COMMITTEE ON THE STATUS OF MINORITIES IN ASTRONOMY

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SPECTRUM

A report on underrepresented minorities in astronomy

A National Analysis of Minorities in Science and Engineering Faculties at Research Universities *by Donna J. Nelson*

The first national and most comprehensive demographic analysis to date of tenured and tenure track faculty in the top 100 departments of science and engineering disciplines shows that minorities and women are significantly underrepresented. There are relatively few tenured and tenure-track underrepresented minority (URM) faculty in these research university departments, even though a growing number and percentage of minorities are completing their Ph.D.s. Qualified minorities are not going to faculties of many science and engineering disciplines. However, in some engineering disciplines, there is a better match between the percentage of URMs in recent Ph.D. attainment versus among assistant professors. The percentage of URMs in science and engineering B.S. attainment generally continues to increase, but they are likely to find themselves without the minority faculty needed for optimal role models and mentors.

There are few minority full professors in the physical sciences and engineering disciplines studied; the highest percentage of all URMs combined among full professors is less than 5% (chemical engineering). Comparing the

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New Partnerships Between the Tohono O'odham Nation and Kitt Peak National Observatory

by Katy Garmany, NOAO

Quick, what's the second largest Native American reservation in the continental United States? If you are an astronomer, particularly an observer, you probably know the answer – or at least you know the name of the people who live there. The Tohono O'odham Nation, southwest of Tucson, covers an area the size of Connecticut. It is home to approximately 18,000 members of the 28,000 people enrolled as Tohono O'odham. Kitt Peak National Observatory is located on the nation's land, under the terms of a lease signed between the O'odham and the NSF in 1958.

The O'odham nation consists of 11 districts, historically separate, and each with a strong sense of their own identity. All mountains hold a special place

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- *Find the latest statistics on minorities in science and engineering faculty.*
- *Read about innovative outreach programs to Native American communities and other minority groups in astronomy.*
- *Learn about current research in cultural astronomy, archaeoastronomy, and ethnoastronomy.*
- *Read a review of a new book on diversity in academia.*

National Analysis of Minority S&E Faculty... (cont'd)

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representation of URMs among assistant professors in the top 50 departments, versus those in the next group of 50, gives mixed results; in engineering, the top 50 departments have higher percentages of URMs, while the top 50 chemistry, math, and computer science departments have much lower representations of URMs. In each discipline except biological sciences, the percentage of White males in top 50 departments is about equal to or greater than in the next group of 50.

URM women faculty, especially "full" professors, are almost nonexistent in physical sciences and engineering departments at research universities. Surprisingly, most of the few female minority full professors in those disciplines were not born in the U.S.

In most disciplines studied, the percentage of URMs among recent Ph.D. recipients is significantly above their percentage among assistant professors; exceptions include civil engineering and mechanical engineering. In the top 50 departments of chemistry and math, the percentage of Hispanic and Native American faculty among assistant professors is lower than among associate professors, revealing a decline in hiring these minorities. In contrast, in all disciplines studied, the highest percentage of female faculty is at the level of assistant professor, as a result of increased recent hiring of women.

In most disciplines, URM faculty are so few that a minority student can get a B.S. or Ph.D. without being taught by or having access to a URM professor in that discipline. However, there is a disproportionate number of White male professors as role models for White male students. For example, in 2005, 16.7% of the students graduating with a B.S. in chemistry were URMs, but in 2007, only 3.9% of faculty at the top 100 chemistry departments were URMs. For females, those data are 51.7% and 13.7%, respectively. In contrast, the corresponding percentages for White males are 37.4% and 74.2%, respectively. While the percentages of women and of URMs in science and engineering Ph.D. attainment have increased in recent years, the White men still dominate the corresponding faculties.

A cycle is perpetuated. Minorities are less likely to enter and remain in science and engineering when they lack mentors and role models. In most science and engineering disciplines, the percentage of URMs among faculty recently hired is not comparable to that of recent minority Ph.D.s and is far below that of recent B.S. recipients. This results in fewer minority faculty to act as role models for minority students. Minority students observe this in the course of sampling the educational environment. If minority professors are not hired, treated fairly, and retained, minority students perceive that they will experience the same. This will not encourage them to persist in that discipline.

Trends in data for women are very similar to those observed for URMs, but more obvious due to greater magnitudes. Therefore, the most useful comparisons may be those for representation of women across disciplines. For example, in the top 100 departments, the representation of females among professors in chemistry, versus astronomy or earth sciences, is lower at each rank. The ratios of chemistry: astronomy: earth science are 21.2%: 25.3%: 28.2% for assistant professors, and 13.7%: 15.8%: 16.5% for professors of all ranks combined. However, the representation of female students in chemistry is and has been higher than that of astronomy or earth sciences for years (51.7%: 42.4%: 41.9% for B.S. in 2005, and 32.4%: 22.7%: 31.8% average for Ph.D.s in 1996 – 2005). Astronomy and earth science may have desirable hiring practices which could be used by other disciplines.

Using these data to identify points of strength and challenge for each discipline could guide the search for programs, resources, and attitudes which are responsible for the results. We hope this will facilitate the transfer of good practices among disciplines.

General Methods

Our data were gathered by surveying the top 100 departments in each of fifteen science and engineering disciplines, as ranked by the National Science Foundation (NSF) according to research funds expended.[3] Each department chair was asked to provide the gender, race/ethnicity, and rank of each tenured or tenure track faculty member. Data from chairs were entered into tables, which are provided in the Appendix [of the full report]. A URL to posted tabulated data was emailed to respondents,

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New Partnerships: Tohono O'odham and KPNO (cont'd)

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in the culture and religion of the Tohono O'odham, and Baboquivari Peak, which dominates the view to the south from Kitt Peak, is especially important. There are daunting issues facing the O'odham: health (60% of adults are diabetic), education (over 25% don't graduate from high school), and social issues stemming from a 15% unemployment rate, plus all the problems that come from being located along the contentious US–Mexican border. Like many tribes, the O'odham have opened casinos in recent years, and the money is used to support a number of new initiatives. This includes a young community college located in Sells, the nation's capital, and five well-equipped recreation centers around the nation.

In recent years, the scientists and staff at NOAO have recognized that the observatory could be offering a lot more assistance across the educational spectrum on the nation. While every NOAO job ad carries the line "NOAO and NSO are affirmative action and equal employment opportunity employers. Preference granted to qualified Native Americans living on or near the Tohono O'Odham reservation," the majority of O'odham who work at Kitt Peak are in service-related jobs. With this in mind, the observatory has begun supporting a number of projects, primarily through the division of Public Affairs and Educational Outreach (PAEO), but involving a number of NOAO scientists and staff.

We have visited schools and rec centers around the nation for star parties, talks and hands-on science activities. These include regular visits over the past 18 months to the Boys & Girls Club in Sells, where PAEO staff and student assists have presented a program called "Kitt Peak Hands-On Optics." In part because of these new connections, the Boys & Girls Club approached the Kitt Peak Director Buell Jannuzi about holding their summer horse camp on Kitt Peak to escape the desert heat. The horse camp, which is about kids taking personal responsibility as much as it is about learning to handle horses, took place in late June. Had you been on the mountain observing that particular weekend, you were sharing it with over a dozen horses and about 50 children and adults who all camped at the picnic grounds. All parties agreed it went very well, and hope to have the camp return next year.

I began teaching Astronomy 101 at the Tohono O'odham Community College in 2004. This gave me an opportunity to meet a variety of members of the community and learn more about the issues facing them. It was exciting to be teaching astronomy to students who could step outside their homes into some of the darkest skies in the country,

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Ethnoastronomy: Pondering Celestial Diversity

By J. C. Holbrook, Bureau of Applied Research in Anthropology, University of Arizona

As a student of astronomy, I found that astronomy lacks gender and ethnic diversity, which is reflected in both the history of astronomy and the way that astronomy is presented. Those cosmologies and understandings of the sky found in non-Western traditions are not considered a part of astronomy because they are considered to be non-scientific. In contrast, I find a deeper and more complex story as I study non-Western astronomy which includes environmental adaptation, religion, artistic inspiration, and survival, as well as science. Studying astronomy within cultures humanizes astronomy and brings much needed diversity to astronomy, as well as a broader human significance. But can astronomers learn something from these other ways of viewing the heavens? I return to this question in my concluding remarks.

Cultural Astronomy, Archaeoastronomy, Ethnoastronomy

Ethnoastronomy is the study of "the knowledge, interpretations, and practices of contemporary cultures regarding celestial objects or phenomena" [1]. Archaeoastronomy focuses on non-living cultures. Ethnoastronomy arose out of cultural anthropology, while archaeoastronomy comes from archaeology. In spite of these differences until the 1990s, 'archaeoastronomy' was the term used to describe studying astronomy beliefs and practices in their cultural context whether ancient or contemporary; today the term 'cultural astronomy' is used instead with archaeoastronomy and ethnoastronomy relegated to subfields along with the history of astronomy [2, 3].

