

Understanding physics identity development through the identity performances of Black, Indigenous, and women of color and LGBTQ+ women in physics

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Identity development is critical to student retention in physics degree programs. Historically, research on physics identity has been conducted at Predominately White Institutions and has largely ignoring the unique identity intersections experienced by Black, Indigenous, and women of color (BIWOC) and women who identify as Lesbian, Gay, Bisexual, Transgender, and Queer (LGBTQ+). In this study, we adopt the theory of identity as performance to better understand how multiply-marginalized students negotiate their multiple intersectional identities in their environments. We conducted semi-structured interviews with women who identify as racial minorities and/or as LGBTQ+ at two Hispanic-Serving Institutions located in Central Texas. Our analysis focuses on the way students fragment or integrate their identities in the physics setting and how this may affect their view of themselves as physicists.

I. INTRODUCTION

Over the past few years there has been an increase in physics education research exploring the physics identity development of students and systems that support membership and belonging in the field [1-7]. However, the literature available on physics identity has largely ignored the experiences of Black, Indigenous, and women of color (BIWOC) and lesbian, gay, bisexual, transgender, and queer (LGBTQ+) individuals who participate in physics [4,5,8,9].

Our research centers the lived experiences of BIWOC and LGBTQ+ women in physics in order to understand the critical and often-ignored aspects that contribute to their retention and success. To do this we chose to connect the existing work in physics identity with the work of STEM education researcher Maria Ong. Ong's research [8] describes how the embodied performances of femininity and racial identity done by women of color affect their experiences in physics. We draw on this in order to develop a framework to better understand the deeply interwoven relationship between identity negotiations and embodied identity performances.

II. BACKGROUND

A. Previous work on the identity process

Hazari et al. [2] developed a theoretical framework for physics identity based on Carlone & Johnson's [10] study of the science identity of successful women of color in science-related careers. In Hazari et al.'s large quantitative study, the physics identity measure strongly predicted physics career intentions in first-year college students. In a follow-up study [3], Lock, Hazari, & Potvin identified "recognition as a physics person" as the most important predictor of physics identity. They found that women reported lower recognition on average; in addition, the regression model showed that women need a higher level of recognition to achieve the same level of physics identity as men.

Close, Conn, and Close [1] combined Hazari et al.'s [2] framework with enacted identity as understood through Communities of Practice theory [11]. They found that the physics students in their study placed high value on experiencing community membership and a sense of belonging, which supported them in continuing in the physics major. In a later study, this result was supported specifically for women of color and LGBTQ+ women, who described community membership as critical to their success [5].

Hyater-Adams et al. [6,7] combined Hazari's work with that of Na'ilah Nasir [12] to develop the Critical Physics Identity framework which centered the experiences of professional Black physicists in the analysis. The framework takes a critical perspective on how Black physicists develop their identities in a society where racism is systemically normalized. The work published by Hyater-Adams et al. is

monumental as the first in-depth examination of Black physics identity.

Ong [8] published a longitudinal study examining the strategies women of color in physics use to achieve ordinariness in multiple realms: gender, ethnicity, and science. Ong writes that individuals perform "complex social choreography" in order to achieve ordinariness. When existing in science spaces—traditionally white, male, and heterosexual—women of color must fight to be seen as competent members of the scientific community, making their social choreography especially dramatic [4,5,8].

The strategies outlined by Ong, along with the previous investigations on physics identity [1-3,6-8] lay the groundwork for understanding the physics identity development of BIWOC and LGBTQ+ women through performed identity. We elaborate on this below.

B. Performed Identity

Examining identity through embodied identity performances expands the research lens beyond the internal understanding of identity and views the outward expression of identity on different stages. These stages are the environments the individual acts in and the performance includes the way one dress, speak, interact and exist in these environments. For women of color, with their "visibly contrasting bodies--in terms of their feminine curves and/or darker skin tones" [8], the embodiment and performances are counter to and incompatible with traditional physics culture and practices surrounding ordinary science. Physics, as it is dominated by heterosexual, cisgender, white men, is an inherently male and white space where multiply-marginalized women are constantly fighting to be seen as normal and ordinary [8].

While our focus in this study is primarily on the ways the interviewees perform their identities, we also consider the unseen negotiations examined by the research outlined in subsection II.A [1-3,6-8]. The framework we are developing draws out the relationship between the inner negotiation of identity—the identity process—and the outward identity expression—the identity performance.

