Undergraduate Seminar Course on Physicists from Underrepresented Groups

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Abstract: This seminar course covers pioneering physics research in optics, astron-omy, and nuclear physics, with an emphasis on discoveries by women physicists, African-American physicists, and other groups who are underrepresented in physics. © 2021 The Author(s)

How can we design a physics course to celebrate diversity in physics and promote inclusivity in the field? The topics in a typical introductory physics course were discovered more than 150 years ago, but women and minorities were not able to fully participate in physics until the end of the 19th century, concentrating in the burgeoning fields of astrophysics, optics, and nuclear physics [1, 2]. In this paper, I describe a new physics course dedicated to studying the pioneering physics research done by women, African Americans, and members of other groups underrepresented in physics. In addition to reading about these physicists' lives and discoveries, students also learn about the hidden and overt obstacles that can hinder their persistence in the field, including bias, imposter syndrome, and stereotype threat. The goal of the course is to highlight the diverse scientists who have been major players in physics for over a century but who do not get covered in a standard introductory curriculum [3]. This is also an opportunity to teach modern physics and state-of-the-art research to non-majors and majors alike.

The goal of this paper is to share ideas and resources to promote the development of similar courses. There are wonderful resources available, but it can be challenging to assemble them into a coherent story. For example, excellent biographies of women physicists can be found in McGrayne's *Nobel Prize Women in Science* [4], Calvin's *Beyond Curie* [5], Byers's *Out of the Shadows* [6], Rayner-Canham's *A Devotion to their Science* [2], and the American Institute of Physics (AIP) *Teaching Guides on Women and Minorities* [7]. In addition, resources on the demographics of physics and the challenges faced by groups underrepresented in physics are detailed in the American Physical Society (APS) *LGBT Climate* report [8], the AIP *TEAM-UP* report [9], and the AAUW *Why So Few?* report [10], as well as recent commentary in *Physics Today* [11–13] and *Optics and Photonics News* [14, 15].

The course uses three physics themes to tie everything together: nuclear physics, optics, and astronomy (along with astrophysics and space exploration). The course schedule is listed in Table 1. In addition to the resources listed above, the major readings for the course are Des Jardins's *The Madame Curie Complex* [16], Conkling's *Radioactive!* [17], Howes's *Their Day in the Sun* [18], Kiernan's *The Girls of Atomic City* [19], Mickens's *Edward Bouchet* [20], Pollack's *The Only Woman in the Room* [21], Sobel's *The Glass Universe* [22], Al-Khalili's *The House of Wisdom* [23], and Shetterly's *Hidden Figures* [24]. Many other physicists and resources used in the course do not fit within the page limit of this paper but will be presented at the conference.

This course is taught during Middlebury College's 4-week winter term, in which students take a single course which meets for 2 hours for 4 days per week. The class meeting begins with a brief lecture on the physics, a recap of the physicist's biographies, and an open discussion of the readings. After a short recess, students break out into small groups to discuss the challenges faced by physicists from underrepresented groups. Outside of class, in addition to readings, there is a major paper due at the end of each week: writing a physics autobiography [25], exploring obstacles faced by underrepresented physicists, and writing a biography of a physicist which includes an explanation of the scientific discovery. For the final project, students give a poster presentation highlighting physicists that are not already covered in the course, and the posters are publicly displayed as a long-term exhibit along our physics department corridor.

References

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Table 1. Physics topics, people, and inclusivity activities covered in the course, with each row in the people and activities columns corresponding to one 2-hour class meeting.

physics	topic	people	activity
nuclear physics	pioneer women of radioactivity	Marie Curie Harriet Brooks	demographics of women in science
		Lise Meitner Irène Joliot-Curie	feminism and science
	Manhattan Project	Leona Woods Libby Maria Goeppert Mayer Chien-Shiung Wu	Nobel Prize representation
		Carolyn Beatrice Parker J. Ernest Wilkins, Jr.	stereotype threat
optics	first African-American physicists	Edward Bouchet Elmer Imes	African-Americans in physics
		Willie Hobbs Moore Shirley Ann Jackson	intersectionality
	women in modern optics	Donna Strickland Lene Hau Michal Lipson	imposter syndrome
	x-ray diffraction	Rosalind Franklin Herman Branson	gender discrimination
astronomy	women pioneers in astronomy	Williamina Fleming Henrietta Swan Leavitt Cecilia Payne-Gaposchkin	accessibility
	women in modern astrophysics	Jocelyn Bell Burnell Vera Rubin Andrea Ghez	LGBT physicists
	Islamic Golden Age of Science	al Khwarizmi Ibn Al-Haytham Abdus Salam	Hispanic astrophysicists
	space race	Katherine Johnson Mary Jackson	racial discrimination

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