CAMPARE and Cal-Bridge: Promoting Astronomy & Physics for Underrepresented Students in California

Alexander L. Rudolph, Cal Poly Pomona

Astronomy Colloquium
UC Berkeley
October 16, 2014
Why CAMPARE and Cal-Bridge?

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- “Little progress has been made in increasing the number of minorities in astronomy.” – 2010 Decadal Survey

California

United States
Why CAMPARE and Cal-Bridge?

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- Black Americans, Hispanic Americans, and Native Americans constitute 27 percent of the U.S. population, yet they account for only 4 percent of astronomy PhDs awarded in the United States and only 3 percent of faculty members
Why CAMPARE and Cal-Bridge?

Percent of doctorates awarded to URM students

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<th>Year</th>
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Data Source: Survey of Earned Doctorates
GRE does not predict success

- GRE correlates modestly with 1st year graduate GPA
- GRE does not correlate strongly with scientific success (PhD completion, research productivity, publication citations)
- Other measures – grit, performance character, and other non-cognitive skills – strongly correlate with success and are not correlated with GRE scores (e.g. Duckworth et al 2007)*
- Average PhD completion rate in US: ~50% (Council of Graduate Schools, 2004)

*See also work by William Sedlacek (U Md) and Carol Dweck (Stanford)
Physics GRE: Impact of Cutoff Scores

Source: ETS

*40th percentile for tests taken 2010-2013

Slide courtesy of Ted Hodapp, APS Bridge Program
Physics GRE: Impact of Cutoff Scores

Source: ETS

*40th percentile for tests taken 2010-2013

Slide courtesy of Ted Hodapp, APS Bridge Program
Misuse of GRE suppresses diversity

- Use of GRE cutoff scores (even on the quantitative test) in grad admissions significantly impacts diversity.

- Can explain minority underrepresentation in PhD programs fully from GRE quantitative cutoff

The cost of the GRE is a burden on low-income students

- The GRE costs $195 and the PGRE costs $150, plus it cost $27/school to report scores
- Many students take the exam multiple times and apply to 5-10 programs; the GRE can represent a $500-2000 investment, sometimes with no return
- ETS fee reduction program covers 50% of these costs a single time, and has exceptionally stringent eligibility requirements
Some possible solutions to problems caused by the GRE

- A statement is being presented to the AAS/APS/AAPT councils with recommendations for change
  
  - Grad programs, particularly in Astronomy, should consider dropping the GRE requirement altogether
  
  - Programs that do require the GRE should accept self-reported scores until the student matriculates
  
  - Create a national scholarship program for GRE fees; grad programs that require the GRE should contribute
  
  - Fund regional GRE prep courses like that run by CPAPC*

*California Professoriate for the Advancement of Physics Careers
Bottom line

• We are pretty bad at selecting graduate students (50% attrition rate)

• Even if a program’s attrition rate is lower than this, there are intrinsic biases in the system in favor of some groups – e.g., GRE, less access to “prestige” schools, research opportunities

• “Diversity” programs like CAMPARE and Cal-Bridge should be considered “equal opportunity programs”: a way to balance the intrinsic advantages society gives to the majority groups

• These programs can help identify those students with the “grit” or other factors that lead to success, and help them complete their B.S. and successfully apply to graduate school
The good news

- We now know of other ways to assess potential for success in academia
- Non-cognitive measures, such as grit, have been shown by research to be highly correlated with long-term success in fields like research
- These measures are not hard to implement, but they do take some extra effort, e.g., interviews of at least some candidates
- No one is suggesting ignoring grades or letters of recommendation; in fact, a good letter from a mentor in a program like Cal-Bridge may carry more weight than ever
- Change will only come when graduate programs acknowledge the research on the misuse of the GRE (subject and general)
Probably will succeed in grad school but not very diverse
Probably will succeed in grad school but not very diverse

Students we take now, many of whom struggle and fail
Students we take now, many of whom struggle and fail

High risk, likely to struggle and fail

High risk, likely to struggle and fail

Probably will succeed in grad school but not very diverse

GRE scores

Grit

High

Low
We’ve been looking here

<table>
<thead>
<tr>
<th>Low Grit</th>
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<th>High GRE scores</th>
</tr>
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<tbody>
<tr>
<td>Low</td>
<td>Lower risk, much more likely to succeed, <em>and</em> more diverse</td>
<td>Students we take now, many of whom struggle and fail</td>
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GRE scores

Grit

Lower risk, much more likely to succeed, *and* more diverse

High risk, likely to struggle and fail

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We should be looking here.
Low hanging fruit...