Identity performances fall into two main categories: fragmentation and integration [8]. Both are strategies employed by multiply marginalized women in order to succeed in their physics careers.

Fragmentation is the conscious or unconscious breaking apart of one's identities to minimize cultural differences in order to achieve community membership and personal success [8]. Fragmented performances may come at the cost of social and personal community membership for the women—separating their social identities and their physics identity may lead to a higher cognitive load for individuals, especially for transgender and other LGBTQ+ students who may be learning physics in a homophobic environment [8,9,13,14]. In addition, the act of using fragmentation strategies validates the existing boundaries faced by

multiply-marginalized women in physics environments [8]. However, fragmented performances are a strategy to achieve success through becoming “ordinary” and embody the presumed cultureless culture of physics.

Integration, in the barest of terms, is the opposite of fragmentation. It is a holistic acceptance of one’s intersecting social identities (racial, ethnic, sexual, gender) with one’s professional identity as a physicist. The performance of an integrated, intersection physics identity is completely dependent on how the physicist views themselves—the importance and identification of an integrated performance is interpreted in the narratives of ownership and agency of their physicist, racial, gender, and sexual identities. This performance is an act of rejection of the myth of a cultureless science as the physicist chooses to bring her culture into her work and onto her physics environment’s stage.

While the two performances seem diametrically opposed, multiply-marginalized women often use both fragmentation and integration to achieve personal success and community membership in their environments. It is simple to say that the goal of an individual is an integrated identity performance, but this is impossible in a field that is riddled with systemic racism, sexism, and homophobia. Large scale transformation is necessary to achieve holistic performances.

Understanding identity as a performance allows us to gain insight into how BIWOC and LGBTQ+ students exist in physics through a critical lens, and how they view their own individual identities. To do that the authors analyze the participant’s narratives with a critical race critical queer, and intersectional lens.

An intersectional lens allows us to examine the power structures and oppressive systems that exist in physics, while at the same time treating each individual as a holistic person and not representative of a certain race, gender, or sexuality. Using the term BIWOC—Black, Indigenous, and women of color—brings to the forefront the specific oppression faced by Black and Indigenous women in the United States. In addition, explicitly choosing not to define the participant population as underrepresented minorities, the study promotes the inclusion of East Asian, Southeast Asian, Native Hawai’ian, Native Alaskan, and Pacific Islander women, a group largely ignored within the “Asian” racial demographic conglomerate.

At the moment the study does not include transgender women in physics, but the authors choose to use LGBTQ+ in an effort to make it clear that transgender women are women and will be included in the future.

III. METHODS

We begin with our positionality in the field. The first author identifies herself as a Black and Indigenous Chamorro, bisexual and cisgender woman. The two remaining authors identify as white, cisgender, straight women. The interviews were conducted and analyzed by the

first author while she was an undergraduate student. The second author performed analysis as an undergraduate student and is currently working in medical physics. The third author is the faculty research mentor and advisor for the first two authors.

To date, nine interviews have been performed with eight unique participants at two large, public Hispanic-Serving Institutions in Central Texas. Of the women interviewed, all eight identify as cisgender women; six identify as women of color or biracial; five identify as lesbian or bisexual, and three as heterosexual. The women discussed in this paper self-identified themselves according to the labels in Table 1.

A. Who is a physicist?

The study defines a physicist as simply as possible: someone who participates in, studies, or does, physics [4,5]. This definition varies greatly from the common understanding that one must have at least a bachelor’s degree to be a “real physicist.” However, a destruction of the gate prevents gatekeeping. Broadening the definition of a physicist allows for a more equitable understanding of the field and begins to open the doors towards seeing students as experts in their education and their identity.

All the participants were recruited through self-identification as a racially minoritized woman either through university provided documentation or a voluntary survey. Women who identify as part of the LGBTQ+ community were primarily found through in-person social networks. We go into more detail about the specific recruitment of participants in previous papers [4,5].

We chose to do interviews over other qualitative methods in order to elicit a narrative of the interviewee’s varied experiences in and out of the physics environment. The interviews were performed in a clinical style using the same general protocol. The semi-structured nature of the protocol allowed each interview to be a unique conversation between participant and interviewer (e.g., including red lipstick recommendations or conversations about Mileva Einstein).

The interviews were conducted by the first author, whose identities may have had an effect on the comfort levels of the participants and the narratives they were willing to share. The protocol used was designed to understand the ways the participant understands her identities and perceptions of physics environments. Participants were also asked to engage in an activity asking about the saliency of

TABLE I. Racial/ethnic, sexual orientation, and gender identities of women in study.

