

Race-evasive frames in physics and physics education: Results from an interview study

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Mainstream physics teaching and learning produces material outcomes that, when analyzed through the lens of Critical Race Theory, point to white supremacy, or “the systemic maintenance of the dominant position that produces white privilege” (Battey & Levya, 2016). In particular, the continued, extreme underrepresentation of People of Color in physics and a growing number of first-person accounts of the harm that People of Color experience in physics classrooms and departments speak to a system that valorizes whiteness and marginalizes People of Color. If we take Critical Race Theory as a lens, we expect that maintaining white supremacy in physics happens in part via discipline-specific instantiations of broader mechanisms that reproduce whiteness. In this study, we illustrate one such mechanism: race evasiveness, a powerful ideology that uses race-neutral discourse to explain away racialized phenomena, evading race as a shaping force in social phenomena. We offer examples from interviews with twelve university physics faculty, showing what race-evasive discourses can look like in physics and how physics epistemologies, discourses, and stories reify race-evasive frames. This work aims to support faculty in *refusing* race evasiveness in physics teaching and learning, toward developing *race-conscious* analyses that can help us challenge white supremacy in our discipline.

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I. INTRODUCTION

In physics, phenomena such as the underrepresentation of People of Color [1] and the descriptions of institutional and interpersonal racism offered by scholars such as Brown III, Quichocho, Rosa, Prescod-Weinstein, Hyater-Adams, Hodari, Fries-Britt, Ivory, Mervis, Ong, and Morton and Parsons [2–15] point to the pervasiveness of white supremacy¹ in the discipline. For example, Rosa and Mensah [11] identified study groups as a “mechanism of exclusion” for the Black women physicists in their study. Hyater-Adams *et al.* [8] highlight that “not all barriers that

Black physicists face are material”; many are in fact “ideational,” meta-messages about “the norms, values, and practices of the physics discipline,” including the notion that physics is free from the influence of “systems of oppression and marginalization inherent in society,” the very systems of oppression that are a real and often marked part of Students of Color’s experiences in physics. Quichocho *et al.* [13] use interview excerpts to illustrate the cost of (identity) fragmentation for a queer Woman of Color in physics, and name structures that supported the women in their study to “perform an integrated physics identity and claim the title ‘physicist.’”

Situated in this broader context, this paper is about ways in which physics faculty nonetheless *evade race* as they sense-make about these phenomena and others, drawing on race-evasive frames—“powerful explanations” that make the underrepresentation of People of Color and other racialized phenomena in physics teaching and learning seem like natural, nonracial facts of life [17,18]. Race evasiveness, as an ideology, is designed to make it seem like race is immaterial in determining outcomes; instead, race evasiveness argues that outcomes are determined by merit, preferences, and/or deficits. A race-evasive analysis, then, allows dominant actors “to maintain racial innocence and absolve themselves from responsibility in addressing” racism in society [19].

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¹In contrast to a meaning of white supremacy that focuses on overt acts of racialized hatred, when we use the term “white supremacy,” we mean the everyday enactments of “the systematic maintenance of the dominant position that produces [w]hite privilege” [16]—the multitude of mechanisms by which whiteness stays at the center.

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This paper uses quotes from interviews with twelve physics faculty to illustrate discipline-specific instantiations of race evasiveness: ways in which physics has internalized and adapted race evasiveness, and ways in which mainstream physics epistemologies, stories, and discourses reinforce white supremacy and shape pedagogy in the classroom [20]. These discipline-specific instantiations are part of the answer to the question of how physics maintains and reproduces white supremacy. In the following example of race-evasive discourse, a physics professor we interviewed answers a question of whether he thinks it is an advantage to be white² in physics, saying,

“Yeah, I think so. I mean, the main reason why I would, um, have trouble with the question is that, um, it’s at least, at least thinking about it from a physics perspective of what experiment are we talking about? Suddenly change the color of my skin and ask what happens. That’s not a thing, right? You can’t do that. Um, and, and you can’t do the controlled experiment, um, where you take five babies who are white and five babies who are Black and put them in exactly identical circumstances—same family, same schooling—how are they going to do as physics majors? You know, we can’t do that. And so the issues, the challenges that we face with representation are, um, all about, uh, the entire process. Um, and so you can’t separate them. And so, um, you know, the advantages, the advantages that I have, the disadvantages that I have, I mean, mostly the main advantage I have is my mother. She was just awesome. She’s still awesome. Um, has nothing to do with my skin color. Um, so, um, it comes out that we’re all individuals”.

Here, the participant offers a “yes and no” answer: while he originally agrees (yes, in principle, being white is an advantage in physics), the substance of his response calls this “yes” into question, drawing on mainstream physics epistemologies to do so. “The main reason he would have trouble with” the idea that whiteness confers advantage is that you cannot do a controlled experiment to prove it: it is too complicated, and there are too many variables. Using this logic, whiteness *could* be an advantage, or it could not be an advantage; we do not have the evidence to say. This uncertainty leads the participant to name what he thinks

²In this paper, we choose not to capitalize white and do choose to capitalize Black, Latinx, Indigenous, and Students or People of Color. This choice is informed by critical scholarship and activism, such as that by Dumas and the PoC in PER group [12,21]. For example, Dumas writes that Black is a “self-determined name of a racialized social group that shares a specific set of histories, cultural processes, and imagined and performed kinships”. white, on the other hand, is a socially constructed category that was created for the purposes of dominance and exclusion; it “does not describe a group with a sense of common experiences or kinship outside of acts of colonization or terror”.

gave him an advantage: his mother. It is not race; “we’re all individuals”.

We can see immediately that this participant’s analysis evades race; he explains racial privilege³ in terms of individual family and community (schooling) dynamics. By the end of this paper, we will be in a position to illustrate a host of ways in which this quote draws on specific race-evasive frames, functioning to recuse the participant from taking responsibility for addressing white supremacy in physics.

Race evasiveness functions this way on a broad scale in the United States. While the signs and symptoms of white supremacy are inescapable from the perspective of Critical Race Theory (CRT)—showing up in, for example, differential incarceration rates for Black men [17,22], differential rates of expulsion for Students of Color [23–25], and housing segregation [26]—people draw on white supremacist ideologies such as race evasiveness to explain and justify the impacts of institutional racism. CRT, a theoretical framework that originated in the work of legal scholars [27–30] who sought to name the often-hidden, ongoing role of racism in every aspect of U.S. society, challenges race-evasive analyses, instead arguing for race-conscious analyses that center the experiential knowledge of People of Color [27,31–33].