There are many famous case studies in archaeoastronomy and ethnoastronomy. The site most strongly associated with archaeoastronomy is Stonehenge in the United Kingdom. Stonehenge is an archaeological site dated to the Neolithic (7000 – 1700 BCE). Several hundred books and articles have been published about Stonehenge and its solar and possible lunar alignments. The significance of Stonehenge includes that it is a massive stone structure that has been precisely placed without the use of modern equipment and aligned to the Sun's solsticial positions. Other alignments and the significance of the structure to the builders continue to be the subject of debate. The pyramids of the Giza Plateau in Egypt are another popular archaeoastronomy topic. Popular theories are that the pyramids mirror the constellation Orion on the ground; that air shafts point to Sirius, the North Celestial Pole, and other bright stars; and that some of the pyramids are laid out cardinally. However, their layout, external alignments, and the alignments of the air shafts to celestial bodies continue to be debated. Similarly, the most well-known ethnoastronomy case study is that of the Dogon of Mali done by Marcel Griaule [4, 5]. His findings on Dogon cosmology are not as controversial as those on the Dogon's detailed knowledge of the solar system and the Sirius star system. The academic world has debated the validity of his findings since Griaule's publications appeared because without a telescope it should not have been possible for the Dogon to know about the other stars found in the Sirius system. The popularity of these archaeoastronomy and ethnoastronomy case studies lies in the debates – there simply is not enough information to scientifically prove or disprove everything. But the benefit is that these case studies capture the public imagination and bring publicity to the field of cultural astronomy.

My cultural astronomy research is in ethnoastronomy focusing on living people. Currently there are several theories circulating in ethnoastronomy. Early ethnoastronomy theory suggested that societies could be ranked in evolutionary stages of culture depending upon their astronomy. The premise was that in order to observe, record, and understand the longest observable celestial cycles a culture has to be technologically advanced. The theory suggested that most cultures used observations of the Sun, Moon, and stars to create their time-keeping system or calendars. Calendars can be based on sky observations of several years with compensations to account for the extra quarter day (such as our leap year) established over decades. Thus, time-keeping is present in even what was formerly classified as primitive cultures. More technologically advanced cultures, in addition to time-keeping, noted the periods and motions of the planets, and the most advanced cultures added

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University of Arizona students Sanlyn Buxner, Audra Baleisis, Maria Pena, and Veena Monihor in Cape Coast Ghana. The picture was taken when the Sun transits directly overhead; notice the students' shadows.

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knowledge of the precession of the equinoxes to these. The only planets visible without a telescope are Mercury, Venus, Mars, Jupiter, and Saturn. Saturn is the furthest of these planets and has a 30 year cycle as observed from the Earth. The precession of the equinoxes is a 25,800 year cycle of the motion of the North Celestial Pole, as a result, the position of the equinoxes and solstices shift their positions from one constellation to the next approximately every 2,150 years. Ethnoastronomers busily added other astronomy feats these technological stages, until anthropologists showed such evolutionary schemes to be Eurocentric. Also, this theory emphasized what astronomers and researchers today think are the most important feats of observing without telescopes across all time, thus perhaps astronomer-centric.

Ethnoastronomy theories circulating today avoid placing external value judgments on indigenous astronomy knowledge in favor of exploring the local values and meanings the people themselves place on their astronomy knowledge. Ethnoastronomy continues to study time-keeping and the creation of calendars in cultures around the world. The theory is that all people have used observations of celestial bodies for time-keeping purposes. Some cultures have lunar calendars that follow the cycles of the Moon, others have solar calendars based on observing the Sun's position on the horizon, and still others have calendars that use a combination of these two along with observing certain stars and natural changes in their local environment. Many cultures have multiple calendars which they use simultaneously. Ethnoastronomers have yet to identify a calendar that does not have some roots in observing the sky.

The Tropical Archaeoastronomy Theory suggests that the astronomy found among peoples living in the tropics will be different from those living elsewhere [6]. In the Tropics the Sun passes directly overhead twice a year, the stars rise and set vertically, and the north and south celestial poles are not visible. In contrast, towards the north and south in the temperate zones the celestial poles are visible, the stars rise and set at an angle and there are circumpolar constellations that are always visible. This theory is still being tested, in Aveni's words "If these systems of knowledge [in tropical cultures] are found to be similar to the systems of those cultures located in northern, temperate, latitudes, then

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Struggling to Diversify: Privilege and Diversity in the Academy *by Frances A. Maher and Mary Kay Thompson Tetreault*

A book review by Susan Talburt, reprinted with permission from Academe Online.

When thinking about changing faculty demographics, one might turn to the opening lines of Dickens's A Tale of Two Cities: "It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity . . . we had everything before us, we had nothing before us." For those who believe that a diverse faculty is intrinsically valuable, with the potential to transform scholarship and curriculum, what time is this?

Frances Maher and Mary Kay Thompson Tetreault's careful study of institutional, individual, and collective meanings of faculty demographics on three campuses rejects a best/worst dichotomy, creating instead an unsteady narrative of progress. The authors position their text as a challenge to disembodied scholarship on higher education's corporatization, which they describe as a "negative national literature" that only "fleetingly . . . touches on demographic changes in the faculty." They ask what conditions have made these demographic changes possible, what factors have impeded them, and what effects the changes have had on institutional policies and practices. Their narrative does not trace a straight line from white male privilege to diversity—it is neither the best nor the worst of times, but a time in which we have something before us.

Through institutional ethnographies of Stanford University, the University of Michigan, and Rutgers University–Newark, Maher and Tetreault explore historical, social, political, and economic contexts that have shaped responses to what they call "the challenges of diversity" over the past several decades. The book takes readers into the institutions themselves, focusing on interviews with faculty and administrators. Particularly refreshing, and somewhat unusual in ethnographic studies, is the naming of individuals interviewed—among the familiar figures are Renato Rosaldo, Estelle Freedman, and Claude Steele at Stanford and David Halperin, Abigail Stewart, and Nancy Cantor at Michigan. Noteworthy are the preponderance of advocates for change and the paucity of "big names" from Rutgers–Newark.

The historical backdrop for the reconfiguration of higher educational hierarchies includes the rise of science-based research universities with the Cold War buildup of Big Science, which changed funding priorities of private foundations; the GI Bill's expansion of higher education for white males; and heightened racial and economic segregation that accompanied the rapid growth of the suburbs in the 1950s. Within these contexts, the authors examine Stanford's entrepreneurialism and institutional privilege, Michigan's preemininence in the social sciences, and Rutgers–Newark's disadvantaged position. The authors thus contrast the physical environments of Palo Alto, Ann Arbor, and Newark while depicting a national hierarchy of universities and stratification within them according to departments and areas and methods of study. Research commercialization, entrepreneurialism, and the quest for national rankings emerge as key factors in creating and perpetuating patterns of structural, demographic, and intellectual privilege. Demographic changes, however, first of students and more slowly of faculty, have encouraged new practices that challenge singular notions of excel-lence.

> *"The book takes readers into the institutions themselves, focusing on interviews with faculty and administrators."*

In framing their analysis, the authors define excellence as "a code word for commonly agreed-on high standards of academic performance —in other words, rigorous scholarship with universal applicability—and a deservedly high stature for those who meet those standards. Diversity has then meant a spreading out of, a dilution of, and a threat to those standards." Rather than denoting quality, excellence consolidates privilege, solidifying institutional norms to control who counts as a scholar and what content and methodologies count as scholarship.

Making explicit an arguable narrative of progress, the authors employ feminist phase theory

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to understand changing dynamics of privilege and diversity on these campuses. The five phases, originally developed to study curricular transformation, include (1) viewing as standard "a white male professoriate" (during the time of few women faculty or faculty of color); (2) "ending race and sex discrimination and becoming 'just like them,'" or the civil rights–era effort to build a diverse faculty as long as it was, as at Stanford, "the best possible faculty" (the most egregious example of a "just like them" mentality); (3) challenging "university standards, norms, and cultures," or questioning curricular norms and scholarly standards for tenure decisions; (4) "linking diversity and excellence," or refusing to understand these terms as opposites and making diversity a part of excellence in policy and practice; and (5) "shifting the focus from excellence and diversity to privilege and diversity," or challenging individualistic ideologies of success by making structures of privilege an explicit part of institutional discourse.

"In framing their analysis, the authors define excellence as 'a code word for commonly agreed-on high standards of academic performance'..."

Several chapters detail the institutions' struggles to diversify their faculty, revealing an elaborate interplay of external and internal dynamics and offering insights into actors' understandings of their institutions. The narratives also raise questions about the authors' assumptions. Phases 3 and 4 receive the most elaboration, with examples at Stanford of challenges to tenure norms and the infamous 1980s curricular debates over the transformation of the undergraduate Western culture requirement to Cultures, Ideas, and Values (CIV), which mandated attention to race, class, and gender. But here the authors' assumptions, not to mention dominant ideologies, go unchallenged. The book is premised on "positionality," the idea that membership in a marked category of gender, race, or ethnicity offers an alternative worldview. Yet the discussion fails to note that this essentializing assumption is belied by the reversal of the CIV requirement under Condoleezza Rice, who served as Stanford's provost during most of Gerhard Casper's presidency.

