsuperscript{st} year; TA or fellowship support in 2\textsuperscript{nd} year

(4) Extended new Bridge Student orientation
- provided initial housing assistance, advance on stipend for those in need
- diagnostic assessment exams in core physics subjects to help place students in appropriate UG or grad courses

(5) Early and extensive progress monitoring, academic support, and mentoring
- multiple mentors (academic, research, peer) & social events to develop cohort
- early and frequent checking with course instructors (before midterm!)
- intervene when needed (listen, direct students to campus resources, make expectations clear)
Main elements of Physics Bridge Programs at OSU (continued)

At OSU, we are also developing graduate-level and advanced UG-level active learning “Guided Group Work” Tutorials for core physics subjects (so far QM and E&M).

Unanticipated benefit of starting Bridge Program:

We have used several of the programs and resources developed for the Bridge Program to benefit all our PhD students

Our Physics Education Research (PER) group has started a study of factors that impact graduate student advancement and retention, with partial focus on students from underrepresented groups

We have also seen a large increase in applications to the PhD program from underrepresented students (increased visibility due to Bridge Program??)
# Impact on program diversity (so far)

## Impact on year-by-year recruiting of underrepresented students

<table>
<thead>
<tr>
<th>Admit Year</th>
<th>Domestic PhD Enrollment</th>
<th>URM PhD Enrollment</th>
<th>Bridge Students into PhD</th>
<th>% URM of PhD Students</th>
<th>New Bridge Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>34</td>
<td>1</td>
<td>-</td>
<td>3%</td>
<td>-</td>
</tr>
<tr>
<td>2012</td>
<td>38</td>
<td>0</td>
<td>-</td>
<td>0%</td>
<td>-</td>
</tr>
<tr>
<td>2013</td>
<td>31</td>
<td>3</td>
<td>1</td>
<td>13%</td>
<td>4</td>
</tr>
<tr>
<td>2014</td>
<td>21</td>
<td>6</td>
<td>2</td>
<td>35%</td>
<td>3</td>
</tr>
<tr>
<td>2015</td>
<td>29</td>
<td>4</td>
<td>3</td>
<td>22%</td>
<td>2</td>
</tr>
<tr>
<td>2016</td>
<td>15</td>
<td>2</td>
<td>0</td>
<td>13%</td>
<td>3</td>
</tr>
<tr>
<td>Averages since 2013</td>
<td>24.0</td>
<td>3.8</td>
<td>1.5</td>
<td>21%</td>
<td>3.0</td>
</tr>
</tbody>
</table>

## Impact on overall URM population

![Graph showing %URM PhD+Bridge and %URM PhD only over years 2009 to 2017. National % BS and national % PhD are indicated with dashed lines.]
Process at Ohio State for finding and supporting bridge students:

- Review applications (from APS and direct to OSU)
- Interview (phone or Skype) ~6-10 applicants for ~3 positions, (borrowing heavily from existing bridge programs, especially Fisk-Vanderbilt, for interview questions, protocols, and evaluation rubric)

Candidate Evaluation Worksheet – adapted from Seldacek via Fisk-Vanderbilt Bridge Program

<table>
<thead>
<tr>
<th>Candidate Name</th>
<th>Interview Date</th>
<th>Interviewer</th>
</tr>
</thead>
</table>

Candidate Assessment

Rate on High-Medium-Low scale using the Interview rubric and Qualities/Accountabilities bullets. Please include further explanations in the designated section(s).

<table>
<thead>
<tr>
<th></th>
<th>Academic Preparation</th>
<th>Relevant Research Exp.</th>
<th>Positive Self Concept</th>
<th>Realistic Self-Appraisal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long vs. Short term goals and commitment</td>
<td>Support Person Availability</td>
<td>Leadership/Community Involvement/Outreach Activities</td>
<td>Knowledge in a field/non-traditional learning</td>
<td>Perseverance/Fire-in-the-Belly</td>
</tr>
</tbody>
</table>
Bridge Applicant Interview Questions:

1) Goals and Objectives
   a) Why physics? What is compelling about this opportunity with the Bridge program?
   b) Did you apply to grad schools? Why not? Why do you think you might have been denied admission?
   c) This Bridge program is designed to set you on a course towards obtaining your PhD. What do you want to do with a Physics PhD long term?

