Findings from the *Inside the Double Bind* Synthesis Project: Empirical Research on Women of Color in STEM, 1970-2008

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Mini-Symposium on Women of Color in STEM

Arlington, VA • October 27, 2009

Based on research supported by the National Science Foundation, "Inside the Double Bind: A Synthesis of Literature on Women of Color in Science, Technology, Engineering, and Mathematics" NSF-DRL #0635577

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Inside the Double Bind
Project Team

- Maria (Mia) Ong, PI (TERC)
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- Carol Wright, Senior Researcher (TERC/MIT)
- Lorelle Espinosa, Senior Researcher (IHEP)
- Apriel Hodari, Senior Researcher (CNA)
- Megan Bang, Senior Researcher (TERC)
- Christine Bath, UG Researcher (REU, BU)
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Inside the Double Bind
Advisory Board

- Patricia Campbell (Campbell-Kibler Associates, Inc.)
- Evelynn Hammonds (Harvard University)
- Cheryl Leggon (Georgia Tech)
- Abigail Levy (EDC)
- Anne MacLachlan (University of California - Berkeley)
- Shirley Malcom (AAAS)

- NSF REESE Program Officer: Dr. Elmima Johnson

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Outline of Presentation

- Motivating factors for the study
- Methods and analysis
- Findings
  - Undergraduate
  - Graduate
  - Career
- Research agenda and future actions
- Policy recommendations

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Motivating Factors: The Past & Present

- The double bind: Interaction of racism and sexism in US, STEM (Malcom, Hall, & Brown, 1976)
- Most STEM programs & societies serve women or underrepresented minorities (URM)
- In most STEM fields, minority women are less likely than minority men in their respective race/ethnicity to earn Ph.D.s or be employed
- URM women are less likely than White women to earn Ph.D.s or be employed in STEM fields

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Motivating Factors: The Present & Future

- Increased potential for scientific and technological innovation from broadened perspectives
- Capacity of women of color to widen the STEM talent pool
- The need for equitable representation
- Changing demographics towards majority minority in US and majority female on campuses

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Inside the Double Bind
Research Question

What empirical knowledge do we already have about women of color in STEM?

Inside the Double Bind: A Synthesis of Empirical Literature on Women of Color in STEM

Oct. 2006 - Dec. 2009

NSF-DRL #0635577

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Methods: Search Criteria

- Pertaining to the production of US-born women who are African American, Asian American/Pacific Islander, Chicana/Latina, or Native American
- Higher education and/or on career trajectories in STEM fields
- Produced between 1970 and 2008
- Published or unpublished
- Undergraduate, graduate, postdoctoral, early/mid-career, and/or professional leadership

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Methods: Search Criteria

- From fields that include: STEM, education, and the social sciences
- Project definition of ***empirical work***:
  - *Presents a research question, research design*
  - *Data collection and analysis, findings, and answers*
  - *Qualitative, quantitative, or mixed methods*
- Only empirical works involving the *intersection of race and gender* were included in the final library

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Methods: Search Terms

US
US-born
Foreign-born
Women of color
Minority
Diversity
Race
Gender
Sex
Females
Equity
Discrimination
Title IX
Affirmative Action
EEOC
Litigation
Lawsuit
Civil Rights
Higher Education
Desegregation Plans
Intervention
Academic support
Academic achievement
Faculty
Professor

Native American (American Indian)
African American, Afro American (Negro/ Black)
Asian American (Pacific Islanders / Southeast Asian / Chinese/ Japanese/ Indian/ Cambodian/ Indonesian/ Korean/ Hmong/ Filipino)
Hispanic American (Latina(o) / Spanish/ Portuguese/ Brazilian/ Colombian/ Mexican/ Cuban/ Puerto Rican / Dominican/ Other Hispanics, Chicana/o)

Undergraduate
College
Career
Early Career
Postdoctoral
Graduate School
Leadership
Professional
Higher Education
Bachelor's degree
Masters degree
Doctorate

Geology (n.b., Geological Society of America)
Neuroscience
Nanoscience
Biomedical Engineering (BME)
Earth Sciences
Oceanography
Atmospheric Sciences
Agricultural Sciences
Ocean Sciences
Computer Sciences
Electrical Engineering
Industrial Engineering
Material Engineering
Mechanical Engineering
Civil Engineering
Chemical Engineering
Aerospace Engineering
Biological Sciences
Physical Sciences
Chemical Sciences
Mathematics
Astronomy
Statistics
Scientist
Engineer
Technology

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Methods: Data Collection & Analysis

- 48 e-database & physical library searches
  - e.g., WorldCat, ERIC, Google Scholar, etc.
- Solicitation
  - 6 services and listservs (e.g., NSF GSE)
  - 18 organizations (e.g., AWIS, NSBP)
  - 15 conferences (e.g., AERA, NCORE)
  - 70 journals (e.g., *JWMSE, Diverse*)
- Development & testing of codebook
- Analyses, summaries, synthesis

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Study Characteristics by Race/Ethnicity

Race/ethnicity	Number of Studies	Including White Women	Multiple Race/ethnicity
African American	97	19	86
Chicana/Latina	65	22	54
Asian American/Pacific Islander	44	15	39
Native American	43	20	42

Note. Columns do not add up to total study count of 114 since there may be more than one race/ethnicity per study and since not all studies included White women.