Although the authors purport to reject a best-worst dichotomy, Michigan emerges as something of the "best of times," which the authors attribute mostly to the university's commitment to interdisciplinarity (in contrast to the entrenched departmental structures and norms at Stanford). Indeed, interdisciplinarity is figured as a hero throughout the book, enabling the development of pluralistic standards of excellence and programs designed to effect change through strategic hiring of clusters of faculty, joint appointments, and recruitment of senior female faculty. Across the campuses, interdisciplinary women's and ethnic studies are described as locations of both possibility and marginalization. Yet the authors fail to emphasize the revenue generating potential of particular interdisciplinary formations as a significant factor in their positions in institutional hierarchies.

At Rutgers–Newark, which the authors describe as recently beginning to "catch up" with other institutions, there are efforts to link excellence to the university's urban mission. The search for resources, however, works against diversification, as significant investments in sciences and a defunding of other departments—including the predominantly African American academic foundations department—privilege "traditional" scholarship and stratify faculty internally.

Despite the authors' intentions, the book often supports "worst of times" thinking about corporatization's effects and the dominance of the sciences in universities, particularly regarding Stanford's adherence to the "Stanford style" of the scientist-hero-entrepreneur and Rutgers–Newark's stratification of departments and faculty in its quest for resources and prestige. At the book's end, Maher and Tetreault remain puzzled by warnings that academic capitalism endangers faculty autonomy and scholarly integrity, despite their own portraits of commercialization's role in perpetuating the hierarchies and privileges the text bemoans. Nonetheless, despite minor disagreements (did I mention that heterosexual privilege functions largely as an add-on?), this book offers compelling ideas worthy of serious consideration.

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Ethnoastronomy: Pondering Celestial Diversity (cont'd)

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we will learn something of the cognitive unity of mankind. If they prove to be dissimilar, then we will be reassured of the human capacity for change and adaptation to diversity [7]." My research on navigation by the stars supports this theory for I found that my research populations living in the tropics used rising and setting stars whereas those living north where Polaris is visible used this non-moving North Celestial Pole marker for navigating [8], thus their navigational techniques were dependent upon their latitude.

Rather than a theory, there is a belief among ethnoastronomers that people project themselves, their cultural values, and their environment onto the sky. Through studying the names assigned to celestial bodies and the stories associated with celestial bodies one can learn about particular cultures and the environment in which they live. Epic stories of the founding of some ethnic groups are traced among the stars, others claim that certain constellations are their ancestors, and many stories about the Sun, Moon, and planets involve idealized marital relationships. People assign asterism to animals that are found in their local environment. For example, constellations named after the Giraffe are not found among North American Indians. There are two levels of interpretation, the insiders and the outsiders, and ethnoastronomers must uncover the insiders' perspective to understand why certain people, cultural values, and elements of their environment are stellified.

A theory focused on the content of myths arose from works such as Hamlet's Mill [9], and more recently expounded upon in When They Severed Earth From Sky [10]. The theory is that many myths and religious beliefs stem from true historical celestial events such as the precession of the equinoxes. Suggested examples of religions include Mithraism (precession of the equinoxes from Taurus to Aries) and Christianity (a bright star appearing in the East and precession of the equinoxes from Aries to Pisces). The problem with this theory is that not all myths and religions reflect celestial events, and not all celestial events become the source of myths, religions, or are recorded in any way like in rock art or paintings. For example, a study of the Tabwa in Central Africa supports the theory because they changed their burial practices to include symbolism related to comets after witnessing several comets during the 1800s [11]. But, the comets observed by the Tabwa were visible by many other ethnic groups, where are their stories and changes in cultural practices?

I have been working with an applied astronomy knowledge theory that the sky is another part of people's natural environment and similar to how they have adapted to living in certain terrains they have adapted to their sky. In particular I am interested in how people use the sky as part of their livelihood: They use changing atmospheric conditions to predict changes in weather, they observe the positions of stars and other celestial bodies to predict seasonal climate changes such as the onset of the rainy season, and they use celestial bodies for direction finding. Also, many people use the position of celestial bodies for divination to predict human events, actions, and suggest possible futures like astrology.

> *"I have been working with an applied astronomy knowledge theory: similar to how people have adapted to living in certain terrains, they have adapted to their sky."*

Doing Ethnoastronomy Research

What skills are needed to do ethnoastronomy research? Starting with astronomy, a working knowledge of the night sky is the most important [12]. Ethnoastronomy depends upon collecting the names of local celestial bodies and asterisms, however these need to be mapped onto a star chart. Knowing the Western names makes this mapping easier. The simple act of identifying what a person is pointing to in the sky takes practice. It helps to know how to use hands and fingers to measure distances on the sky. Knowing which constellations and planets are visible during certain part of the year is important. This aids in correlating the appearance and disappearance of celestial bodies to local seasonal climate changes. Collecting celestial

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stories and their meanings is difficult when working in another language, the researcher must learn the language or work with a translator. It is most important to read as much as possible about the people and culture before beginning fieldwork especially studies done by anthropologist. In general, working in another culture is challenging and any cross-cultural training is helpful.

There are two academic graduate programs in the United Kingdom that provide training in archaeoastronomy and ethnoastronomy research. The Sophia Centre for the Study of Cosmology in Culture at the University of Wales Lampeter offers a master's in cultural astronomy and astrology as well as a doctorate. The Department of Archeology and Ancient History at Leicester University offers doctorates that can include training and research in archaeoastronomy. Many undergraduate classes are taught in astronomy departments in the United States, though no degree program exists. Serious students tend to learn from working directly with ethnoastronomers rather than through classes and degree programs. Nonetheless, undergraduate courses that will be useful to future ethnoastronomers are introduction to cultural anthropology, qualitative research methods, anthropology of religion, introduction to folklore, introduction to astronomy, history of astronomy, and astronomy laboratory.

"The simple act of identifying what a person is pointing to in the sky takes practice. It helps to know how to use hands and fingers to measure distances on the sky."

A Selection of Current Projects

Ethnoastronomy research peaked in the early 1980s, but continues at a steady rate albeit with less than ten projects running a year. In general, qualitative research takes more time to both collect data and for analysis, thus the average time period for a project is six to seven years. The three projects below are collaborations including Africans, African Americans, astronomers, and non-astronomers. They are exploratory in that they are discovering new aspects of people's relationship to the sky, but also show different research agendas and data collection methods. Yet, all these fall under the umbrella of ethnoastronomy research.

The Astronomy of the Bamana of Mali[1]

This is a collaborative research project that combines ethnoastronomy research methods with the performance arts to study the indigenous astronomy of the Bamana people of Mali. The Bamana are neighbors to and linguistically related (Mande ore Mende) to the Dogon. The Bamana (Bambara) people were chosen because of the astronomy knowledge traditionally held by the members of their Tyiwara (Chiwara, Ci Wara) agricultural society and the Komo men's society. The Komo society is an initiation society formed for blacksmiths [13] but includes priests and elders. Their duty is to protect the Bamana from harm, both physical and spiritual, and maintain a harmonious community. The recorded indigenous astronomy of the Bamana is embedded in the works of many anthropologist, historians, and art historians who conducted their field research during the 1950s to the mid-1970s. Since then, no scholars have undertaken the task of analyzing if their indigenous astronomy remains intact or the ways in which it has been modified over the last thirty-some years. The Komo have symbolic writing and with their writing have recorded key astronomy concepts important to their society [14]. Their writing has several hundred symbols and when they are laid out in their correct pattern, they represent the Milky Way. The Tyiwara are experts on the seasonal cycles and the celestial mechanics of the earth-sun system [15, 16]. The Tyiwara society has a complex knowledge of the annual motions of the Sun and its relationship to the seasons, which is important for agriculture. Knowledge of the Bamana calendar has been reported in Bamana society, in general, and is not secret knowledge. The Bamana have ritual, agricultural, and ceremonial calendars based on observations of the sun, moon, and stars, and a fourth calendar based on sacred numbers. There has been little research on Bamana women and their sky knowledge. The goals of the project are to document the current indigenous astronomy of the Bamana people of Mali, to compare their astronomy today with that recorded on film and in the

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National Analysis of Minority S&E Faculty... (cont'd)

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with a request that they report any desired changes, and requested changes were made. Details of our methodology are given in a separate section at the end of the [full] report.

I. Disparity Between Representations of URMs in Academia versus U.S. Population

A Person Like Me

Although the representation of Blacks, Hispanics, and Native Americans in the 2006 U.S. population was estimated [6] to be 12.8%, 14.8%, and 1.1%, respectively, their representation at almost each point in academia is lower. If the URM representation among U.S. professors is noticeably less than in the general population, especially at higher levels in academia, this can influence URM students' self-esteem [7] and the evaluation which URMs make of their own likelihood to receive appropriate rewards and reach higher levels in academia.[8]

Our data (see Appendix of full report) reveal that few science and engineering departments have more than a single URM faculty member. As a result, minority faculty can feel isolated or marginalized, and attempts at change made by URMs can make little or no difference.[9] Some URM faculty have reported being overwhelmed with advising numerous minority student organizations and token assignments on multiple committees.[10] Some minority professors cite a hostile working environment as their biggest job-related concern. [10] It has been reported that negative office politics can have more detrimental impacts than outright acts of discrimination.[10] Students sample this environment while pursuing their degrees; if URM students' mentors and role models are struggling instead of thriving, then URM students perceive that they will struggle similarly if they continue to those same levels in academia.[8]

Glacial URM Faculty and Promotion Increases

As seen in Table 1, the few minority faculty members present in academia are usually concentrated in the lower ranks, chiefly as assistant professors. For example, in sociology all URMs combined represent 19.2% of assistant professors (newest hires), 11.1% of associate professors, and 10.8% of "full" professors in FY2007. In only 3 of the 15 disciplines surveyed in FY2007 are the majority of URM faculty at the rank of associate professor. In no discipline surveyed was the highest percentage of URMs at the rank of "full" professor. The opposite is true for White males.