2) Academic Experience/Challenges:
   a) Describe a time when you have faced a difficult academic challenge or hurdle that you successfully navigated. What did you do to face this challenge? Follow-up: Do you seek out help?
   b) Describe how you prepare for an exam. Follow-up: Do you study by yourself or in groups or both? (If both, what’s a rough percentage breakdown of how much time you spend in a group vs. studying alone.)
   c) If you could solidify any undergrad coursework, which courses would you choose to (re)take?
   d) What do you think will be the biggest academic challenge for you as you move to advanced studies?
   e) Graduate School is a huge time commitment and you will be asked to manage many different priorities. How do you organize your time when you have many things to get done? What challenges do you see with this kind of time commitment/management? How does this relate to your day-to-day schedule now?

3) Research Experience/Challenges (in class, lab or other):
   a) Tell us something about your undergraduate research that you’re most proud of accomplishing or being part of.
   b) What was most challenging about it and how did you figure out what to do? What did you learn most from this experience?
   c) Who did you work with, and describe the working relationships. Who was your main research mentor?
   d) Based on the materials that we have sent you about the physics PhD program, do you have any questions about the research opportunities at OSU?
   e) The OSU Physics Dept. has research going on in many different areas. However, due to various constraints and academic prerequisites, it may not be possible to assign you to your top-choice research area during the Bridge program. How flexible are you about your research area during this program?
Bridge Applicant Interview Questions (continued)

4) Personal Experience/Challenges:
   a) Were there any personal obstacles or challenges that had a significant impact on your college experience? Please describe this challenge.
   b) What did you learn most from this experience?
   c) *(Briefly describe Columbus, size, housing costs, activities, public transportation)* Do you foresee any personal challenges in moving to a new place, Columbus, OH? *(family, financial?)*

5) Key Relationships
   a) Who are the faculty or other mentors who have been most important to you during college? Would you tell us about that relationship—how it developed, how you work together, why it is important?
   b) If we talked to your mentor, what would he/she say you are really good at? What would he/she say you need to improve?

6) Leadership/Service
   a) Have you had any experiences where you were in a leadership or mentoring role for others?

7) Do you have questions for us? *(about research areas in Dept., about Bridge Program & program requirements, about Columbus)*
<table>
<thead>
<tr>
<th>Attribute</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Self-Concept</td>
<td>Expresses confidence they can complete challenging goals, makes positive statements about abilities</td>
<td>Shows confidence and independence but may be unsure about adequacy or skills</td>
<td>Is unsure they can complete the program, exhibits low self-esteem</td>
</tr>
<tr>
<td>Realistic Self-Appraisal</td>
<td>Can clearly and realistically delineate strengths and weaknesses, works on self development</td>
<td>Has trouble identifying strengths and weakness but appreciates/seeks both positive and negative feedback</td>
<td>Over or underestates abilities, does little to no self-assessment, does not appear to have learned from experiences</td>
</tr>
<tr>
<td>Preference for Long vs. Short Term Goals</td>
<td>Clearly communicates long-range goals beyond the PhD</td>
<td>Primary goal is PhD completion</td>
<td>Is vague about long-term goals, or goals are short term such as coursework</td>
</tr>
<tr>
<td>Support Person Availability</td>
<td>Can define a professional support network including mentors</td>
<td>Expresses support from one individual, or family or community</td>
<td>Expresses little or no support from family or institution for goals</td>
</tr>
<tr>
<td>Leadership/Community Involvement</td>
<td>Demonstrates involvement and leadership ability in either academics, family, community, religious group, or athletics</td>
<td>Demonstrates involvement in groups in academia or extramural but has not shown leadership</td>
<td>Not involved in institutional or community group, no demonstrated leadership</td>
</tr>
<tr>
<td>Knowledge in a Field/Non-Traditional Learning</td>
<td>Has engaged in, and learned from, experiences outside the classroom, i.e. performed independent research, extramural activities, self-taught skills</td>
<td>Shows some evidence of non-traditional learning experience</td>
<td>Has not engaged in or indicated learning from experiences outside the classroom</td>
</tr>
<tr>
<td>Perseverance</td>
<td>Can describe a time they failed or encountered an obstacle and successfully coped</td>
<td>Can identify a time they hit an obstacle but has trouble defining how they overcame the challenge</td>
<td>Has little experience with failure/obstacles. Cannot provide an example or describe response</td>
</tr>
</tbody>
</table>

Modified from Seldacek

[http://www.vanderbilt.edu/gradschool/bridge/tools.htm](http://www.vanderbilt.edu/gradschool/bridge/tools.htm)