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Study Characteristics by Objects of Study

Objects of Study	Number of Studies
Students	89
Faculty	15
Professionals	25
Institutions	7
Programs (e.g. enrichment)	6
Administrators	6
Parents	1
Departments	1
Classrooms	1
Companies	1

Note. Column does not add up to total study count of 114 since there may be multiple objects of study per empirical work.

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Study Characteristics by Field and Life Stage

Field	Undergraduate	Graduate	Career
Life Science	2	1	0
Physical Science	7	3	3
Mathematics	13	2	4
General Science	23	11	15
Computer Science/Technology	9	6	5
Engineering	18	12	20
STEM	19	4	5

Note. Columns do not add up to total study count of 114 since there may be more than one life stage per study.

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Study Characteristics by Design and Method

	Design		
Method	Qualitative	Quantitative	Mixed Methods
Case Study	4	-	-
Ethnography	9	-	-
Interview Study	23	-	-
Phenomenological	3	-	-
Descriptive	-	22	-
Experimental	-	12	-
Quasi-experimental	-	32	-
Mixed Methods	-	-	9
Total	**39**	**66**	**9**

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Findings: Undergraduate Level

- Student-faculty relationships
  - Faculty mentorship instrumental, especially when part of a formal STEM undergraduate research program
  - Perception by professors as a serious student important
- Peer support networks
  - Positive peer experiences in formal retention programs critical
  - Inability to infiltrate peer groups, resulting social distance
- Family and community
  - May act as a crucial support, “push” factor
  - Can also act as a “pull” factor

Sources: Carlone & Johnson (2007); Seymour & Hewitt (1997); Alfred, et al. (2005); National Research Council (2006); Hurtado, et al. (2007); Varma, (2002)

Findings: Undergraduate Level

- Women of color often use their status to harness personal empowerment
  - Ties to the way in which students deal with racism and their abilities to navigate the STEM environment
- Personal strength, confidence, and competence
  - Early success often means that women arrive to college campuses with a well-developed sense of personal agency and drive

Sources: Carlone & Johnson (2007); Seymour & Hewitt (1997); Alfred, et al. (2005); National Research Council (2006); Hurtado, et al. (2007); Varma, (2002)

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Findings: Graduate Level

- Social climate a dominant theme
- Interpersonal relationships caused more difficulty than structural barriers
- Social isolation meant few opportunities to form strong academic and social peer networks
- Difficult transition coming from HBCUs and other academic environments deemed more supportive and community-minded

Sources: Brown (1994); Joseph (2007); Hall (1981); MacLachlan (2006); Ong (2005)

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Findings: Graduate Level

- Student-faculty relationships
  - Faculty mentorship rare but incredibly valuable
  - Social discrimination and cultural bias
  - Lack of encouragement equivalent to discouragement
- Influences of mentors and role models
  - Decisions re: whether to stay or leave STEM
  - “Someone who looks like me, does what I want to do”
- Funding critical to persistence in STEM

Sources: Brown, (2000); Burlew & Johnson (1992); Hall (1981); Leggon (1996); MacLachlan (2006); Ong (2002); Sader (2007); Solórzano (1995); Sosnowski (2002)

Findings: Career Level

- Racial, cultural dynamics affect career productivity and mobility
  - Women of color likely to not fit in the engineering culture; those with lighter skin tone reported fewer problems at work
  - Tenure-track women of color overloaded with committee assignments, campus diversity work
  - African American and Asian American women concentrated at the lower end of the occupational hierarchy (academia, industry & government)

Sources: Eng & Layne (2002); Hanson (2004); Lucero (2002); Maxfield (1981); Nelson (2007); NSF (2007); Tharp (2002); Yan (1999)

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Findings: Career Level

- Limited research base
  - Wide gaps in empirical studies at advanced career level, especially in industry and government
  - Gaps in family - work balance for women of color
  - Strong need for more systematic data collection

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Research Agenda & Future Actions

- Overall, increased study on women of color in STEM; disaggregated data by gender/race
- Quantitative (advanced statistical analyses) and mixed-methods studies
- Longitudinal studies, case studies
- Empirical research especially on:
  - the experiences of women of Asian American, Chicana/Latina, and Native American backgrounds
  - career trajectories of women of color, especially mid- and late-career stages

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Research Agenda & Future Actions

- Research on infrastructural / institutional characteristics that promote or hinder women of color in STEM
- Research on career choice and success of women of color who began in STEM and stayed vs. those who left
- Strategies to publish more studies on women of color in STEM
- Policy actions to promote women of color in STEM