Consequently, a relatively large proportion of minority faculty members lack tenure. Without job security or a critical mass, most minority faculty members lack the capability or leverage to change the environment greatly within their discipline.[10] Many URM faculty feel they have worked too hard to reach their current position to risk losing their job, no matter how alienating or unfavorable their environment.[11] Tenure is given and denied by other faculty members,

Table 1. URM Professors (Black, Hispanic, Native American) by Rank and Year at the Top 50

Discipline	FY2002*				FY2007			
	Assistant	Associate	Full	All Ranks	Assistant	Associate	Full	All Ranks
Chemistry	2.8%	7.5%	2.3%	3.2%	4.7%	5.4%	3.0%	3.7%
Math	6.0%	4.6%	3.0%	3.6%	2.3%	2.7%	2.2%	2.3%
Computer Science	2.1%	1.7%	1.3%	1.6%	3.1%	2.9%	1.9%	2.5%
Astronomy**	5.5%	4.0%	1.6%	2.5%	3.3%	2.1%	2.0%	2.2%
Physics	5.2%	2.8%	2.0%	2.6%	4.4%	2.2%	2.0%	2.5%
Chemical Eng.	3.4%	8.2%	4.2%	4.9%	7.7%	6.8%	4.7%	5.6%
Civil Eng.	9.3%	4.8%	3.9%	5.4%	10.5%	8.0%	4.4%	6.6%
Electrical Eng.	5.4%	8.2%	2.2%	4.3%	4.3%	4.6%	3.0%	3.6%
Mechanical Eng.	7.0%	5.4%	2.4%	3.9%	8.1%	5.3%	2.8%	4.3%
Economics	6.6%	4.4%	3.4%	4.3%	10.9%	5.7%	3.7%	5.7%
Political Science	8.0%	9.8%	4.5%	6.9%	8.3%	8.3%	5.4%	6.9%
Sociology	14.8%	12.4%	6.6%	10.1%	19.2%	11.1%	10.8%	12.9%
Psychology	12.0%	9.4%	3.1%	6.3%	12.5%	8.0%	4.5%	7.1%
Biological Sciences	5.7%	3.0%	2.1%	3.0%	6.5%	4.4%	2.5%	3.8%
Earth Sciences	not available				5.4%	5.4%	2.0%	3.4%

*Chemistry and astronomy data are for FY2003. **Top 40 departments in FY2007

Table 2. Percentage of Ph.D.s Earned, by Race and Decade, in Science and Engineering Disciplines

Discipline	Black		Hispanic		Native		Asian		Female		White Male	
	1986-1995	1996-2005	1986-1995	1996-2005	1986-1995	1996-2005	1986-1995	1996-2005	1986-1995	1996-2005	1986-1995	1996-2005
Chemistry	1.7	3.5	3.2	3.4	0.4	0.6	11.4	12.8	26.3	32.4	62.6	55.3
Math	1.5	2.5	2.3	3.3	0.2	0.3	13.9	12.4	22.5	28.7	64.1	58.7
Computer Science	1.1	3.2	1.5	2.9	0.3	0.5	16.7	19.0	19.8	21.2	64.2	59.9
Astronomy	0.7	0.9	2.1	2.8	0.3	0.4	5.9	7.2	15.2	22.7	77.9	68.6
Physics	1.0	2.0	2.5	2.9	0.2	0.3	13.6	13.2	10.8	14.3	75.0	70.8
Chemical Eng.	1.8	3.2	2.5	3.9	0.3	0.6	18.1	17.9	17.1	23.7	64.4	58.5
Civil Eng.	2.3	3.3	3.7	4.4	0.3	0.5	17.9	16.5	12.7	22.0	65.6	58.6
Electrical Eng.	1.9	3.8	2.2	3.7	0.2	0.4	25.2	26.2	8.6	12.3	64.8	59.1
Mechanical Eng.	1.3	1.5	1.8	1.9	0.2	0.3	23.1	24.5	7.3	8.4	68.2	66.0
Economics	4.0	3.9	2.6	4.3	0.2	0.2	10.1	13.6	25.7	30.2	61.4	55.1
Political Science	7.5	8.0	3.3	4.0	0.3	0.7	5.1	5.2	32.8	38.9	55.3	51.0
Sociology	6.8	9.5	4.8	5.9	0.6	1.0	6.1	6.6	53.4	60.8	37.2	29.9
Psychology	3.9	5.8	3.9	6.3	0.5	0.8	2.3	4.3	59.1	67.8	37.0	27.5
Biological Sciences	1.8	3.0	2.7	4.2	0.3	0.6	9.8	14.7	39.6	46.3	51.9	42.2
Earth Sciences	0.2*	1.4	1.9*	3.4	-*	0.7	18.6*	7.4	22.5*	31.8	62.1*	59.5

*Data are for 1995 only.

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giving untenured faculty little incentive to challenge the status quo.[11]

The slow promotion rate of URM faculty has significant consequences. It results in consistently low numbers of tenured minority faculty members, and therefore it impedes progress in improving the environment of minority faculty members.[10] Moreover, only 5 of the 9 engineering and physical sciences disciplines increased their representations of URM professors from FY2002 [12] to FY2007.

II. Increase in URM Ph.D. Recipients

Between the years 1986-1995 and 1996-2005, the percentage of Ph.D. recipients who are URMs increased by about 2.5%, a growth rate below that of females (5.9%). This increase in representation among Ph.D. recipients is much less than the 7% increase in URM representation in the U.S. population from 1980-2000 (18.8 % to 25.9%).[2] Most of this 7% increase can be attributed to a rise in the Hispanic population (from 6.4% to 12.6%).[2]

The cause of this slow growth in Ph.D. attainment is only partly revealed by comparing the representation of URMs among B.S. recipients in 2000 versus Ph.D. recipients in 2005 (Table 3). On average, URM representation in Ph.D. attainment drops from that in B.S. attainment by a factor of 2 to 3. This trend suggests that more efforts and programs should be directed at strengthening the pipeline at this transition. In none of the disciplines surveyed was the representation of URMs among Ph.D. recipients larger than among B.S. recipients.

Table 3. URMs Among Degree Recipients and All Professors

Discipline	B.S. 2000	B.S. 2005	Ph.D. 2005	Top 50 Faculty FY2002	Top 50 Faculty FY2007
Chemistry	17.0%	16.7%	8.5%	3.2%	3.7%
Math	14.4%	13.1%	9.1%	3.6%	2.3%
Computer Sci	17.6%	20.6%	6.5%	1.6%	2.5%
Astronomy	6.4%	8.6%	4.5%	2.4%	2.2%
Physics	9.5%	10.3%	5.6%	2.6%	2.5%
Chemical Engr	14.2%	14.7%	11.0%	4.9%	5.6%
Civil Engr	14.0%	14.3%	8.2%	5.4%	6.6%
Electrical Engr	15.8%	16.1%	9.5%	4.3%	3.6%
Mechanical Engr	12.5%	11.5%	8.9%	3.9%	4.3%
Economics	12.4%	13.1%	10.7%	4.3%	5.7%
Political Science	20.1%	20.8%	13.9%	6.9%	6.9%
Sociology	27.0%	28.7%	19.2%	10.1%	12.9%
Psychology	20.1%	21.6%	13.4%	6.3%	7.1%
Biological Sci	15.5%	16.5%	9.6%	3.0%	3.8%
Earth Sciences	5.4%	6.6%	6.7%	na	3.4%

III. URMs Among Ph.D. Recipients (Hiring Pool) vs. Assistant Professors (Recent Hires)

Comparing representations of URMs, shows a disparity between their representations among 1996 – 2005 Ph.D. recipients (the hiring pool) versus FY2007 assistant professors (faculty most recently hired) at the top 100 departments of most disciplines (Table 4). Sociology is a noteworthy exception to this, with a

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Ethnoastronomy: Pondering Celestial Diversity (cont'd)

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literature, to analyze the ways in which the Bamana encode astronomy principles into cultural practices, beliefs, and everyday activities; to utilize those astronomy principles revealed in current practices to illuminate pre-colonial practices that perhaps went undetected or unanalyzed, and to determine how the Bamana learn about the sky and if they are transmitting their knowledge to the next generation.

