Studying Structures of Inequality in Astronomy through Narrative Analysis and Social Network Visualization

BY LUIS FELIPE R. MURILLO, SHARON TRAWEEK, JARITA HOLBROOKS, REYNAL GUILLEN, DIANE GU

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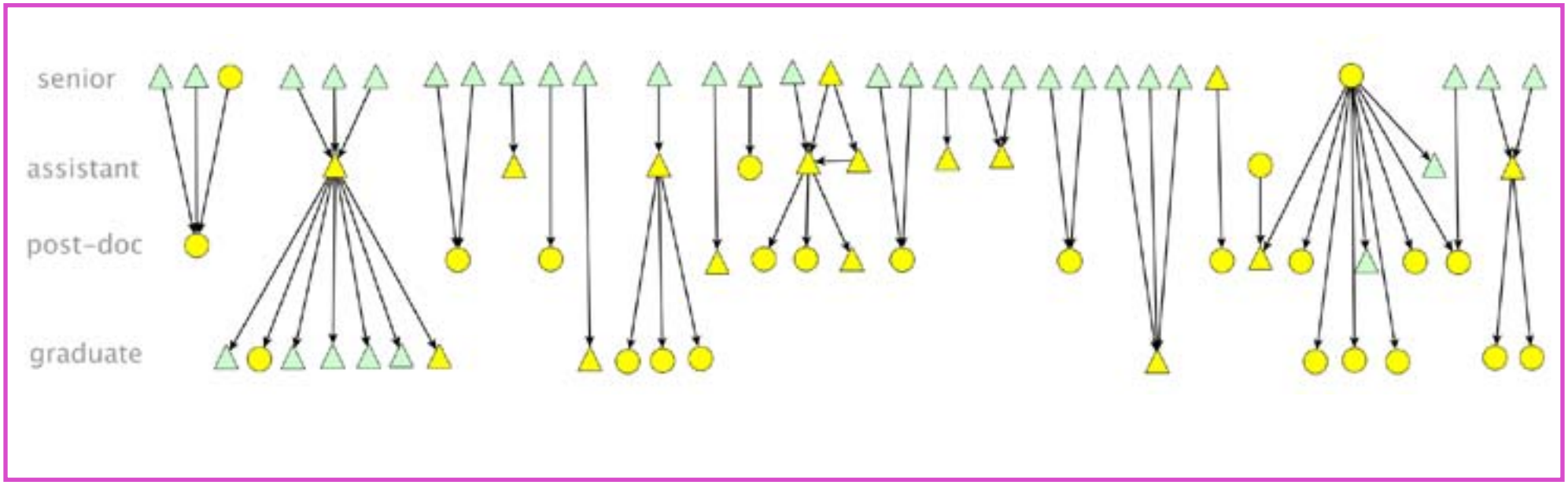
LOOKING At the 40 top-ranked astronomy and astrophysics departments in the United States reveals the underrepresentation of minority groups in these fields. In 2005, of the 647 tenured faculty in the departments, 89 were women, 5 were African American, 50 were Asian, 3 were Hispanic, and 1 was Native American (Nelson 2005). In 2007, of the 594 tenured faculty in the departments, 94 were women, 6 were African American, 42 were Asian, 7 were Hispanic, and none were Native American (Nelson 2007). It is against this context of stark disparity that we place our research focus.

In order to respond to the question of why it is much less likely for members of underrepresented groups to build a career in science, we mobilized an experimental approach combining research techniques from history, anthropology, gender, and ethnic studies. In our National Science Foundation-sponsored pilot project, "Women and Minority Astronomers' Strategic Engagement with Distributed, Multi-Disciplinary Collaborations and Large-Scale Databases," our main objectives included identifying women, ethnic minority, and foreign-born astronomers; learning about their trajectories; and investigating strategies, relationships, and mentorship practices that helped them to build a career. In the context of large-scale collaborations in (e-)science more broadly, we looked specifically at how gender, ethnicity, and nationality intersect in the process of scientific formation, as well as in the process of engaging partners for the construction of instruments, design, and implementation of large-scale data management systems.

Following Sharon Traweek (1988, 2000) in her studies of high-energy physicists, we start with the assumption that collaboration histories, personal trajectories, institutional arrangements, and regimes of knowledge production can be identified in the way tools and techniques, such as databases and visualizations of data, are deployed in astrophysics. Diverse aspects of group dynamics, including knowledge-making and transmission, are embedded in instruments that astronomers build to explore the universe. By looking at the process of knowledge-making in data-management techniques, we also investigate the position and the



role of women, ethnic minority, and foreign-born scientists as they build their careers.