Minorities in astronomy, physics, computer science, and engineering.

- 18,000 minority bachelors degrees in these fields per year
  - 50% were lost at pre-major to major transition
  - 20% go on to Masters degree
  - 1.5% go on to PhD
Priority 1

Undergraduate Retention and Completion

- We propose, as a near-term focus for increasing the participation and success of underrepresented minorities in STEM, programs that increase undergraduate completion through strong academic, social, and financial support.

- Financial support for underrepresented minorities that allows them to focus on and succeed in STEM will increase completion and better prepare them for the path ahead.

- This financial assistance should be provided through higher education institutions along with programs that simultaneously integrate academic, social, and professional development.

National Academies (2011)
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- One of the top approaches the Decadal survey recommended to overcome this underrepresentation is, “Partnerships of community colleges and minority-serving institutions with research universities and with national centers and laboratories”
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- “Federal agencies should encourage projects that establish collaborations between research universities and community colleges or other institutions that do not have research programs.” – President’s Council of Advisors on Science and Technology (PCAST), Feb 2012

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- California
- United States
California is the place to create these programs
The CSU is the place to find URM students

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<td>% of CSU enrollment</td>
<td>61.0</td>
<td>69.2</td>
<td>67.9</td>
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*http://nces.ed.gov
CAMPARE: a network of STEM research opportunities for underserved undergraduates

22 home institutions
14 CSU campuses
8 community colleges
19 Hispanic Serving Institutions

10 Research institutions
8 in California
7 in Southern California
2 in Arizona

CAMPARE
15-20 students per year

Cal State Long Beach
Cal State Dominguez Hills
San Diego State Univ.
Cal State Sacramento
San Francisco State Univ.
Cal State Fresno
SETI Institute
Northern Arizona Univ.
University of Arizona
JPL/Caltech
UCI, UCLA, UCSD, UCR, UCSB

Cal State San Bernardino
Cal State Northridge
Cal State Los Angeles
Cal State Fullerton
Cal Poly Pomona
Cal State San Marcos
San Jose State Univ.
Sonoma State University
El Camino College
Santa Monica College
MiraCosta College
Mt. San Antonio College
Cypress College
Palomar College
Norco College (Riverside)
College of the Canyons

CAMPARE Mission Statement

• The mission of the California-Arizona Minority Partnership for Astronomy Research and Education (CAMPARE) program is to advance undergraduate Astronomy research and education among Hispanic and other minority students, in order to promote their participation and advancement in Astronomy and closely related fields, and increase their numbers in PhD programs in those fields.

• CAMPARE provides paid summer internships to students from the “home institutions” on the previous chart to work at one of the research institutions in the CAMPARE network.

• CAMPARE is currently funded by the PAARE program of the Astronomy Division of the National Science Foundation.
49 participants over 5 years

*Drop in 2014 due to drop in funding
Demographic Breakdown of CAMPARE Participants 2010-2014 (N=49)

**Gender**
- Women: 51%
- Men: 49%

**Ethnicity**
- Hispanic: 45%
- White: 41%
- African American: 8%
- Asian: 4%
- Dual: 2%
CAMPARE: Who has participated?

49 students from many different majors and schools have participated in CAMPARE:
- Physics and Astronomy, Geology, Math, Computer Science, Biology, Zoology
- Aerospace, Computer, Electrical, and Mechanical Engineering
Recruitment of **students** and **mentors** is key to the success of the CAMPARE program

**Home Institutions**
- Alex Rudolph, Cal Poly Pomona
- Matt Povich, Cal Poly Pomona
- Josh Smith, Cal State Fullerton
- Susan Terebey, Cal State LA
- Damian Christian, Cal State Northridge
- Gerardo Dominguez, CSU San Marcos
- Prashanth Jaikumar, CSU Long Beach
- Carol Hood, CSU San Bernardino
- Eric Sandquist, San Diego State Univ.
- Michael Kaufmann, San Jose State
- Doug Singleton, Cal State Fresno
- Bill DeGraffenreid, Sac State
- Lynn Cominsky, Sonoma State
- Gary Fouts, Santa Monica College
- Arturo Hernandez, El Camino College
- Rica French, MiraCosta College
- Phu Tran, Norco College (Riverside)
- Ron Armale, Cypress College
- Michael Hood, Mt. San Antonio College
- Takashi Nakajima, Palomar College
- Eric Lara, College of the Canyons