The Swahili Trade Networks[2]

Archaeological evidence shows that the Swahili people of East Africa have long been participants in the Indian Ocean Monsoon trade network. Trade goods indicate a circulation from Southeast Asia to the coast of East Africa [17-19]. Focusing on the fishing communities and archaeological sites of Zanzibar, Mafia, and Kilwa, this project explores Swahili navigation methods, maritime livelihood activities, and technological interventions as a means of understanding the Swahili contributions to current and historical trade network throughout the Indian Ocean. The project includes excavations, participant observation, questionnaires, interviews, and archival research. Combining what we learn about the Swahili today with the evidence of the past enables us to understand the Swahili's role in the creation and maintenance of the Indian Ocean trade network. Ibn Majid documented the navigational methods of the 1400s that made such a large trade network possible. In 2004, it was found that some of these same methods are known to the Swahili fishermen of coastal Tanzania today. Through direct comparison with Ibn Majid's treatise, we are marking the evolution of the Swahili navigational methods and the effect of new innovations in navigation and how these impact their trading. The following hypothesis about the interplay

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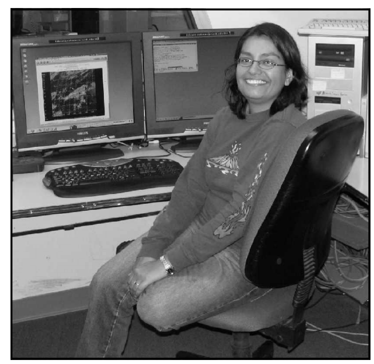
Meet Claudia Knez at U. Maryland

By Keivan G. Stassun



Claudia Knez was born in Guadalajara, Mexico. There she attended a bilingual school, the American School Foundation of Guadalajara. She was always interested in science and math, and in 4th grade the back-up crew to the *Challenger* visited Guadalajara. Her mother Celina, as a teacher at the school, procured many images and posters from NASA and gave them to her science loving daughter. From that point on Claudia's fascination with space grew. She decided she was going to be an astronaut.

When Claudia was 12, she moved from the second largest city in Mexico to rural Virginia. This transition was a difficult one for several reasons. First, there was an obvious culture change both in the sense of two different countries and the contrast between big city and rural living. This difficulty was further compounded by the problems associated with trying to fit in with a relatively closed social group of teenagers. The first challenge arose when the principal at the middle school wanted to place Claudia in 6th grade even though she had completed 6th grade math, reading and language arts. Her mother would not accept that and pushed for her to be placed in 7th grade (with kids her own age). She proved her mettle by winning the Spelling Bee in both 7th and 8th grades and representing Middlesex County at the state competition.

Ignorance about other countries including Mexico was rampant in Claudia's new environment. One time on the school bus, a kid with snot dripping from his nose asked Claudia, "Did you ride donkeys in Mexico?" Since in her vacations in the mountains she had ridden a donkey, she was not sure exactly what the boy meant. He clarified that he wondered whether Mexicans had cars or whether they used donkeys as transportation. Such sentiments were additionally ironic since the county had only 1 traffic light and the closest entertainment (e.g., a movie theater, bowling alley, or even shopping center, etc.) was at least 30 miles away.

In high school, she continued pursuing her love for science and math. When she was a senior, she enrolled in physics at the community college (since the high school did not have a physics teacher). However, only one other person enrolled

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Meet Claudia Knez (cont'd)

and the community college cancelled the course. Despite complaining to the school board, the school was unable to offer physics that year. While Claudia did not have the opportunities of a larger school, she had support from her teachers. Her calculus teacher gave her after-school lessons to help prepare her for the AP exam since not all the material was going to be covered in class.

After high school, she went to the University of Virginia, where she received the University Achievement Award Scholarship. She majored in Astronomy and Physics, and she became involved in the Hispanic Society. As a member and officer in the organization, she helped organize leadership workshops and conferences. She helped organize and participated in a mentoring program for Hispanic/Latino students. The program was developed to support incoming students by pairing them with an upper class student in their area of interest.

She then attended the University of Texas at Austin for graduate school. There she was part of a large incoming class (17 students) of which two-thirds were women. This was very strange for her since the percentage of women in her undergraduate science classes had generally been much lower.

In 2002, Claudia, along with fellow graduate student Amy Forestell, attended the conference on "The Status of Women in Astronomy" in Pasadena. Claudia and Amy began to think of how the Department of Astronomy could be improved, especially since the grad student population was ~50% female. They realized that the departmental colloquium speakers were predominantly male and decided that was one easy way to improve the visibility of women in astronomy. First, they made sure that more women speakers were invited to the department. When women speakers came to visit, Claudia and Amy organized informal discussions with the speakers to talk about their careers. Additionally, Claudia and Amy along with two professors, Harriet Dinerstein and Neal Evans, presented a departmental colloquium outlining the statistics learned at the conference along with suggestions on how the department could improve the number of women especially at the professorial level.

At the conference in Pasadena, Claudia also became more aware of the extremely low numbers of minorities in astronomy during Keivan Stassun's presentation. In 2004, the AAS CSMA announced a conference sponsored by the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) to be held in Austin. Since it was in her current home town, she could not pass up the opportunity. She attended and met Marcel Agüeros and Kevin Covey, graduate students at the University of Washington. There she learned about their efforts and decided to do something at her own institution. She organized a group of students and faculty dedicated to improving diversity of astronomy students. In an effort to join forces with other departments, Claudia gave a presentation to the graduate coordinators in the College of Natural Sciences. This was organized through the Dean's office. In 2005-2006, she received the Fred T. Goetting Jr. Presidential Scholarship for her service to the department. In 2007, partially as a result of Claudia's efforts, the Department of Astronomy at the University of Texas received an award from the College of Natural Sciences in recognition of the efforts to improve diversity.

In 2005, she was invited back to her alma mater Middlesex High School as the Commencement speaker. She was very honored to be invited especially since this had been an honor reserved for older adults with more life experience. It was an interesting experience since she personally knew several of the new graduates, having babysat them when she was in high school.

At the University of Texas, Claudia worked with her co-advisers Neal Evans and John Lacy. She studies chemistry in star forming regions using infrared spectroscopy. She has been part of the *Cores to Disks* (*c2d*) Spitzer Legacy team led by Neal Evans. With Lacy, she has worked with the Texas Echelon Cross Echelle Spectrograph (TEXES). Her thesis work included TEXES data taken at the IRTF. She completed her PhD in 2006 and moved back to the East Coast.

Currently, Claudia Knez is a Postdoctoral Research Associate at the University of Maryland. There she continues to use Spitzer data to study the ice and dust composition of molecular clouds. She was recently awarded time on the Spitzer Space Telescope Infrared Spectrometer (IRS) to study the effects of star formation activity on cloud composition by using stars behind the clouds. She is also part of the *Gould's Belt* Spitzer Legacy team.

Reaching for the Stars at the University of Washington

By Cody Curtis, reprinted with permission from The Daily, University of Washington

Editor's Note: The Pre-Major in Astronomy Program at University of Washington was started by Professor Eric Agol and former UW graduate students Marcel Agueros, Kevin Covey, and Andrew West. For its first two years, the program was funded by the NSF Diversity Appraisal Fund and by the UW Astronomy Department; now Pre-MAP is supported by the NSF.

Brooding in star and moonlight is something people from all places and ages share.

Where we are and how we fit into the scheme of the universe is among our most basic curiosities and has given birth to one of our most ancient and important sciences: astronomy.

Nurturing this fascination with astronomy and other sciences is the goal of an innovative UW program called Pre-MAP (Pre-Major in Astronomy Program), now in its third year at UW.

Professor Eric Agol and several graduate students created Pre-MAP in 2005, and Agol continues to supervise the program.

"We're trying to increase the diversity of astronomy, with the goal of increasing the pool of scientists both in astronomy and other sciences," Agol said.

Traditionally underrepresented groups in higher education (women, ethnic minorities, and those from poorer socioeconomic backgrounds) are becoming more prevalent in the college setting, according to the U.S. Census Bureau Web site.

However, enrollment in STEM (science, technology, engineering, mathematics) disciplines is still predominantly white males with a wealthy background, Agol said.

"We're going to have to recruit from a wider variety of backgrounds," he said. "White males represent a decreasing potion of our population. … More minorities and women will need to be attracted to the sciences for science to continue to advance."

As a student, Agol came from a poorer family than his coevals and believes that diverse classrooms make for better learning environments.

"Diverse settings have proven to be more creative and get more done than homogenous ones," Agol said. "[Diversity] will make others feel more comfortable in science."

According to the American Council on Education, 46 percent of students who intend to obtain a degree in a STEM field finish in a STEM field. Twenty-seven percent of underrepresented students who intend to obtain a STEM degree do so.

"Undergraduate classes don't grab them," said Nick Cowan, a TA and recruiter for Pre-MAP. "We take math and science and make it look good."

The reason many students don't take science courses or don't continue with a science-oriented academic path is that they perceive it as being too difficult and can't imagine a career in science, he said.

Pre-MAP offers an alternative approach to science education with smaller classes and a more hands-on curriculum. Program recruiters attract underrepresented students through e-mail and other promotional campaigns. In fact, all but one of the students in Pre-MAP this year said they wouldn't have known about the program without these recruitment efforts.

Students who take Pre-MAP are placed as a group into Astronomy 102 and Astronomy 192 concurrently. In Astronomy 102, students learn the theories of astronomy while applying them to research projects in the seminar class, Astronomy 192.

Pre-MAP gives its students the unique experience of doing research early in their academic careers, allowing them to taste what professional science entails.

The research is not just for practice; the goal with each project is to eventually have the research published. Each project is taken on by a pair of students with guidance from faculty and graduate students. This gives students the opportunity to learn astronomical principles, math skills and technical skills (i.e. computer programming) through one-on-one mentorship.