For example, a *race-conscious analysis* of housing segregation would consider the history of discriminatory lending practices, the denial of available housing to Black renters, and discriminatory banking practices [34]. Importantly, such practices are *institutional* and *ideological*; they do not rely on individual actors’ bad faith to persist [35]. On the other hand, a *race-evasive analysis* might explain neighborhood segregation in naturalizing terms, such as “like gravitates toward like,” or draw on stereotypes (inaccurately) linking cultural traits (e.g., family culture) to social outcomes (e.g., poverty). CRT has expanded into several disciplines, with a long history in education [31]. It is both a framework and a praxis [36] that seeks to undermine race-evasive ideology and to “eliminate racism as a part of a larger goal of eliminating all forms of subordination” [37].

As we will see throughout this paper, the physics faculty we interview often evaded race in their sense-making about a variety of racialized phenomena in physics teaching and learning, drawing on discipline-specific instantiations of race evasiveness. Importantly, though these frames are marshaled by individual physics faculty in our study, this study is not about *individuals as racist*; that is itself an explanation that evades structural analyses of white

³We use “privilege” (specifically, racial privilege) in ways consistent with Bonilla-Silva [17] to mean the material benefits conferred to white people by racism—*i.e.*, the material benefits associated with being white in U.S. society. Race evasiveness, in seeking to justify the existence and persistence of the racial hierarchy in neutral, normalizing terms, maintains the system that confers racial privilege.

supremacy. While individuals may deploy—and resist [17,38,39]—race-evasive frames, the use and substance of the frames are evidence of something much bigger and broader; in particular, that faculty marshal race-evasive frames in physics-specific ways tells us that the internalization and adaptation of race evasiveness is part of the socialization process in physics, just as it is in higher education broadly speaking [40]. In offering themes from 12 interviews with physics faculty, our goal is to illustrate and contextualize—to support others in being able to identify this “slippery, apparently contradictory, and often subtle” [17] ideology at work, in themselves and in their local contexts [41], with the ultimate aim of reckoning with the impacts of white supremacy in physics.

In the following section, we outline a race-evasive framework that we will use to analyze interview data throughout the paper. Section III gives details about our sample, interview protocol, and analysis. In Sec. IV, we define what we mean by “physics discourses, stories, and epistemologies,” which we claim reify race evasiveness within physics. In Sec. V, we offer examples of race-evasive discourse in physics teaching and learning. We wrap things up with a discussion in Sec. VI.

II. CONCEPTUAL FRAMEWORK: RACE-EVASIVE FRAMES

Babb [42] has said of whiteness that

“Part of the difficulty in characterizing whiteness lies with its having no genuine content other than a culturally manufactured one, developed unevenly over a period of time, influenced by and responding to a variety of historical events and social conditions: among them, the need to create a historical past, the need to create a national identity, and the need to minimize class warfare. As whiteness evolved in response to these demands, it did so in no linear or orderly fashion, had no single abiding vision that created it, had no single source from which it sprang. It unfolded ad hoc, as a mishmash of elements attuned to an ever-changing American culture. In different periods, a variety of symbols, laws, and institutions have been mobilized to sustain the concept of whiteness, and over time, repeated representations have cemented its identity”.

That is, whiteness, an ideology [16], evolves with culture to maintain white supremacy, the “systemic maintenance of the dominant position that produces white privilege” [16], even as mainstream values, practices, and policies change over time. For example, as enslavement became illegal and then Jim-Crow-era tenets became less socially acceptable, “a new powerful ideology...emerged to defend the contemporary racial order” [17], an ideology that Bonilla-Silva

has called color-blind racism and that Annamma *et al.* [33] (and we) call race evasiveness.⁴ Race evasiveness draws on tenets of liberalism (e.g., meritocracy), cultural stereotypes, ideas about what is “natural,” and accounts of history to explain racial phenomena in nonracial terms. Bonilla-Silva calls race evasiveness “a curious racial ideology”: it is “slippery, apparently contradictory, and often subtle,” “blaming the victim...in a very indirect ‘now you see it, now you don’t’” kind of way [17]. It draws on rhetorical strategies like “yes and no, but,” which allow people to save face by agreeing, in principle, but disagreeing, substantively and in practice [17]. The *function* of race evasiveness is to “serve as a powerful explanatio[n]—which ha[s] ultimately become [a] justificatio[n]—for contemporary racial inequality” that excuses dominant groups “from any responsibility for the status of [P]eople of [C]olor” [17].

Bonilla-Silva introduces four *frames* of race-evasive ideology, “set paths for interpretation” that “misrepresent the world,” “hid[ing] the fact of dominance”. The potency of these frames is due in part to their having *some* foundation, whether that is being rooted in shared (dominant) cultural values or drawing on (though misrepresenting) factual information. All four of these serve to maintain the racial status quo. We offer a brief summary of the frames here, with more emphasis on abstract liberalism, given (at least for us) its conceptual and theoretical density.

A. Race-evasive frame #1: Abstract liberalism

Abstract liberalism involves “using ideas related to political and economic liberalism in abstract ways that seem reasonable” to explain racial phenomena in race-neutral terms [19]. Such ideas include meritocracy, anti-government intervention (“nothing should be forced on people”), and individualism. “By framing race-related issues in the language of liberalism, whites can appear ‘reasonable’ and even ‘moral,’ while opposing almost all practical approaches to deal with de facto racial inequality” [17]. In Bonilla-Silva’s interviews, this frame often took one of three forms:

The use of “abstract notions of equal opportunity to justify [participants’] racial views” (emphasis ours), with no attendant structural analysis that attends to the systematic marginalization of People of Color in all aspects of social life. For example, participants in Bonilla-Silva’s interviews often objected to affirmative action, saying that People of Color “should have the same opportunities as

⁴We use *race evasive* in lieu of *color blind* to (a) problematize an assumption that equates blindness with ignorance, which inaccurately conveys and distorts the unique way blind people interact with the world; and to (b) rethink and remove ableist language as core to our explicit efforts toward social justice in all aspects of our work, particularly in research and scholarship [33].

everyone else,” sometimes buffering such statements with race-evasive analyses:

“I don’t know [why People of Color “tend to perform worse” than white people academically]...um, like I said, I don’t see it as a group thing. I see it more as an individual [thing] and I don’t know why as a whole they don’t do better. I mean, as I see it, they have the same opportunity and everything. They should be doing equal”. [17]

Here, the participant in Bonilla-Silva’s original study marshals individualism to express the (moral) belief that with equal opportunities, anyone—including People of Color—can be successful (i.e., there are no inherent differences among groups). This race-evasive analysis allows the participant to seem race neutral—certainly not racist!—but misses a structural analysis (that People of Color are systematically being *kept from* succeeding) and in fact objects to systems-level remedies for inequality, subtly shifting the blame to the individual: “they *should* be doing” better than they are.