**Research Institutions**
- Chris Impey, Arizona
- John Bieging, Arizona
- Ed Prather, Arizona
- Josh Eisner, Arizona
- Don McCarthy, Arizona
- Yancy Shirley, Arizona
- Nathan Smith, Arizona
- Daniel Apai, Arizona
- **Cynthia Phillips, SETI Institute**
- Adrian Brown, SETI Institute
- Jean Chiar, SETI Institute
- Lori Fenton, SETI Institute
- Gerry Harp, SETI Institute
- Peter Jenniskens, SETI Institute
- Franck Marchis, SETI Institute
- Rachel Mastrapa, SETI Institute
- Richard Quinn, SETI Institute
- **Jenny Tieu, JPL/Caltech**
- Davy Kirkpatrick, JPL/Caltech
- Amanda Mainzer, JPL/Caltech
- Joseph Masiero, JPL/Caltech
Science with CAMPARE

• Astronomy
  – Studies of the M17 Molecular Cloud (Omega Nebula)
  – Extended Red Objects and Stellar Wind Bow Shocks in the Carina Nebula
  – Modeling Emission Lines and Dust around T Cha
  – IR Variability in Young Stars
  – Obliquity Measurements from Starspots in the GJ1214b Exoplanetary System

• Planetary Science
  – Morphology of Dunes Observed on Titan
  – Morphology and Classification of Martian Dunes
  – Search for Hazardous Near-Earth Objects

• Astrobiology
  – OREOcube experiment on the ISS
  – SETI: Software Development at the ATA

• Astronomy Education Research
  – Worldviews of Introductory Astronomy Students
Over 20 CAMPARE students have presented at national meetings such as the American Astronomical Society (AAS) meetings in Seattle, Austin, Long Beach, and Washington, DC, the American Geophysical Union (AGU) meetings in San Francisco, and LPSC in The Woodlands, Texas.

Stephanie Zajac (above) was selected as one of the winners of the Chambliss Astronomy Achievement Student Award competition, “given to recognize exemplary research by undergraduate students who present posters at the semi-annual AAS meetings.”
They even have fun
CAMPARE: Where are they now?

Of the 21 participants who have graduated since CAMPARE began:

- 12 are pursuing or have a graduate degree (M.S. or Ph.D.)
- 7 are in Ph.D. programs (UCLA, UCR, USC, U. Rochester, Georgia Tech, Kent State)
- Most of the others are pursuing a variety of STEM careers

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<th>Major</th>
<th>Post-graduation activities/plans</th>
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<tr>
<td>Amber Butcher</td>
<td>Geology</td>
<td>PhD program, Department of Earth Sciences, USC</td>
</tr>
<tr>
<td>Mario Cabrera</td>
<td>Physics</td>
<td>PhD program, Astronomy, University of Rochester</td>
</tr>
<tr>
<td>Heather Chilton</td>
<td>Physics</td>
<td>PhD program, Earth and Atmospheric Sciences, Georgia Tech</td>
</tr>
<tr>
<td>Greta Cukrov</td>
<td>Physics</td>
<td>PhD program, Chemical Physics, Kent State</td>
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<tr>
<td>Clint Hawkins</td>
<td>Physics</td>
<td>Nuclear Propulsion Officer Candidate Program (NUPOC), U.S. Navy</td>
</tr>
<tr>
<td>Courtney Lemon</td>
<td>Physics</td>
<td>Education Programs Assistant, American Institute of Physics</td>
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<tr>
<td>Nicole Sanchez</td>
<td>Physics</td>
<td>Fisk-Vanderbilt Master’s-to-PhD Program, Astronomy</td>
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<tr>
<td>Remington Sexton</td>
<td>Physics</td>
<td>PhD program, Astronomy, UCR</td>
</tr>
<tr>
<td>Alec Vinson</td>
<td>Physics</td>
<td>PhD program, Astronomy, UCLA</td>
</tr>
<tr>
<td>Jill Walker</td>
<td>Biology</td>
<td>PhD program, Astrobiology, Georgia Tech</td>
</tr>
<tr>
<td>Stephanie Zajac</td>
<td>Physics</td>
<td>MS, Astronomy Instrumentation, SUNY Stony Brook</td>
</tr>
</tbody>
</table>
A story of growth