"Starting off with research is a great way to learn about what science really is," said Oliver Fra-

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Graduate Assistant in Astronomy and Mentor in the Pre-MAP program, Mark Claire, shows Pre-MAP students, freshman Samir Rajani (left) and sophomore Ivan Huang (center), how to check data from a light curve. Photo by Jennifer Au.

(Continued from page 14)

ser, a graduate student who helps in the Pre-MAP classroom.

He said the best way to get students interested in astronomy is to expose them to its "intrinsic coolness."

Last year, Pre-MAP students Amy Rose, Amber Almy, Kenza Arraki, AJ Singh and Kathryn Smith discovered 1,300 new asteroids in our solar system that obscured their view of supernovae.

This year, there are eight Pre-MAP students working on four projects: Edward Charles and Monica Huang (searching for eclipsing binaries); Jeanne McKeever and Deborah Tugaga (variable stars and planetary nebula); Samir Rajani and Ivan Huang (searching for hot jupiters); and Joel Leigh and Lauren Pope (merging supermassive blackholes).

Pre-MAP students also have the opportunity to familiarize themselves with cutting-edge technology such as the Apache Telescope in New Mexico, where most of their data comes from.

The class will take a field trip later in the year to see the LIGO (Laser Interferometer Gravitational-Wave Observatory) facility in eastern Washington.

"I love Pre-MAP," said McKeever, who has hopes of becoming a researcher and professor of astronomy. "It's an excellent way to get right into research."

Like a number of current and former Pre-MAP students, McKeever plans to use her research experience in Pre-MAP to get jobs in the lab throughout her undergraduate studies.

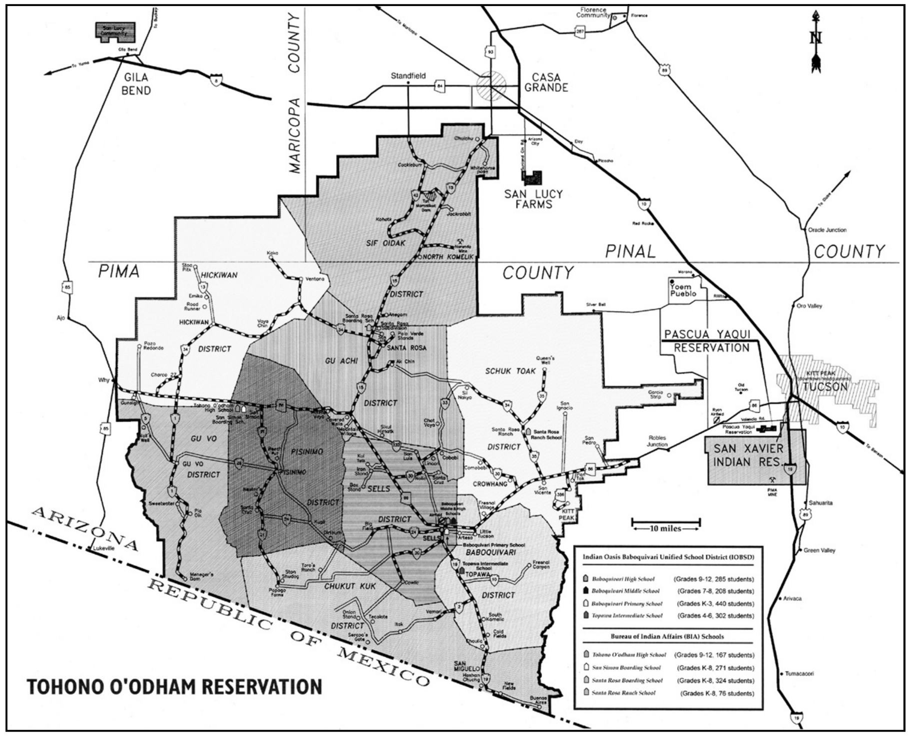
Pre-MAP gives students a unique opportunity to expand their curiosities about astronomy and get an inside look at professional science.

"'Why is the sky blue?' is a good place to start," Pope said. "And then what happens when galaxies collide."

Cody Curtis *is a freshman at the University of Washington.*

New Partnerships: Tohono O'odham and KPNO (cont'd)

(Continued from page 3)



but I learned that illegal border crossers and drug runners make this too dangerous for many of my students. However, Kitt Peak is our class's observing site, and enrollment in this class has grown rapidly. The college has also chosen to use photos taken at Kitt Peak observatory (of both students and tribal elders) as part of its new fundraising campaign.

When asked by my students about the number of Native American astronomers, I'm disappointed to admit that the number is impossibly small. But there are signs of progress (with a PhD candidate student at Indiana University who is Navajo, as one) and some new ideas are emerging.

Recently, Kitt Peak observatory staff were approached by the Sells school district representing grades K-12 with a proposal to help them with a good-attendance initiative. These schools are suffering, particularly in this era of high-stakes school testing, because their attendance figures are very poor. As their superintendent points out "If you don't come to school, you can't learn." Their incentive program, which they titled "Reach for the Stars," is a multi-pronged effort—among other components, it will bring many students to Kitt Peak for an evening program this year. Perhaps a future O'odham astronomer will be among them.

There is also an effort developing to highlight Native American stories and cultural traditions related to the sky as part of emerging plans for the International Year of Astronomy, led by Dennis Lamenti (the aforementioned IU student).

But back to my initial question: I've found that members of the O'odham nation are intrigued when I point out that while the average American has never heard of the Tohono O'odham Nation, I believe practically all astronomers have! But is that correct? I may conduct a poll at the next AAS meeting.

A star party at Al Jek recreation Center, located about 150 meters from the US- Mexican border on the SW corner of the Tohono O'odham reservation.

Ethnoastronomy: Pondering Celestial Diversity (cont'd)

(Continued from page 12)

between navigation, trade, and new technologies are being tested: 1) Navigation by the stars survives because it requires minimal or no equipment, is inexpensive, and exact enough for the fishermen's needs. 2) Modern navigation aids are not attractive because they are delicate, require space, need to be maintained, are expensive, are used in conjunction with nautical charts, conflict with the self-image of the navigator, hard to acquire, and/or are overkill for the range in which the fishermen navigate. Hypothesis about their navigation by the stars: 3) The fishermen use a variety of techniques of which navigation by the stars is one. 4) Navigation by the stars should continue to be used because of some combination of unknown factors and known factors such as cost, availability, efficiency, professional self-image, and simplicity. Current project goals are to continue to interview Swahili fishermen about their trade networks and their sky knowledge especially how sky knowledge relates to navigation; to assess what has changed over the centuries in terms of both the trade networks and navigation techniques, to examine the role of introduced navigational aids, to gather demographic information, especially education information for the fishermen, to search Arabic text archives of Tanzania for more information about Swahili navigation and their historical trade networks.

> *"The primary goal of this project is to develop avenues of influence for positively impacting the career development of underrepresented minorities and women."*

Culture for Astronomy – An Innovation in Diversifying the Global STEM Pipeline[3]

This project is under development and directly addresses the issue of diversity in astronomy. The primary goal of this project is to develop avenues of influence for positively impacting the career development of underrepresented minorities and women. Members of the traditionally disenfranchised groups of the US (e.g. African- and Native-Americans), members of America's territories and former colonies (e.g. Puerto Rico & the Philippines), Latinos, and women today continue to be underrepresented in the fields of physics and astronomy relative to their percentage of the US population. African-, Native-, and Latino-Americans comprise ~25% of the US population but only ~2.5% of all astronomers and only ~2.5% of physicists in the top 50 physics departments. This pattern of under-representation has remained constant for the last 25 years and was far worse previously. While the under representation of women in astronomy has improved over recent years, currently only ~20% of astronomy Ph.D. recipients, postdocs, assistant professors, and associate professors of astronomy are women. And only ~10% of full professors of astronomy are women. But, the number African American astronomers continues to lag far behind women. The target population of this project is African American and African students, but will also include other ethnic groups that make up the introductory astronomy classes at all the partner universities. Working with the astronomy instructors, each class will be surveyed at the beginning and the end of the course about their attitudes towards astronomy and their perceived ability to do astronomy. The introductory astronomy classes will have varying amounts of indigenous African astronomy content. One thesis it will test is if young African-Americans will change attitudes towards astronomy if they view astronomy as part of their heritage. At the time of this writing, new teaching modules including information about minority astronomers and ethnoastronomy are being created for the instructors. My favorite ethnoastronomy example to teach is indigenous calendars from around the world. Faced with the issue of creating an accurate calendar, people were ingenious in combing observations of the sky with observations of animal behavior, annual floods, and plant cycles to establish a local calendar that worked [20-28]. To explore this topic, students need to understand the cycles of the sun, moon, and planets; need to understand relationship between latitude and these cycles; they need information about the local

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Ethnoastronomy: Pondering Celestial Diversity (cont'd)

(Continued from page 17)

climate and environment; they need to know something about the local culture; and they need to know basic mathematics. At the time of this writing also, links are being established with introductory astronomy professors at Historically Black Colleges and Universities and Universities in Africa to participate in this project.