The use of meritocratic notions of success to dismiss structural analyses of racism. One participant in Bonilla-Silva’s study responded to questions about affirmative action saying, “I don’t think you should admit [just] anyone [to university]. It’s gotta be, you’ve gotta be on the level to do it”. Bonilla-Silva notes that this meritocratic deployment of the abstract liberalism frame is often accompanied by the use of cultural stereotypes that reify deficit thinking; participants explain differences in “success” in terms of group traits or stereotypes (e.g., laziness, unintelligence), rather than attributing “lack of success” to the active work of white supremacy.

The use of individualism, or the idea that “nothing should be forced on people” and “governments should intervene in economic and social matters as little as possible”. Instead, “social change should be the outcome of a rational and democratic process”—the “changing of hearts and minds”. For example, participants would say that they “don’t have a problem with all-white and all-Black neighborhoods if that’s the choice of the people, the *individuals*,” and apply the same logic to busing and romantic relationships. The problem with this, Bonilla-Silva says, is that “if minority groups face group-based discrimination and whites have group-based advantages, demanding individual treatment for all can only benefit the advantaged group”.

B. Race-evasive frame #2: Naturalization

“Naturalization is a frame that allows whites to explain away racial phenomena by suggesting they are natural occurrences” [17]. E.g., segregation is natural because people “gravitate toward likeness,” or a preference for white friends and partners is “just the way things are”. Naturalization reinforces the myth of nonracialism by

suggesting preferences are “biologically driven and typical of all groups in society” [17].

C. Race-evasive frame #3: Cultural racism

Cultural racism is “a frame that relies on” deficit-oriented cultural stereotypes “such as ‘Mexicans do not put much emphasis on education’ or ‘[B]lack have too many babies’ to explain the standing of minorities in society” [17]. Cultural racism, then, “puts the onus on the [individual’s] family or culture,” rather than acknowledging the structural nature of inequality [19].

D. Race-evasive frame #4: Minimization of racism

Minimization of racism is “a frame that suggests discrimination is no longer a central factor affecting minorities’ life chances (‘It’s better now than in the past’ or ‘There is discrimination, but there are plenty of jobs out there’).” “People who use this frame may acknowledge that racial discrimination exists, but they do not believe systemic racism to be the main reason for contemporary racial inequality. For example, they may dismiss racism by arguing that while it still exists, they have not witnessed it and therefore it must not be that common; or they change the focus from race to lack of credentials” [19].

E. Race-evasive styles and stories

In addition to these four frames, race evasiveness relies on styles and stories, “rhetorical strategies...that allow users to” instantiate white supremacist arguments and narratives while saving face, and “socially shared tales” that “are the ideological ‘of course’ narrative”. Race-evasive styles such as “yes and no, but” allow speakers to be incoherent without recognizing it; stories such as “the past is the past” help speakers to “gai[n] sympathy from listeners” or to “persuad[e] them about points they want to convey”. Though not central to our analysis in this paper, we occasionally point out race-evasive styles and stories within physics teaching and learning. Figure 1 summarizes the four race-evasive frames and the meanings of race-evasive styles and stories in Bonilla-Silva’s framework.

F. Race-evasiveness in STEM education

Russo-Tait [19] summarizes a number of ways in which race-evasive ideologies materially shape harmful outcomes for science, technology, engineering, and mathematics students, keeping faculty from “embracing justice-centered approaches” and instead cueing “deficit approaches to Students of Color,” in addition to obscuring or erasing “exclusionary racialized experiences of students of color”. Though the literature speaks extensively to the ways in which race evasiveness shapes educational spaces through policy, curriculum, and interpersonal interactions [25,31,43–49], it has rarely been applied specifically to