Name	Identities
Nadya	Hispanic & white, heterosexual, cisgender ₁
Paige	White, lesbian, cisgender ₁
Fabiola	Hispanic & white, bisexual, cisgender ₁
Alexis	Hispanic/Latina, heterosexual, cisgender ₁

₁“cisgender” describes people whose sense of personal identity and gender is the same as their assigned birth sex

their social identities in their “physics life” and their “personal life”. In later interviews the first author also participated in this activity as a way to share her identities and understanding with the participants.

IV. INTERVIEW DATA AND ANALYSIS

A. The negative cost of fragmentation

Fabiola, who identifies as a Hispanic/white, bisexual, cisgender woman, discussed an experience surrounding her sexuality in the classroom. A few minutes before the presented quote when Fabiola and the interviewer discuss how Fabiola makes “casual jokes about her sexuality” (i.e., “I’m too gay to draw a straight line.”)

Fabiola then recalls an instance where she casually made a similar statement in a math classroom and the group she worked with had a negative reaction.

Fabiola: There's specifically in one of the last classes I took, there was a point where I was working with a group entirely made up of men...that I wasn't familiar with.

I've definitely gotten the reaction of—I don't know how to explain it, other than-It was like the circus freak effect. I just got—This guy just kind of ended up giving me looks. You could tell by the way-his relationship with me changed from that point on, even though we had been, like, good. We'd been okay friends in the class and we'd work together and stuff like that. The way he treated me, definitely shifted, when [the joke] came out.

Fabiola then goes on to discuss how being in an uncomfortable situation, such as one where she is unable to bring her full identity to light, affects her academic success:

There are definitely situations where I just don't feel like ... If I don't feel comfortable and I don't feel ... I don't know.

There's a certain level of emotional support I get from being around [people I'm comfortable with]. When I'm not around that, I can definitely see that it's harder for me to work through things I find difficult and that are kind of mentally taxing.

The performative effort that Fabiola must exert to fragment herself in order to interact in this classroom environment had a direct effect on her ability to complete work and be motivated. While she may have had minute success in her group membership, her academic and personal success suffered.

B. Integrated performance through recognition and stereotype reconstruction

Paige, a white, lesbian, cis-woman, graduate student, gives a clear example of an integrated identity performance through the recognition of herself as a physicist.

Interviewer: Do you see yourself as a physicist?

Paige: Oh, fuck yeah.

Interviewer: Fuck yeah.

Paige: Absolutely.

While Paige was interviewed while a graduate student, she did reflect in her interview that this identity developed during her undergraduate education. This is more than a yes or no question-- if anything it has the ability to be answered with a “yes, but...”. However, asking explicitly about this specific identity asks if interviewee chooses to have agency and ownership of the title alongside her other identities, therefore, asking if she is able to redefine the image of a physicist into one that matches herself [4,8].

This act of stereotype reconstruction doesn’t only apply to the interviewee alone. The gates of becoming a physicist are high and mighty, but we have the ability to open the doors wide by recognizing others as physicists as well.

Nadya, a Hispanic/white, heterosexual, cis-woman who was interviewed during her last semester in undergrad, also talks about her identification as a physicist. In the beginning of her answer there is an inkling of a, “yes, but...” but rather than a concession of the things that may cause her to disassociate fully with the physicist identity she begins to explain the reasons why she is a physicist.

Nadya: I think now I see myself as a physics person or a physicist. I used to not feel that way—I ... because ... oh, God. Because like, someone like me being a physicist? Oh, oh, oh, oh, never.

They're like big smart men that know everything. And I'm like, "Oh my God, that's not me." (Laughs).

I'm a small woman (laughs) that likes to have a good time. But, um ... no, but I—I do see myself as a physicist.

I work hard, just as much as any other person in the department, and they have the same questions as I do.

The interviewer asks later, “Do you think your peers view you as a physicist?” Nadya begins by discussing her female friends in the department, and her hope in the men as well. However, while she hopes that all of her peers see her as a physicist, she notes that she absolutely sees the others in the same light as herself:

Yeah. So, I would really hope, because I think we're all—we're all. I mean, I know for sure I see all my equals as physicists because we're all out here. We all have something to bring to the table, we all have our strengths, we all have our weaknesses, and we're all trying to make it through.