Concluding Remarks

Ethnoastronomy has been around for a long time with scholars collecting celestial terms around the world and suggesting various unifying themes [29, 30]. With training in ethnoastronomy theories and methods and by becoming familiar with ethnoastronomy case studies, a new scholar can contribute significant research. The danger of doing ethnoastronomy research is in assigning importance and meanings from an outsider position rather than learning from insiders. It is tempting for astronomers to visit another culture with a list of astronomy facts that they will test for to see 'what the people got right'. The result is a disconnect list of rights and wrongs from which they build ungrounded theories like the technologically advanced cultures - astronomy theory mentioned above. The human story and local context are lost in the subconscious or conscious effort to prove that Western astronomy is superior or right.

Can astronomers learn something from these other ways of viewing the heavens? Ethnoastronomy explores the diversity of ways that people view the heavens as a clear example of how people around the world making sense of their physical environment and adapt to their environment. Ethnoastronomy shows the ways that astronomy is culturally imbedded. It shows how the same stimulus, the night sky, has resulted in inspiring art, songs, dances, and stories that are culturally and locally unique. It shows that astronomy knowledge reaches beyond the world of astronomers even in Western culture into science fiction books and films. Ethnoastronomy brings diversity to astronomy in that the astronomy knowledge of people of color, women, and non-scientists are included.

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National Analysis of Minority S&E Faculty... (cont'd)

Table 4. Racial Distribution of Ph.D.s (1996-2005) versus Assistant Professors (FY2007)

Discipline	Black			Hispanic			Native American		
	% Ph.D.s	% Asst. Profs.		% Ph.D.s	% Asst. Profs.		% Ph.D.s	% Asst. Profs.	
		Top 100	Top 50		Top 100	Top 50		Top 100	Top 50
Chemistry	3.5%	3.4%	2.0%	3.4%	2.8%	2.7%	0.6%	0.4%	-
Math	2.5%	2.3%	1.4%	3.3%	2.4%	0.9%	0.3%	0.3%	-
Computer Science	3.2%	1.8%	1.3%	2.9%	1.8%	1.8%	0.5%	-	-
Astronomy	0.9%	-	-	2.8%	3.3%	3.3%	0.4%	-	-
Physics	2.0%	1.2%	1.6%	2.9%	3.3%	2.7%	0.3%	-	-
Chemical Eng.	3.2%	2.3%	3.0%	3.9%	4.6%	4.7%	0.6%	0.8%	-
Civil Eng.	3.3%	3.2%	3.2%	4.4%	5.9%	7.2%	0.5%	-	-
Electrical Eng.	3.8%	1.9%	2.3%	3.7%	1.6%	1.8%	0.4%	0.1%	0.2%
Mechanical Eng.	1.5%	3.0%	3.4%	1.9%	3.7%	4.7%	0.3%	0.2%	-
Economics	3.9%	1.7%	1.9%	4.3%	8.9%	8.9%	0.2%	-	-
Political Science	8.0%	5.6%	3.6%	4.0%	5.2%	4.7%	0.7%	0.5%	-
Sociology	9.5%	11.7%	12.0%	5.9%	7.6%	7.1%	1.0%	-	-
Psychology	5.8%	4.8%	5.8%	6.3%	5.1%	5.6%	0.8%	1.3%	1.1%
Biological	3.0%	1.8%	2.0%	4.2%	4.3%	4.3%	0.6%	0.1%	0.2%
Earth Sciences	1.4%	0.8%	1.0%	3.4%	3.8%	3.9%	0.7%	1.1%	0.5%

(Continued from page 11)

representation among assistant professors well above that among Ph.D. recipients for both Blacks (11.7% versus 9.5%) and Hispanics (7.6% versus 5.9%). However, in the engineering disciplines surveyed, the representation of URMs among assistant professors at the top 50 departments was generally comparable to or greater than among Ph.D. recipients. In chemistry, math, and computer science, the opposite was the case, with a representation of URMs at higher-ranked departments below that of lower-ranked ones. In most disciplines the representation of URMs decreases at higher professorial ranks (Table 1).

Other interesting differences among disciplines emerge from Table 4. Astronomy has no Black or Native American assistant professors. Among physical sciences, engineering, and social sciences disciplines, only electrical engineering reported Native American assistant professors in the top 50 departments, and only half of these disciplines have a Native American assistant professor in a lower-ranked department.

The above reveals two reasons for grouping the physical sciences and engineering disciplines as shown: chemistry, math, and computer science in one group, and engineering disciplines in another group, along with (marginally) astronomy and physics. These reasons are (1) the agreement between URM representations among Ph.D. recipients versus assistant professors and (2) the different distributions of URMs among the top 50 departments versus the top 100 departments.

IV. URMs Among B.S. recipients (Mentees) versus Faculty (Mentors and Role Models)

Perpetuating a Cycle

Demographics of a faculty impact the ethnic composition of the student population.[14] Dearth of minority faculty at a university or in a discipline discourages minority students from selecting that university or discipline, since most students are comfortable in environments that include people with backgrounds and characteristics similar to theirs.[14] In addition, a university's lack of minority faculty has an adverse effect on the success of its minority students. Without professors of similar backgrounds to mentor them, many URM students feel alienated and unsupported.[15]

Our data reveal that the disparity between faculty versus student body racial / ethnic compositions is increasing. There is concern that commitment to URM students has eroded [16] and that URM undergraduate enrollments are dropping in science and engineering.[17] Nevertheless, overall URM representation at the undergraduate level is still outpacing that of the faculty (Table 3). As a result, faculty who mentor and advise URM under-

(Continued on page 20)

National Analysis of Minority S&E Faculty... (cont'd)

Table 5. Racial Distribution of B.S. Recipients (2005) versus Faculty (FY 2007)

Discipline	Black			Hispanic			Native American		
	% B.S. Degrees	% Faculty Top 100	% Faculty Top 50	% B.S. Degrees	% Faculty Top 100	% Faculty Top 50	% B.S. Degrees	% Faculty Top 100	% Faculty Top 50
Chemistry	8.3%	1.5%	1.3%	7.7%	2.1%	2.2%	0.7%	0.3%	0.2%
Math	6.4%	1.5%	0.9%	6.1%	1.7%	1.3%	0.6%	0.1%	0.0%
Computer Science	12.5%	0.9%	0.7%	7.5%	1.8%	1.8%	0.6%	0.0%	-
Astronomy	1.4%	1.0%	1.0%	6.1%	1.2%	1.2%	1.1%	-	-
Physics	4.5%	0.7%	0.8%	4.9%	1.8%	1.6%	0.9%	0.1%	0.0%
Chemical Eng.	6.3%	2.1%	2.3%	7.7%	3.3%	3.2%	0.7%	0.2%	0.1%
Civil Eng.	3.8%	1.8%	1.8%	9.8%	4.3%	4.7%	0.8%	-	-
Electrical Eng.	7.3%	1.7%	2.1%	8.4%	1.7%	1.5%	0.5%	0.0%	0.0%
Mechanical Eng.	3.9%	1.9%	2.0%	7.1%	2.0%	2.3%	0.5%	0.1%	0.1%
Economics	6.4%	1.8%	1.7%	6.3%	4.0%	4.0%	0.4%	0.1%	0.1%
Political Science	10.3%	4.2%	4.1%	9.7%	2.9%	2.7%	0.7%	0.2%	0.1%
Sociology	17.0%	7.9%	7.9%	10.7%	5.2%	4.7%	1.0%	0.4%	0.2%
Psychology	11.4%	3.4%	3.1%	9.5%	3.1%	3.6%	0.7%	0.4%	0.4%
Biological	8.0%	1.4%	1.2%	7.6%	2.5%	2.4%	0.8%	0.2%	0.2%
Earth Sciences	1.8%	0.9%	1.1%	4.1%	2.3%	2.1%	0.7%	0.4%	0.2%

(Continued from page 19)

graduates are predominantly White male professors. For example, in psychology, White males received 16.3% of B.S. degrees in 2005 and 27.5% of the 1996–2005 Ph.D.s, but constituted 56.8% of the faculty in FY2007 (Table 14 of full report). In the same field, URMs received 21.6% of the 2005 B.S. degrees and 12.9% of the 1996–2005 Ph.D.s, but only constituted 6.9% of the top 100 FY2007 faculty (Table 5). Thus, the imbalance is present at both undergraduate and graduate levels. Also, URMs in computer science received 20.6% of the 2005 B.S. degrees, 6.6% of the Ph.D.s between the years of 1996-2005, but only comprise 2.8% of the top 100 faculty in FY2007 (Table 7 of full report).

The quantity and quality of interactions between same-race and same-gender faculty and graduate students are reported to be higher and more closely related to the future success of those students.[18] Non-minority students are also impacted by the absence of minority faculty.[14] They are deprived of an education diverse in thoughts and ideas that results from a faculty diverse in background and culture.[14] A university's lack of minority faculty sends a message to its students that minorities have no place in academia, thereby perpetuating a cycle of marginalization and discrimination.[14]

Thus, the presence of science and engineering minority faculty is a crucial factor in encouraging and ensuring the continued interest of young minorities in science and engineering. Their presence is equally important to ensure that (1) current minority students, who are majoring in the fields of science and engineering, graduate and (2) some of those students become professors themselves, thus serving as mentors and as successful examples to future generations of minorities.

V. Analysis of Data for Underrepresented Groups

Blacks

In only four disciplines (chemical engineering, 2.1%; political science, 4.2%; sociology, 7.9%; psychology, 3.4%), did Blacks constitute over 2% of FY2007 professors at top 100 departments.