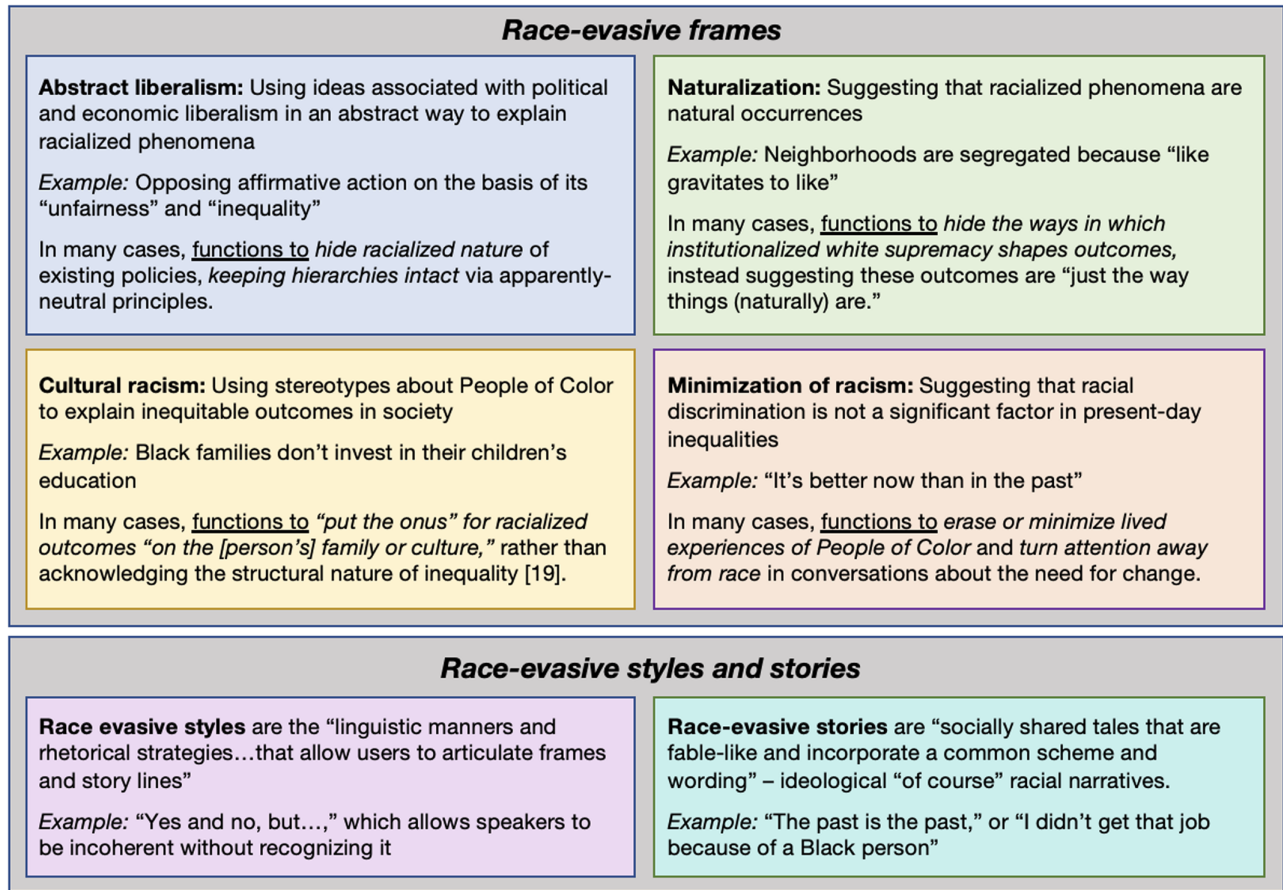


FIG. 1. Summary and examples of race-evasive frames. Image description: Graphic with two large gray rectangles, labeled “race-evasive frames” and “race-evasive styles and stories,” stacked on top of one another. In these large gray rectangles are smaller rectangles in a variety of colors, that describe the frames, styles, and stories of race-evasiveness and offer examples and descriptions of how the frames function. Text in the top left small rectangle reads “Abstract liberalism: Using ideas associated with political and economic liberalism in an abstract way to explain racialized phenomena. Example: Opposing affirmative action on the basis of its ‘unfairness’ and ‘inequality.’ In many cases, functions to hide racialized nature of existing policies, keeping hierarchies intact via apparently-neutral principles”. Text in the top right small rectangle reads: “Naturalization: Suggesting that racialized phenomena are natural occurrences. Example: Neighborhoods are segregated because ‘like gravitates to like.’ In many cases, functions to hide the ways in which institutionalized white supremacy shapes outcomes, instead suggesting these outcomes are ‘just the way things (naturally) are.’ ” Text in the middle left small rectangle reads: “Cultural racism: Using stereotypes about People of Color to explain inequitable outcomes in society. Example: Black families do not invest in their children’s education. In many cases, functions to ‘put the onus’ for racialized outcomes ‘on the [person’s] family or culture,’ rather than acknowledging the structural nature of inequality [19]”. Text in the middle right small rectangle—the final small rectangle in the “race-evasive frames” rectangle—reads, “Minimization of racism: Suggesting that racial discrimination is not a significant factor in present-day inequalities. Example: ‘It’s better now than in the past.’ In many cases, functions to erase or minimize lived experiences of People of Color and turn attention away from race in conversations about the need for change”. In the “race-evasive styles and stories” rectangle are two smaller boxes. The box on the left includes text that reads, “Race-evasive styles are the linguistic manners and rhetorical strategies...that allow users to articulate frames and story lines.’ Example: ‘Yes and no, but...,’ which allows speakers to be incoherent without recognizing it”. The box on the right includes text that reads, “Race-evasive stories are ‘socially shared tales that are fable-like and incorporate a common scheme and wording’—ideological ‘of course’ racial narratives. Example: ‘The past is the past,’ or ‘I didnot get that job because of a Black person.’ ”

science, technology, engineering, and mathematics disciplines, with a few recent exceptions [6,19].

III. METHODS

Our goal in this study is to identify discipline-specific instantiations of race-evasive discourse, with the aim of illustrating what race evasiveness looks like in physics

teaching and learning. This goal is well-served by case-oriented research [50], where analysts select *cases of theories in context*, for the purpose of illustrating, refining, or building theory [41,51–53]. Because we are interested in race-evasive discourse, particularly as it relates to and makes sense of physics teaching and learning, we chose an interview study with physics faculty with targeted questions about race in

physics. This work is in the tradition of the “second generation of CRT” [54] (summarized by [55]), focusing on the relationship between racism and words, symbols, and stereotypes, and seeking to address it through the deconstruction of discourses.

Sample.—Our sample is comprised of twelve physics faculty. Participants were recruited via email, using an American Physical Society listserv. The email invited faculty to participate in a video-recorded interview about “views on diversity in physics” with A. D. R. Recipients of the email were told that “the interviews [would] include questions about how faculty think about physics and physics learning, and about how faculty think about representation, success, funding, assessment, and so on”. The stated goal of the study was to “produce knowledge that will help make physics more inclusive”.

More than 100 faculty expressed interest in participating in an interview, using a Google form linked to a recruitment email. We selected participants on the basis of their length of tenure in the field, aiming for even numbers of participants who had been faculty for (i) less than 5 years, (ii) 5–10 years, (iii) 10–20 years, and (iv) more than 20 years, in an attempt to capture discourses across socialization experiences. We likewise aimed for (though did not achieve) as diverse a sample as possible, gender- and race-wise. In total, we reached out to 25 physicists; the sample of 12 in this study were those that scheduled and completed an interview with us.

Most participants are experimentalists or computational physicists, and several (at least 3 out of 12) have worked in department or university administration. In the presurvey, which asked participants to share demographic information as they felt comfortable, all twelve participants described themselves as white; four added the descriptor of European (two European Jewish), one further described himself as Latino. Three identified as women, nine as men. Three were early career (0–5 years), two midcareer (5–12 years), and seven late career (more than twelve years). One described their income as “above average,” three were in the fourth (second to highest) income quintile, and the remaining seven were in the top income quintile. All names in this paper are pseudonyms chosen by the researchers.

Notably, this sample is not representative. At the time of the writing of this paper, the most recent statistics reporting the race and ethnicity of physics faculty map the demographics as 2.1% Black, 14.3% Asian, 3.2% Latinx, and 79.2% white [56]. Likewise, the American Institute of Physics (AIP) reports that between 12% and 27% of physics faculty are women, depending on rank [57]. According to these statistics, our sample likely overrepresents women faculty and certainly overrepresents white faculty, as compared to a representative sample. However, we do not believe that mapping directly to AIP statistics would yield a representative sample, for a variety of

reasons, among them that AIP statistics do not include Indigenous or multiracial scholars;⁵ the statistics do not include trans and nonbinary folks; and neither we nor AIP track disability status or account for the complex reality of intersectionality [28,59].