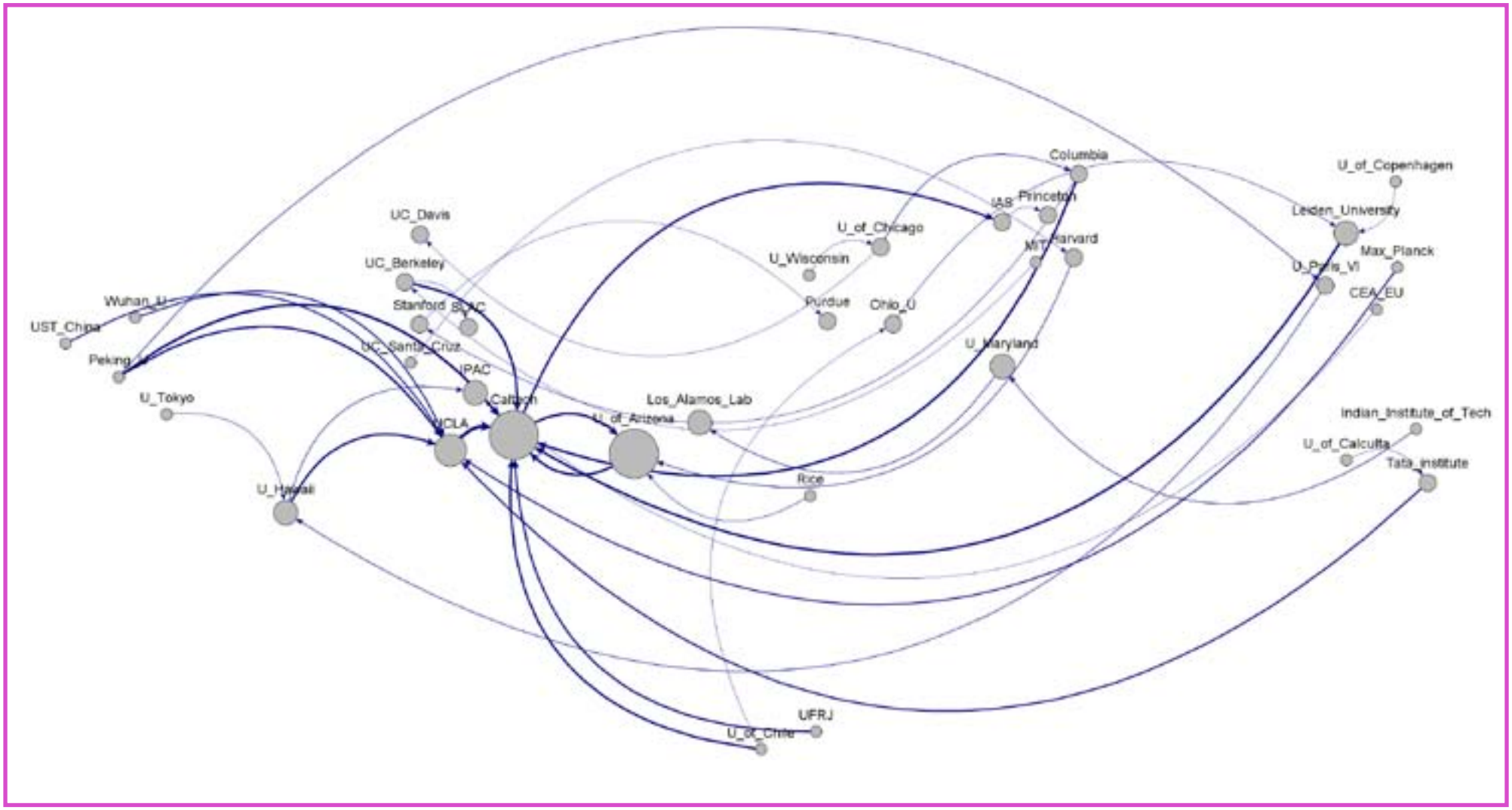
During the first phase of our oral history interviews and ethnographic encounters, we constructed relational data in order to further explore patterns in large scientific collaborations. By extracting relational information from narratives, we probed into the nature of social and professional ties that facilitate (or hinder) career progression in astronomy. Our dataset included other sources as well, such as statistics from the National Science Foundation on diversity in sciences and ethnographic social network mapping.

Using the concept of meshworks (Escobar 2008; Ingold 2007), we described relationships that set the conditions for underrepresented astronomers to engage in scientific practice. Our initial hypothesis was that our target group tended to rely on close-knit networks. What we identified in our corpus of interviews is that female and ethnic minority astronomers depend on stronger support from senior researchers and host institutions, which help to foster favorable conditions for engagement with other astronomers. In terms of network patterns, we have found a tendency toward clustering among astronomers of the same national and ethnic background, as shown in the mentorship graph below.