- Nicole Sanchez began life as an Art major.
- After taking Astro 101, she fell in love with astronomy and decided to become an astronomer.
- She transferred to Cal Poly Pomona (CPP) as a Physics major.
- Though a good student, she struggled at times due to family issues.
- She participated in CAMPARE after her sophomore year, working with John Bieging of Arizona and Matt Povich of CPP studying triggered star formation in M17.
A story of growth

• She continued this work throughout her junior and senior years and attended the 2013 AAS meeting in Washington, D.C., where she presented her results
• Bruce Elmegreen, the father of triggered star-formation, talked to her for over half an hour by herself at her poster and afterwards asked her where she was in graduate school
• When told she was an undergrad, he couldn’t believe it
• Nicole is now enrolled in the Fisk-Vanderbilt Master’s-to-PhD program
Testimonials

“I attribute all of my success thus far to CAMPARE. I would be nowhere without the program. If they say a journey starts with single step, well for me that first step was CAMPARE.”
–Nicole Sanchez, Fisk-Vanderbilt Master’s-to-PhD program

“CAMPARE was a gateway...I can trace my current path of acceptance to a doctoral program at Georgia Tech...to a conversation with Dr. Rudolph who encouraged me to apply for CAMPARE. [The program] builds a network of support and encouragement, a network which some of us have lacked [and] is often overlooked.”
–Heather Chilton, Earth Sciences PhD program, Georgia Tech

“As an undergraduate physics major...I was really interested in astronomy, but pursuing a PhD in physics or astronomy was out of the question for me...all I could read and hear from people was how difficult it was for a minority student like me to get into PhD programs. Being a participant of the CAMPARE program opened many doors for me, and developed me into a competitive applicant for graduate school. I will now be able to pursue my dreams of becoming an astronomer as I was accepted into four physics and astronomy PhD programs.”
– Mario Cabrera, Astronomy PhD program, U. Rochester
Cal-Bridge:
A CSU-UC PhD Bridge Program
Modeled after Fisk-Vanderbilt, one of the most successful Bridge programs in the country

- Program on track to award 10 times the US institutional average of URM PhDs in astronomy, 5 times the average in physics
- In 2011, Vanderbilt became the top research university to award PhDs to URM in astronomy, physics, and material science
- Extramural grants from NSF and NASA supporting Bridge program exceed $25M
- Keys to their success
  - Holistic admissions process, including an interview, designed to identify students with “unrealized potential” using research-based criteria
  - Full funding for three years (tuition, stipend, insurance)
  - Integrated mentoring by both Fisk and Vanderbilt faculty
  - Monthly professional development seminars to prepare students for the PhD
  - No guaranteed admission to PhD program, but concrete requirements in place which, together with mentoring, leads to 90% retention rate

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http://www.vanderbilt.edu/gradschool/bridge/
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Cal-Bridge Mission Statement

- The mission of the Cal-Bridge program is to increase the number of traditionally underrepresented groups, including minorities and women, completing bachelors and PhD degrees in astronomy, physics, or closely related STEM fields. **Students selected for the program become “Cal-Bridge Scholars”**

- We have received 5 years of NSF funding to support 5-6 students per year, for a total of 18 Cal-Bridge Scholars at one time (in steady state)

- We are working with the CSU Chancellor’s office and the UC Office of the President to obtain system funding to support this program
What is Cal-Bridge?

• Cal-Bridge provides scholarship funding, mentoring, professional development opportunities, and research opportunities, to help Cal-Bridge Scholars complete their degree in Physics, and successfully enter a PhD program in Astronomy or Physics at one of five southern California UC schools (UCLA, UCSD, UC Irvine, UC Riverside, UC Santa Barbara)

• The program is open to students at participating CSU and community college campuses in Southern California

• Faculty from both the CSU and UC campuses participate in all aspects of the program, from selection, to mentoring, to assisting in the application process to a PhD program
Location of Cal-Bridge campuses
There is a strong network of faculty involved in this project