However, because our goal in this paper is to begin to identify some of the ways in which physics discourses reify and reshape race evasiveness, it is not necessary for our sample to be representative or our data to be comprehensive. In fact, because white people hold a dominant position in the U.S. racial hierarchy and thus have a vested interest in maintaining it [60], one might argue that our sample is especially appropriate for our purposes. Either way, the data we collected was thick enough to allow us to illustrate race-evasive frames in this early-stage, exploratory work. Though we report numbers of interviews that evidenced particular frames, we do not expect these numbers to be predictive; we share them only to indicate that use of the frames is not idiosyncratic.

Interview context.—Interviews were conducted in two rounds, the first round (5 of 12 participants) in September 2020, and the second round (remaining 7 participants) in November 2020. As we interviewed participants and analyzed data, we were in the midst of local, national, and international uprisings spurred by the police murders of George Floyd and Breonna Taylor, two of many state-sanctioned murders of People of Color in this country, while in the thick of a global pandemic and preparing for the 2020 presidential election. Though not the specific focus of any of our questions, faculty often referred to these events in their interviews, whether in response to questions about their instruction (which had moved online), or in thinking about the prevalence of racism.

Interview protocol and logistics.—Our interview protocol is a modification of Bonilla-Silva’s original Detroit area study (DAS) [61], adapted for physics teaching and learning contexts, in collaboration with Bonilla-Silva. To construct our protocol, we grouped questions from the DAS by theme (friendship, neighborhood segregation, hiring, etc.), selected a subset of DAS questions from each theme that seemed relevant to physics, and then adapted from there. Some questions needed very little modification. Others needed more substantial modification to

⁵The erasure of Indigenous peoples in data collection and reporting is a widespread phenomenon. In the context of the COVID-19 pandemic, Abigail Echo-Hawk, Director of the Urban Indian Health Institute (UIHI), calls this “data genocide,” “impact[ing] the ability of local, state, federal and tribal public health authorities to address the COVID-19 virus and limit[ing] policy makers’ ability to make data-driven decisions for equitable policy and resource allocation” [58]. UIHI’s webpage includes resources for partnering with tribal nations to decolonize data collection and center community in data collection and interpretation.

“work” in a physics context. Sample protocol questions are included in Fig. 2.⁶

We made extensive changes to the interview protocol between the first and second rounds of interviews. In those first interviews, we noticed that interviewees focused primarily on interpersonal (individual) acts of racism and not on structural racism that is endemic to physics culture and epistemology. In response to this preliminary finding, we added a question to the second-round protocol that asked participants whether they agreed or disagreed that physics culture perpetuates white, middle class, masculine norms, modeled after [9], and a similar question about knowledge in physics. In constructing the second-round protocol, we also: made Black, Latinx, and Indigenous people the subjects of questions about race (deviating from AIP’s reporting of statistics); deleted questions that did not get used frequently in the first round or questions that elicited relatively straightforward answers with no elaboration; and included additional agree or disagree statements based on our analysis of the work of Brown III, Hodari *et al.*, Hyater-Adams, Ong, Prescod-Weinstein, Quichocho, and Rosa, who report on the experiences of People of Color in physics. For example, we asked participants whether they thought each of the following contributes to underrepresentation in physics: Black, Indigenous, and Latinx students are routinely excluded from study groups [11]; Black, Indigenous, and Latinx students are not seen as capable of being objective [67]; and Black, Indigenous, and Latinx students must suppress aspects of themselves in order to participate in local physics culture [13,14]. The final protocol for the second round of interviews can be found at [68].

⁶In constructing the first interview protocol, it was not clear to us whether the subject of our questions about race should be “People of Color,” “Black people” (the subject of most of Bonilla-Silva’s questions), or “Black and Latinx people” (the latter based on the American Physical Society’s statistical analysis of underrepresentation in physics [1]). For this reason, in the first round of interviews, we used three different protocols—one participant received a protocol that had “People of Color” as the subject; two that had “Black people;” and two that had “Black and Latinx people”. The protocol also included parallel questions about women, transgender, and non-binary folks. Notably, questions about race were separate from questions about gender in our protocol, erasing important intersectionalities [59,62] and thus oversimplifying the realities of dominance. Although this is a limitation, it is one that reflects mainstream (white patriarchal) culture in physics and thus takes these (inaccurate but pervasive) categories as “the center of analysis” [63]. Additional dimensions of marginalization such as sexuality, (dis)ability, size, and class, were not explicit foci of our work, in spite of their entanglement with white supremacy [64–66]. Our analysis here largely focuses on answers to questions about race; however, faculty often used similar reasoning for both race and gender and so we occasionally cite examples in the context of gender. Forthcoming work of ours considers some of the entanglements between white supremacy and other systems of oppression using the same interview data.

First and second round interviews were semistructured and lasted approximately 75 minutes. The interviews stopped when we had reached a time limit; rarely were we able to ask all of our questions.

Authors’ positionalities.—Race, gender, class, (dis)ability, size—every identity that exists in a hierarchy of power—all matter in the U.S. social matrix and in shaping how we perceive social phenomena [59], and an important part of qualitative, case study research is articulating what influences our analysis [69]. Further, Smith, Tuck, and Yang [70] emphasize the importance of naming positionality for challenging settler-colonial logics in research; that is, challenging the notion of knowledge as separate from self, community, and place. Thus we articulate our positionalities here.

Robertson is a chronically ill and disabled, physics-Ph.D.-holding, thin wealthy white woman. Robertson grew up in a predominantly white, culturally evangelical Christian, small town in the South, and her formative years were deeply shaped by race-evasive discourses. These roots—and Robertson’s professional training in physics—impacted her relationality as the interviewer in this project; she saw herself and/or her experiences reflected in the discourses that participants brought forward, including race-evasive ones, and she tried to take a stance of non-judgment and curiosity, reflecting back what participants said and seeking clarification and elaboration. Robertson spent most of her life ignorant of the current material landscape of white supremacy, an ignorance encouraged by white supremacy and enabled by her dominant position as a white woman. She approaches equity analyses centered on race with the positionality of a learner theoretically informed by Critical Race Theory, and her writing necessarily reflects (at least in part) the scaffolding she needed (and still needs) as a learner. At the same time, Critical Race Theory, while centering race and the dismantling of racism, has a “larger goal of eliminating all forms of subordination” [37] and thus speaks broadly to the experience (and dismantling) of systemic marginalization. It was in encountering CRT that Robertson was able to name the material and existential impacts of ableism on her life, and her experiences of marginalization as a disabled and chronically ill woman shape how she understands CRT. She sees her scholarship, including scholarship on the impacts of white supremacy in physics teaching and learning, as deeply personal and as part of a collective struggle for liberation [39,71]. In this study, Robertson co-constructed the interview protocol, conducted the interviews with faculty participants, selected quotes for collaborative analysis, and wrote the first draft of the paper.