Because Nadya was able to reconstruct the stereotypical image of a physicist to one that looks like her, does the same things as her, acts like her, she was also able to extend this identity to others who share some of these qualities. The recognition of herself and of others is a quality of an integrated physics identity performance that goes beyond the self and out into the space one exists in.

C. Intentional manipulation of performance

Alexis is a graduate student at a large, Hispanic-Serving, public university. In her interview, Alexis reflects on her experiences in her undergraduate physics program, where there were few or no other women in her courses.

During a discussion of common biases she encounters as a woman in physics, Alexis talks about a specific experiment in identity performance she tried in an undergraduate classroom, where she intentionally used a fragmented performance to be seen as a competent physicist and gain membership with her peers. She initially observed that her “look,” how she felt comfortable presenting herself, seemed to be poorly received by her male classmates:

Alexis: Where, there's like, if I wore, like, I think I wore, like, heavy makeup. Usually I wear, like, winged liner, red lipstick- that's, like, my look that I like I would show up, like, hair curled. Like, just, like, how I felt comfortable. And, like, people didn't talk to me for a while.

In response to this observation, Alexis describes a strategy of fragmentation, making her outward gender performance fit in with the class's aesthetic:

Alexis: So, then I stopped wearing makeup and started wearing, like, sweats and stuff and, like, they were a little more receptive. And, so, I kind of tested it out myself. And, like, I did that for a while, more sweatpants, more, like, just no makeup looks. And they spoke to me more.

Note that for Alexis, this fragmentation was intentional and experimental. Once she accomplished her goal of being at least initially accepted by the other students, she was able to move to a more integrated identity performance:

Alexis: But once I was able to change back to makeup, I think I had gotten them comfortable enough and made, like, "Oh, yeah, I'm smart. Even though I could wear makeup and be smart. And do my hair and be smart." ...And so, now I'm just kind of, like, "eh. What you see is what you get." Some days I'll do my makeup, some days I won't. Because I'm tired.

This narrative is an example of strategic use of fragmentation to accomplish specific goals within the community, in order to reduce marginalizing behaviors by other students. Through this performance of fragmentation, Alexis gains a foothold in the community that enables her to demonstrate her competence and; once this is accomplished, she is able to return to a more integrated performance encompassing both competence and red lipstick.

V. BLACK LIVES MATTER. A CALL TO ACTION

We, the authors, have the privilege to be able to work alongside our participants, whose commitment to physics is extraordinary. The ability to talk about their experiences in a way that uplifts the BIPOC and LGBTQ+ community while ideally working towards creating a more equitable and diverse physics culture is something we do not take lightly.

It is necessary to also talk about our lives outside of the classroom and outside of the labs as it is impossible to separate our “outside” lives from our lives in physics and academia and industry.

Doing physics and being a physics student goes further than what is written on the whiteboard. We found ourselves a few months ago trying to figure out how to teach in the midst of a global pandemic, while making sure our students were supported. Now, as the pandemic is still ongoing, we are fighting in a social revolution trying to prove to our government, our families, and our friends that Black Lives Matter.

We cannot pretend that business is going on as usual. As educators and as physicists it is our duty to not turn a blind eye to what is going on in the world. We have a responsibility, especially non-Black people of color and white folks, to educate ourselves on how to support our Black colleagues and our Black students during this time. There is no point in pretending that we, as scientists and educators, exist in a vacuum where the outside world does not affect us. Participating in that charade, both with intention and subconsciously, intentionally forces BIPOC out of the field and uplifts white supremacist views and actions.

Staying silent is an act of violence. Speaking up, being active, and supporting others is the only solution to the lack of diversity, inequity, racism, sexism, and homophobia we see in physics.

I, as the first author, am doing my part, as a Black and Indigenous bisexual woman, in participating in education research and writing this paper. Now, how do we go forward with this knowledge to arm us, to change the field?

Our ongoing and future work seeks out to identify support structures—both systemic and social—that operate in institutions of higher education that allowed these women to perform an integrated physics identity and claim the title “physicist” and their holistic selves. The authors acknowledge that a single paper is not enough without direct action in our departments and schools. If you found this paper insightful or helpful the authors encourage you to read the literature cited in the papers and to begin working in your departments to develop an anti-racist, anti-sexist, and anti-homophobic culture. It is only then, when we actively support Black and Indigenous and brown and queer physics students—beyond going to an implicit bias training and patting ourselves on the back for it—that will we see a shift in physics culture to become more inclusive, more equitable, and more diverse.

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