In the domain of Science and Technology Studies (STS), meshworks can be defined as complex, historically contingent groupings of social and political networks. As part of our theoretical work, we hypothesize that meshworks are not networks composed of linked discrete entities, but overlapping networks which compose what the entities themselves are. By virtue of coming

Graph 1. Mentorship Ties

Yellow nodes represent female, ethnic minority, and foreign-born astronomers. Triangles represent men, and ellipses women. Directed arrows (edges) stand for the relationship of mentorship, linking a senior researcher to a junior one.



Graph 2. Circulation of astronomers

The thickness of the connection between research institutions represents a denser path between them. The directed links represent sender and receiver institutions. The size of each node corresponds to its density.

together and being related, cross-cutting various domains of social life, meshworks produce characteristics that transcend those of particular entities. Therefore, we are interested in further experimenting with the relational argument (Ingold 2001) that it is the links, edges, connections, relationships of various sorts that constitute the nodes ontologically through the very bundle of relations that persons find themselves, and normatively through institutionalization in the field of astronomy and science in general. Meshworks, in this sense, are complex networks, interdependent and shifting representations of relationality.

Our research takes an experimental route by attempting to generate ethnographic meshwork maps that retain as much relational information

as possible. Our process analytically slices astronomy meshworks by variables (e.g., institutional circulation, affiliation, and mentorship) into separate maps, comparing and contrasting the resulting set of relational data and analyzing regularities and singularities between them. In Graph 2, we present one slice of our meshwork of minority, women, and foreign-born astronomers based on the history of their institutional affiliation. This graph describes the patterns of circulation of researchers, helping the ethnographer to visualize path density and the structure of connectivity between local and international locations..

In our meshwork visualizations, we are beginning to identify patterns in movement by individuals, showing clustering by gender, ethnicity, and nationality. We are also identifying patterns in mentorship practices across generational cohorts, showing clustering by gender and ethnicity. The preliminary patterns we observed are indicative of more profound social distances, and point to the fact that personal trajectories of underrepresented astronomers should be studied further. A distinctive regularity in our data is the "glocal" character of meshworks created by foreign-born women astronomers working at U.S. institutions. For example, there are approximately equal proportions of Asian to Asian-American and foreign-born Latina/o to Chicana/o astronomers. Furthermore, Asians and Latinas/os are represented in significantly greater numbers than Asian-Americans and Chicanas/os. Sadly enough, each ethnic minority group of professional astronomers in the U.S. is numbered on the order of tens, not hundreds, allowing our research to account for the whole population instead of devising sampling techniques.

We hope this pilot study of astronomy meshworks will help reveal structures of inequality by bridging STS approaches and power analytics from gender, ethnic, and Critical Race theory. Analyses of the propagation of dominance and the emergence of new ways of knowing and acting in technosciences have informed this study of the ways in which those who appear to be at the margins of astronomy are developing strategies for advancing their careers. Visualizations of relational data are useful to exemplify these strategies. Visualization practices foreground—but do not exhaust—important links between people and the contexts in which those links occur, such as institutional belonging, migration, mentorship, and coauthorship patterns. Our preliminary findings have clearly shown that the study of meshworks has significant explanatory value, revealing distinctive practices that vary according to gender, ethnicity, and national origins.

References

Escobar, Arturo. *Territories of Difference: Place, Movements, Life.* Duke University Press, Durham, NC, 2008.

Ingold, Tim. *The Perception of the Environment: Essays on Livelihood, Dwelling and Skill.* London: Routledge, 2001.

Ingold, Tim. "Writing texts, reading materials. A response to my critics" in *Archaeological* Dialogues, number 14 (1) 31–38, Cambridge: Cambridge University Press, 2007.

Nelson, Donna. "A National Analysis of Diversity in Science and Engineering Faculties at Research Universities," OK. January, 2005. http://chem.ou.edu/~djn/diversity/briefings/Diversity%20Report%20Final.pdf

Nelson, Donna. "A National Analysis of Minorities in Science and Engineering Faculties at Research Universities," OK. October, 2007. http://chem.ou.edu/~djn/diversity/Faculty_Tables_FY07/07Report.pdf

Traweek, Sharon. *Beamtimes and Lifetimes.* Cambridge, Mass.: Harvard University Press, 1988.

Traweek, Sharon. "Faultlines or How Modern Became Retro: an historical political economy of knowledge," for *Doing Science + Culture: How Cultural and Interdisciplinary Studies Are Changing the Way We Look at Science and Medicine,* edited by Sharon Traweek and Roddey Reid. Routledge, 2000.

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