Vélez is the U.S.-born daughter of immigrant parents from Panamá and México. She grew up in the Los Angeles area, where she attended Catholic schools from first grade through high school. As immigrants, Vélez’ parents held a strong belief in the American dream and the conviction that

<p>Part 1: Questions about physics</p> <ul style="list-style-type: none"> • What excites you about physics? • What do you want students in your class to learn? To think physics is? • How does this translate into your classroom practice? • What are some of the qualities of a good physicist? How do you know when students have these qualities? 	<p>Part 2: Questions about representation</p> <ul style="list-style-type: none"> • What is the makeup of your department/whom you interact with the most? • To what extent do you agree with these statements about why some people succeed in physics and others do not? (Statements about hard work, innate qualities.) • Do you think it is an advantage or disadvantage to be white in physics? What about being a man? • The National Science Foundation has a number of funding priorities (list: funding for basic science research, funding for basic educational research, funding for scholarships for Students of Color, etc.). Which of these do you think should be prioritized? • Generally speaking, Students of Color score lower on the GRE than white students. Do you think physics departments should provide special opportunities to Students of Color to reverse this trend? • Some people say that over the last 10 or 15 years, there has been a lot of progress in getting rid of racial discrimination in physics. Others say there hasn't been much real change. Which would you agree with more?
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FIG. 2. Sample interview protocol questions (version 1). Image description: Box with a vertical line separating two blocks of bulleted text. To the left of the line is the title, “Part 1: Questions about physics”. Bulleted text under the title is a list of questions. The first bullet reads, “What excites you about physics?” The second bullet reads, “What do you want students in your class to learn? To think physics is?” The third bullet reads, “How does this translate into your classroom practice?” The fourth and final bullet reads, “What are some of the qualities of a good physicist? How do you know when students have these qualities?” To the right of the vertical line in the box is the title, “Part 2: Questions about representation”. Bulleted text under this title is also a list of bulleted questions. The first bullet in this list reads, “What is the makeup of your department/whom you interact with the most?” The second bullet reads, “To what extent do you agree with these statements about why some people succeed in physics and others do not? (Statements about hard work, innate qualities.)” The third bullet reads, “Do you think it is an advantage or disadvantage to be white in physics? What about being a man?” The fourth bullet reads, “The National Science Foundation has a number of funding priorities (list: funding for basic science research, funding for basic educational research, funding for scholarships for Students of Color, etc.). Which of these do you think should be prioritized?” The fifth bullet reads, “Generally speaking, Students of Color score lower on the GRE than white students. Do you think physics departments should provide special opportunities to Students of Color to reverse this trend?” The sixth and final bullet reads, “Some people say that over the last 10 or 15 years, there has been a lot of progress in getting rid of racial discrimination in physics. Others say there hasn't been much real change. Which would you agree with more?”

schooling was the only way out of poverty and the ticket to a better life. Thus, she was shaped by race-evasive ideologies that insisted hard work, persistence, and resilience were the only ingredients needed to succeed. Like many children of immigrants, she served as a translator for her family. She witnessed countless moments of disdain and judgment on behalf of her teachers toward her mother for not assimilating, and the frustration and shame her mother felt as a result. Though she did not have the language then, Vélez understood at early age how schools actively work to subtract her family's culture [72] and envelope her, and others like her, in whitestream ideologies [73]. Vélez went on to pursue grassroots organizing to support Latinx migrant families, like her own, in campaigns for educational reform and completed a Ph.D. in education, with a focus on race and ethnic studies. She was mentored by a prominent critical race theorist in the field, who deepened her theoretical and methodological skills for conducting research on race and racism in education. It was also during this time that she expanded her consciousness on how multiple vectors of power impact her daily experiences as an able-bodied, cis-gender, heterosexual

woman. And while she identifies as Chicana, Vélez also recognizes the benefits she enjoys being phenotypically white. Vélez supported data analysis and contributed writing and extensive edits to the manuscript. Though she did not participate in the interviews, her positionality and training mediated data analysis. Despite the fact she has limited connections to physicists or the academic field of physics, Vélez' background in Critical Race Theory assisted in pointing out nuanced instantiations of race evasiveness in participant interviews.

Hairston is an African American cis-gender male who participates in equity and educational research, training, and facilitation. He was raised in a diverse, urban working-class neighborhood on the west coast of the United States and shaped by the social justice theology of the Black Christian church. This included regular memorable interactions with refugee and immigrant communities. Hairston's lived experiences include a working-class family background and multilingual community. His values for a just society, beloved community, come from these social identities and lived experiences. Having experienced racism personally and institutionally, the perspective Hairston brings is informed by

anti-Blackness advocacy and by the intersectional identity of African American matriarchs. Academically, Hairston holds a PhD in education and his studies include sociocultural studies and liberative frameworks regarding race, gender, and sexual orientation in education. Previous experiences in global engagement includes situating the impact of settler-colonialism in education, from which he conducts research primarily through a constructivist lens. Taken together, Hairston's philosophical worldview is the situated and contextual nature of teaching and learning. As such, Hairston engages physics education research as an outsider, unfamiliar to many of the specific physics concepts and theories discussed in the interview data. At times this feels ambiguous or a place of unknowing, and other times it provides an opportunity to ask the obvious but relevant question. Hairston offered feedback and co-thinking at every stage of this study, from the construction of the protocol through the analysis and writing of the paper.

Bonilla-Silva is an Afro Latino man born in the U.S. but raised in the U.S. territory of Puerto Rico. He endured the arguably deeper racism of Puerto Rico's "racial democracy" where race matters in all aspects of life, but where there is very limited discursive space to talk about race. Silence on race matters is a formidable shield for the Puerto Rican racial order. He moved back to the mainland in 1984 to pursue a Ph.D. in Sociology and quickly realized the import of the "in your face" American racial order. This process led him to rethink his own identity, his politics (then he was a vulgar Marxist for whom all was class), and his focus of work. Slowly but surely, he became a "race scholar" and now, 40 years later, he continues doing research on race matters and working to advance the cause of racial and social justice. Bonilla-Silva co-constructed the interview protocols, contributed to early phases of data analysis, and offered feedback on multiple versions of the manuscript.