Upon omitting the lower-ranked 50 departments, representation of Blacks among all professors generally increased for engineering disciplines and decreased for chemistry, math, and computer science. Sociology had the highest percentage of Blacks among faculty and degree recipients.

The representation of Blacks among all professors versus among recent B.S. recipients, a measure of same-race mentors and role models, is generally more disparate in chemistry, computer science, math, and life sciences. The change in B.S. recipients from 2004 to 2005 ranged from a 0.5% drop (chemistry) to a 0.4% increase (sociology and psychology). Blacks in astronomy received a much lower percentage of B.S. degrees (1.4%) than Hispanics (6.1%), almost at the level of Native Americans (1.1%). Following a general trend for URMs

Table 6. Blacks in the Academic Pipeline, Selected Fields*

Discipline	Students				Departments 1-100 FY2007			
	BS2004	BS2005	PhD86-95	PhD96-05	asst	assoc	prof	all
Astronomy**	1.1%	1.4%	0.7%	0.9%	0.0%	2.1%	1.0%	1.0%
Physics	4.5%	4.5%	1.0%	2.0%	1.2%	0.6%	0.5%	0.7%
Earth Sciences	1.8%	1.8%	0.2%***	1.4%	0.8%	1.5%	0.7%	0.9%

*Full report has 15 fields; blacks were 12.8% of the 2006 US population. **The top 40 departments ***1995 data only

Table 7. All URM Groups Combined in the Academic Pipeline, Selected Fields*

Discipline	Students				Departments 1-100 FY2007			
	BS2004	BS2005	PhD86-95	PhD96-05	asst	assoc	prof	all
Astronomy**	10.2%	8.6%	3.1%	4.1%	3.3%	2.1%	2.0%	2.2%
Physics	10.0%	10.3%	3.7%	5.2%	4.5%	3.0%	1.9%	2.5%
Earth Sciences	6.2%	6.6%	2.1%***	5.5%	5.7%	5.4%	2.4%	3.7%

*Full report has 15 fields; URMs were 28.0% of the 2006 US population. **The top 40 departments ***1995 data only

(Continued from page 20)

(Table 7), there is a dramatic decrease between the representations of Blacks among B.S. recipients versus Ph.D. recipients in all disciplines.

Comparing Blacks among assistant professors versus recent Ph.D. recipients of top 50 engineering disciplines gives a better match than by using the second tier of departments; the reverse is true in chemistry, math, and computer science. Contrasting the past two decades of Ph.D. recipients, the representation of Blacks has increased in all disciplines except economics, where there was a marginal decrease.

Hispanics

Hispanics generally are the largest segment of URM professors (Tables 8 versus 7) in physical sciences and engineering. In astronomy, physics, and engineering disciplines, the representation of Hispanics among top 100 assistant professors is generally higher than among recent Ph.D. recipients. The highest representation is not consistently at one professorial rank, but in the top 50 departments of chemistry and math, it is at associate professor, indicating a decline in hiring. In astronomy, all URM assistant professors but no associate professors are Hispanic.

Hispanics follow the general trend for URMs, showing a higher representation among B.S. recipients than Ph.D. recipients in all disciplines. Nevertheless, in the past two decades Hispanic representation among Ph.D. recipients has increased in all disciplines studied. Although this trend is encouraging, their representation at all points lags far behind their 14.8% of the total 2006 estimated U.S. population.

Native Americans

In this report, the category Native Americans includes Alaskan Natives, Native Hawaiians, and Pacific Islanders. Native Americans have the low-

(Continued on page 22)

Table 8. Hispanics in the Academic Pipeline, Selected Fields*

Discipline	Students				Departments 1-100 FY2007			
	BS2004	BS2005	PhD86-95	PhD96-05	asst	assoc	prof	all
Astronomy**	8.7%	6.1%	2.1%	2.8%	3.3%	0.0%	1.0%	1.2%
Physics	5.0%	4.9%	2.5%	2.9%	3.3%	2.3%	1.3%	1.8%
Earth Sciences	3.6%	4.1%	1.9%***	3.4%	3.8%	3.4%	1.5%	2.3%

*Full report has 15 fields; Hispanics were 14.8% of the 2006 US population. **The top 40 departments ***1995 data only

National Analysis of Minority S&E Faculty... (cont'd)

Table 9. Native Americans, Alaskans, Hawaiians, Pacific Islanders in the Academic Pipeline, Selected Fields*

Discipline	Students				Departments 1-100 FY2007			
	BS2004	BS2005	PhD86-95	PhD96-05	asst	assoc	prof	all
Astronomy**	0.4%	1.1%	0.3%	0.4%	0.0%	0.0%	0.0%	0.0%
Physics	0.5%	0.9%	0.2%	0.3%	0.0%	0.2%	0.0%	0.1%
Earth Sciences	0.8%	0.7%	0.0%***	0.7%	1.1%	0.4%	0.2%	0.4%

*Full report has 15 fields; Native Americans = 1.1% of the 2006 US population. **The top 40 departments ***1995 data only

(Continued from page 21)

est representation at all but one point – assistant professors in the second tier of earth sciences departments (1.8%), where they surpass Blacks (0.6%). Among students, only astronomy 2005 B.S. recipients match the U.S. population (1.1%). In the top 50 departments, psychology assistant professors have the highest Native American representation at 1.1%; in the next 50 departments, four disciplines surpass 1.1%. The only Native American assistant professor in top 50 physical sciences and engineering disciplines is in electrical engineering, indicating a 7-year hiring lapse in the others. In astronomy and in civil engineering, there is no Native American professor at any rank.

Except in psychology, Native Americans follow the URM trend, in which representation among B.S. recipients is greater than or equal to Ph.D. recipients. Comparing the past two decades of Ph.D. attainment reveals that their representation increased in each discipline.

URM Women

The value of survey populations is most obvious when analyzing the data in Table 13. These numbers are headcount, rather than percentages; they are single-digit in most disciplines, especially the physical sciences and engineering. These numbers are so small that it would be impossible to obtain meaningful results, disaggregated by race/ethnicity, gender, and rank, without having data for all departments surveyed (the whole populations); numbers this small would not survive the statistical treatment, which would be necessary if they were samples. "Full" professors are so few that we collected an approximation of national origin information for them. A number sign (#) designates a "full" professor who received her B.S. degree outside the U.S.; an asterisk (*) designates a "full" professor who received her B.S. degree inside the U.S.

The data in Table 13 reveal that the number of Black female professors in physical sciences and engineering is near zero. The vast majority of Hispanic female "full" professors in physical sciences and engineering are from overseas. Although one might assume that being a native of the country in which one works would give one an advantage, apparently this is not always the case. There are sufficiently more URM females in the social sciences and the life sciences, so that their total for all the top 50 departments of a discipline combined, occasionally is two-digit instead of single digit. No tenured female Native American "full" professor in a top 50 department of any discipline was reported.

> *"In astronomy… there is no Native American professor at any rank."*

Conclusion

Impending global crises and U.S. demographic changes require the U.S. to develop its intellectual capital fully, especially in the areas of science and engineering, in order to maintain its global leadership and economic strength. As U.S. population demographic changes continue and make their way through our educational system, they will directly affect thinking and practices regarding science and engineering education in the United States, the future of science and engineering professions, and the need for diversity in the science and engineering work force. The data herein provide one measure of our preparedness to meet these challenges and to groom a balanced representation of

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Table 13. Female URM Professors in Top 50 Departments

Discipline	Black		Hispanic		Nat Am	
	all	full	all	full	all	full
Chemistry	4		9	**#	0	
Math	4	*##	9	######	0	
Computer Sci	3	*	3		0	
Astronomy	2	#	1	#	0	
Physics	1		5	#	0	
Chemical Engr	4	**	6	#	0	
Civil Engr	5		8	*#	0	
Electrical Engr	8	*	3	*#	0	
Mechanical Engr	5		7	#	1	
TOTAL	36	5*, 3#	51	4*, 13#	1	
Economics	5	**	8	*	0	
Political Science	20	******#	8	#	0	
Sociology	42	13*	18	**#	0	
Psychology	30	******	30	******#	3	
Biological Sci	16	***	27	*##	2	
Earth Sciences	2	#	3	*	0	
GRAND TOTAL	151	35*, 5#	145	15*, 18#	6	

*Received B.S. in U.S.; #Received B.S. outside U.S.

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our U.S. citizens not only to participate in, but also to lead, the imminent "Great Crew Change" in science and engineering.

Our data reveal that URMs among our science and engineering faculty are shockingly underrepresented despite increased general growth in their representation among B.S. and Ph.D. recipients. As expected, compared to their share of the U.S. population, URMs are underrepresented at almost every point in the academic pipeline. In most disciplines, there is a drop in representation at each point measured, with a gradual decrease up to the rank of "full" professor, where the lowest representation is found; this reflects an increase in recent hiring in those disciplines. However, in some disciplines, the representation of Blacks, Hispanics, or Native Americans, among assistant professors (the most recently hired rank) is lowest and occasionally zero.

This report has been excerpted from the full report, with permission from the author. The full report may be viewed at: http://cheminfo.ou.edu/~djn/diversity/Faculty_Tables_FY07/FinalReport07.html

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