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Detailed Research Agenda

Undergraduate Level

- Institutional characteristics and environments that aid or hinder women of color undergraduates
- The role of community colleges in preparing women of color for baccalaureate attainment in STEM
- Non-traditional pathways that women of color take between college entry and graduation in STEM majors
- Focus on the disciplines where undergraduate women of color are especially underrepresented relative to white women and all men: physics, computer science, and engineering
- The effects of pedagogy in STEM classrooms on recruitment and retention of women of color
- Pre-graduate school preparation for women of color in STEM
- The influences of funding for women of color undergraduate STEM majors
- National-level data that tracks STEM major retention between college entry and graduation
- The role of implicit bias in the experiences and advancement of women of color undergraduates

IDB Policy Recommendations

- Build on, replicate secondary and postsecondary education programs (e.g., MESA; GEM) that support interest in STEM education and careers for young women of color.
- Provide funding for STEM enrichment programs that *specifically* target women and girls of color.
- Provide funding to enable women of color students in STEM to have:
  - faculty mentorship
  - research opportunities, prof'l dev. opportunities
  - counseling about graduate school, careers

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IDB Policy Recommendations

- Host a National Academies Dinner that brings together women of color STEM students, top women of color STEM professionals and educators, and others who serve this population.
- Expand national agency support to encourage social science research on women of color in STEM.
- Create an annual academic conference for scholars who study women of color in STEM. Provide publishing mentoring and opportunities.

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Inside the Double Bind
Deliverables

- Full Report to NSF & to others on request
- Policy brief
- Scholarly research article (e.g., *JWMSE*) or Special Issue on women of color in STEM
- Article for *Science* magazine
- Methods article (Technical Report)
- Conference papers & presentations (18)

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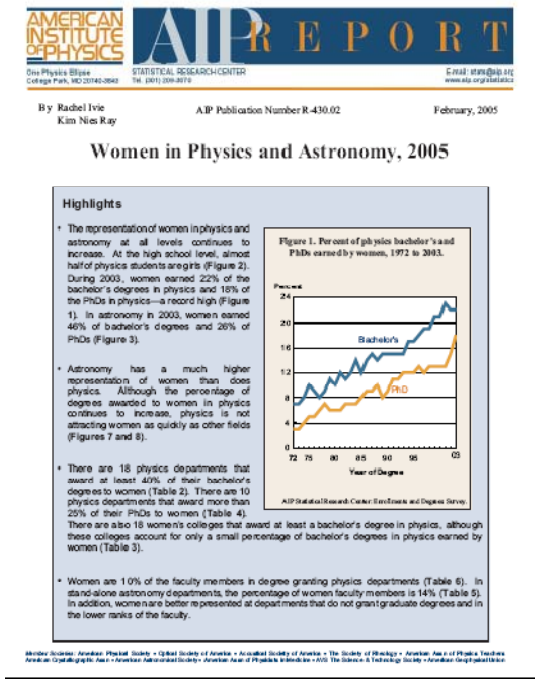
"Minority women especially represent a great, untapped resource that could be drawn on to increase the size of the scientific workforce in the U.S."



AMERICAN INSTITUTE OF PHYSICS

AIP REPORT

One Physics Ellipse, College Park, MD 20740-3843 — STATISTICAL RESEARCH CENTER — E-mail: stats@aip.org

By Rachel Ivie
Kim Nies Ray

AIP Publication Number R-430.02

February, 2005

Women in Physics and Astronomy, 2005

Highlights

- The representation of women in physics and astronomy at all levels continues to increase. At the high school level, almost half of physics students are girls (Figure 2). During 2003, women earned 22% of the bachelor's degrees in physics and 18% of the PhDs in physics—a record high (Figure 1). In astronomy in 2003, women earned 46% of bachelor's degrees and 26% of PhDs (Figure 3).
- Astronomy has a much higher representation of women than does physics. Although the percentage of degrees awarded to women in physics continues to increase, physics is not attracting women as quickly as other fields (Figures 7 and 8).
- There are 18 physics departments that award at least 40% of their bachelor's degrees to women (Table 2). There are 10 physics departments that award more than 25% of their PhDs to women (Table 4). There are also 18 women's colleges that award at least a bachelor's degree in physics, although these colleges account for only a small percentage of bachelor's degrees in physics earned by women (Table 3).
- Women are 10% of the faculty members in degree granting physics departments (Table 6). In stand-alone astronomy departments, the percentage of women faculty members is 14% (Table 5). In addition, women are better represented at departments that do not grant graduate degrees and in the lower ranks of the faculty.

Figure 1. Percent of physics bachelor's and PhDs earned by women, 1972 to 2003.

AIP Statistical Research Center: Enrollments and Degrees Survey

Member Societies: American Physical Society • Optical Society of America • Acoustical Society of America • The Society of Rheology • American Association of Physics Teachers • American Crystallographic Association • American Astronomical Society • American Association of Physicists in Medicine • AVS: The Science & Technology Society • American Geophysical Union

R. Ivie & K. N. Ray.

Women in Physics and Astronomy, 2005 (AIP)

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Thank You

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Demographics of the General U.S. Population vs. the Advanced STEM Workforce, Selected Groups (2005)