<table>
<thead>
<tr>
<th>Cal-Bridge</th>
<th>UC</th>
<th>Astronomy faculty</th>
<th>CSU/Community Colleges</th>
<th>Physics/Astronomy faculty</th>
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<tbody>
<tr>
<td>South</td>
<td>Irvine</td>
<td>Tammy Smecker-Hane</td>
<td>Fullerton</td>
<td>Josh Smith</td>
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<td></td>
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<td>Kevork &quot;Kev&quot; Abazajian</td>
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<td>Mike Loverude</td>
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<td>Michael Cooper</td>
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<td>Riverside</td>
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<td>Bahram Mobasher</td>
<td>Pomona</td>
<td>Alex Rudolph</td>
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<td></td>
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<td>Gabriela Canalizo</td>
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<td>Matt Povich</td>
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<td>Los Angeles</td>
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<td>James Larkin</td>
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<td>Tommaso Treu</td>
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<td>Chuhee Kwon</td>
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<tr>
<td>Santa Barbara</td>
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<td>Joan-Emma Shea</td>
<td>Los Angeles</td>
<td>Susan Terebey</td>
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<td></td>
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<td>Crystal Martin</td>
<td>Northridge</td>
<td>Damian Christian</td>
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<td>San Diego</td>
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<td>Adam Burgasser</td>
<td>San Bernardino</td>
<td>Carol Hood</td>
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<td>Alison Coil</td>
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<td>Laura Woodney</td>
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<td>Bold = Cal-Bridge Steering Committee</td>
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</tbody>
</table>

- El Camino College
- Santa Monica College
- MiraCosta College
- Norco College
- Cypress College
- Mt. San Antonio College
- Palomar College
- Eric Lara
- Gary Fouts
- Rica French
- Phu Tran
- Ron Armale
- Michael Hood
- Takashi Nakajima
- College of the Canyons
First 5 Cal-Bridge Scholars Selected

- Three Hispanics and four women, including one part Native American and two Hispanic women
How does Cal-Bridge work?

- Select promising students (interviews, academics, leadership, communication skills, research experience, grit,...)
- Financial support (no need to work, allowing Scholars to focus on academics)
- Professional Development Workshops: “insider knowledge”
- Research opportunities (CAMPARE, CSU and UC faculty): learn what it means to be a successful researcher
- Active monitoring of performance and progress
  - Network of support (UC and CSU faculty, current and former Cal-Bridge Scholars)
  - Regular check-ins with course instructors, tutoring, active support
  - Community: “critical mass” and “tiered mentorship”
Some keys to success of Cal-Bridge

Community Colleges → CSU Bachelor’s programs → Main pathway → UC PhD programs

- Early involvement of UC faculty
  - Joint UC-CSU committee to select Cal-Bridge scholars
  - Joint mentoring of scholars
    - Regular professional development seminars run by both UC and CSU faculty (e.g., CV writing, grad applications, GRE prep)
    - UC course work and summer research opportunities
    - Where possible, joint UC-CSU research projects
- Early involvement in research
  - CAMPARE (14 CSUs, 8 community colleges, and growing)
  - UC faculty summer research projects
- Clear pathway to acceptance into UC grad program(s) – learn from Fisk-Vand.
- Leverage existing networks (CAMPARE, CPAPC, SoCal CGE, others)
- Funding!
Key Elements of Cal-Bridge

• **Three years of full scholarship funding**: last two years of undergraduate and first year of graduate tuition and fees

• Assignment of **two mentors**: one from a participating UC campus, one from the student’s home CSU campus

• Extensive **mentoring in academics and professional development** to assist in preparing to apply to complete the bachelor’s degree and apply for graduate school

• Summer and academic year **research opportunities** at the participating UC campuses

• Opportunities to **present results at regional and national conferences**
What’s next?

• Work to show that CAMPARE plus Cal-Bridge can successfully have an impact on the numbers of minority students and women obtaining PhDs in Astronomy (will take 5-10 years)

• Find long-term funding for both CAMPARE and Cal-Bridge (CSU Chancellor’s office, UCOP, individual UC campuses)

• Expand Cal-Bridge South to include Physics

• Support creation of Cal-Bridge North?

• Do you want to get involved? Let’s talk!
CAMPARE and Cal-Bridge: Promoting Astronomy & Physics for Underrepresented Students in California

Alexander L. Rudolph, Cal Poly Pomona

Astronomy Colloquium
UC Berkeley
October 16, 2014