Analysis.—Because our goal in this paper is to identify discipline-specific race evasiveness *in discourse*, we use discourse analytic techniques [74] to analyze our interviews, identifying instances of each race-evasive frame. After interviews were complete, they were transcribed by a secure artificial intelligence system and corrected by the research team to ensure accuracy. We then carefully read through each transcript, identifying instances of the abstract liberalism, naturalization, cultural racism, and minimization of racism frames. We grouped these instances into themes that sought to capture the meaning of what participants were saying [41,75]. For example, original themes under cultural racism included "poor schooling," "family investment in education," and "family expectations of high-paying jobs". We looked for ways in which these themes intersected with physics-specific values, stories, and discourses, informed by ethnographic and sociocultural work in physics, and iterated together on those intersections. Analysis was conducted collaboratively, enhancing

the interpretive validity of the work; analysis was also conducted in consultation with Bonilla-Silva, a developer of the original theory, enhancing the theoretical validity of the work [76].

In the remainder of the paper, we illustrate what race evasiveness can look like in physics, using quotes from interviews. Our aim here is to analyze *discourse*, not *people*. We cannot emphasize enough that this analysis is meant to be about *physics* and race evasiveness—how race-evasive frames are marshaled to evade race in sense-making about racialized phenomena in physics, and how physics-specific discourses and epistemologies support and are supported by these frames. It is *not* about individual-physicists-as-racists.

Importantly, though not the focus of our analysis, faculty also issued challenges to white supremacy within physics. For example, when asked about giving priority to People of Color and women, transgender, and nonbinary folks⁷ in hiring, participant C answered that he "think[s] we should have reparations," including "monetary compensation for harms done by legal racism". Faculty also challenged the necessity of aggressive argumentation practices. Every faculty member we interviewed was passionate about equity in physics, expressing a desire to see change happen.

The four frames within race evasiveness do not receive "equal attention" in our writing, and some participants' quotes are featured more than others. This choice was intentional and informed by our primary goal of illustrating race evasiveness in physics. For example, abstract liberalism is both the most complex frame, conceptually, and also the most common frame in our interviews; thus it receives more attention in our writing. Likewise, some interviewees were more keen to offer illustrative examples than others; these examples often made the relationship between physics and race evasiveness especially clear, and so quotes from these interviewees may appear more frequently than others. None of the frames was uncommon, and none of our illustrations are idiosyncratic.

⁷Throughout the manuscript, we use phrases like "People of Color and women, transgender, and non-binary folks," and "People of Color (or women, transgender, and non-binary folks)". In separating these categories ("and," "and/or"), these descriptors obscure the experiences of people who live at particular intersections of gender and race. We know from work like that of Crenshaw, Collins, and Truth [62,77–80] that, for example, Black women are subject to both racism and sexism, meaning that neither the label "women" nor "Black folks" accurately depicts the fullness of their realities, particularly as interpreted in, e.g., mainstream white feminist discourse. The phrases we use here likewise do not accurately depict (or acknowledge) these intersectionalities. They do, however, reflect the structure of our interviews (and mainstream discourse in physics, as used by our interview participants), which largely separated race and gender in questions. This is a limitation of our work.

IV. DEFINING MAINSTREAM PHYSICS DISCOURSES, STORIES, AND EPISTEMOLOGIES

This paper is about discipline-specific instantiations of race evasiveness, and central to our claim is that mainstream physics discourses, stories, and epistemologies reify and/or support race evasiveness. In this section, we briefly say what we mean by “mainstream physics discourses, stories, and epistemologies,” drawing on quotes from our interviews with physics faculty and literature about the culture and practices of physics.

In interviews, faculty often reflected on what they think physics *is* as they answered questions about what drew them to it, what they most want their students to learn, and what they want their students to think physics is (or is not). Faculty repeatedly referred to physics as describing natural phenomena using a small number of basic principles:

- “[We’re] trying to understand natural phenomena from first principles at a most basic level”. (participant M, what physics is)
- “...there are relatively few fundamental principles that govern the way the universe works”. (participant D, what he wants his students to know about physics)
- “[Physics is] an attempt to use a small number of core principles to understand the physical world”. (participant L, what physics is)

Faculty emphasized that these core principles are “written in mathematical language” (participant J), where

“...you start with a real issue, you translate it into mathematics, now you manipulate the mathematics. So you go into a completely different plane, you’re out of the real world, you’re in this mathematical plane and it’s completely a theory if you like, and then you take the mathematics and you connect it back to the real world, and it still describes the phenomenon so it still gives you a statement, it allows you to make a prediction about how the real world behaves”. (participant E)

Participant E goes on to describe the capacity to map physical phenomena onto mathematics and back as “bizarre” and “amazing,” echoing other faculty’s sense of awe and wonder about the capacity of physics and mathematics to describe and predict natural phenomena.

Faculty also emphasized that the knowledge produced within physics is separate from the social processes that produce it. For example, participant M says that the production and acquisition of physics knowledge “is a communal process and has lots of...sociological components,” but

“...when you get to the final product where you say, ‘okay, we actually solved this problem...and now we’re going to write the textbook on it,’ that textbook is not a white, middle-class textbook, it’s a physics textbook”.

According to interviewees, this separateness between process and product means that physics knowledge carries a certain kind of reliability, such that “you will always get the same result” if you set the problem up in the same way (participant A). This separateness is also linked to there often being one right answer, an answer that is disciplined by “reality,” rather than humans (and their feelings): “reality [is]...the ultimate arbiter of what truth is...nobody cares what you think about it” (participant B). The idea that the physics canon reflects a universal reality (and not a local, social construction) is also reflected by participant F, who says she was drawn to physics because she “very much buy[s] into the...idea that...fundamental physics is...unlocking the...underlying rules that the universe runs by”.

According to some interviewees, physics knowledge—the “rules” participant F refers to—is arrived at through a particular process that ensures that it applies across phenomena and is correct and universal. participant M describes this process as

“...our approach to...talking about problems where we really believe there’s a right answer and there’s only one and we should all be focused on getting that”.

Participants L and D add to this, saying that physicists “doubt, we’re skeptics” (participant L) and that being “critical and not accepting of everything we hear” is “part of physics” (participant D). Pointed or critical questions are “the way physics often proceeds,” “keeping the level of discourse scientifically very high” (participant D) and thus making sure that the ideas that are produced meet high standards. Others in our sample emphasized the collaborative nature of knowledge seeking in physics, emphasizing that what is essential is “a sense of shared purpose and collaboration” (participant F).

Many of these sentiments from interviews are echoed in the literature. Ethnographers and scholars in the sociology of the sciences have highlighted a number of ways in which physics, as a culture, sees the discipline as objective, acultural (separate from a particular time or place), neutral, and universal [81–85]. These qualities are thought to be connected to one another—e.g., physics’ aculturality is thought to be necessary for its universality, its neutrality needed for its objectivity. For example, Harding [82] reflects that “it is exactly the lack of cultural fingerprints that conventionally is held responsible for the great successes of the sciences,” and Traweek [81] gives an account of physics as “a culture of no culture, which longs passionately for a world without loose ends, without temperament, gender, nationalism, or other sources of disorder—for a world outside human space and time”.⁸

⁸To be clear, these authors and others *critique* these depictions of science, arguing in fact that science is subjective and deeply rooted in time and place.

Indigenous scholars have articulated some of the ways in which Western science⁹ takes up a “subject-object” orientation to the natural world: Western science “position[s] humans as separate from the natural world...transform[ing] nonhuman forms of life into objects for human use” [88]. (Eurocentric) physics, like (Eurocentric) mathematics, “places an emphasis on standard terminology [over local, embodied experience], a decontextualized epistemology that seems fitting for any place that can be colonized” [89]. This subject-object orientation is endemic in positivism as applied within physics: the notion that there is a physical world ‘out there,’ separate from human perception and culture, that can be known to some level of truth through the use of appropriate (scientific) methods. Grosfoguel [84] traces the subject-object split in science back to Descartes, whose claim that “the mind is of a different substance than the body...allows the mind to be undetermined, unconditioned by the body”. He elaborates as follows:

“The subject-object split, ‘objectivity’ understood as neutrality, the myth of an EGO that produces ‘unbiased’ knowledge unconditioned by its body or space location, the idea of knowledge as produced through an internal monologue without links with other human beings and universally understood as beyond any particularity are still the criteria for valid knowledge and sciences used in the discipline of the Westernized university”.

Here, Grosfoguel goes so far as to say that the mind-body, subject-object split is *a criterion for valid knowledge* as conceived within the sciences: disembodiment is not only an ideal but a requirement. Grosfoguel goes on to argue that the claiming of universality enabled by Cartesian dualism cultivates the (imagined) possibility of producing “an unsituated knowledge that is God-like or equivalent to God”. Hermanowicz [90] argues similarly in the context of physics, highlighting that physics seeks to answer many of the same questions as religion, but with empirical methods, assigning a “near-immortal” status to physics and to physicists.

The literature also describes physics *culture* and *discourses* as competitive, individualistic, rational, and elite

[83,91,92]. These themes from the literature are deeply tied to those from our interviews. For example,

- Physics as in pursuit of a small number of fundamental principles reflects the value of universality (which is also tied to aculturality).
- Physics as described by (abstract) mathematics reflects the value of disembodiment.
- Physics as arrived at through competitive argumentation reflects the cultural values of competitiveness and elitence.

In the remainder of this paper, we will draw on these descriptions, calling them (mainstream) “physics discourses, stories, and epistemologies,” to show ways in which they reify race-evasiveness. This work follows in the tradition of other scholars have likewise highlighted ways in which these values reinforce whiteness [7,8,67,93,94], patriarchy [92,95], and ableism [96].

V. RACE-EVASIVE FRAMES IN PHYSICS AND PHYSICS TEACHING AND LEARNING

In this section, we illustrate physics-specific instantiations of the race-evasive frames of abstract liberalism, naturalization, cultural racism, and minimization of racism. These examples show some of the ways in which physics has internalized and adapted race evasiveness to sense-make about and maintain dominant social structures within the field, supported by mainstream physics stories, values, and practices. Our primary goal here is to offer readers a sufficiently complex and robust analysis of the discourse so as to be able to recognize similar discourses in their own contexts (“generalization by analogy,” as Wehlage [97] calls it). Though not representative, *per se*, the quotes we chose are not idiosyncratic, either in the context of our interviews or in the context of our personal experiences.

A. Abstract liberalism

The abstract liberalism frame was evidenced in all twelve interviews in our study. Here we focus on *discipline-specific* instantiations of this frame—ways in which faculty marshal physics epistemology to further stabilize the frame, and/or stories about physics as a discipline that reinforce the abstract liberalism frame.¹⁰

Abstract liberalism theme: Grit.—When asked what are some of the qualities of a good (or successful) physicist,

⁹Here, our use of “western” and “westernized” does not refer to a geographic location, but instead to an ideological one, that signals how mainstream understandings of the world are not neutral and in fact reflect particular epistemologies, ontologies, and axiologies. According to Brayboy [86], western approaches to knowledge production look for “eternal truths, laws, and principles that may be proven through the posing of hypotheses, test construction, and ‘scientific’ experimentation”. The use of the word “western” reflects the role of these approaches in (European) settler colonialism [87]; in choosing this term, however, we risk overgeneralizing an oppressive ideology to the geographic “west,” which includes South America and some African countries.

¹⁰Though not our focus in this section, abstract liberalism was also used in less-discipline-specific ways, reflecting more general themes reminiscent of those in Bonilla-Silva’s work. For example, when asked if physics departments should provide special opportunities to Students of Color in preparing for the physics GRE, participant H said, “Do you suddenly have, uh, departments that have, once they get a black student, they have all these special classes for them that that’s going to cause a major or, yeah... [Y]ou gotta be careful you don’t, um, I mean, you don’t want to instill discriminatory p- uh, uh, some something that’s discriminatory to improve something that’s been discriminatory”.

and what indicates that students have these qualities, faculty interviewees often drew on a story of *physics as inherently and characteristically hard*. Being hard is part of what physics *is*, according to this story, and thus it requires hard work to be successful in physics. To sustain this hard work over a long period of time requires a kind of “grit”—a willingness to sacrifice in pursuit of understandings, and a love for and curiosity about the discipline that will sustain one’s (difficult) pursuit. For example, participant D reflects on his experience taking a preliminary exam in graduate school, saying,

“I remember in graduate school, um, we took classes for the first year, and then we have this preliminary written exam that you had to pass in order to move on to do your thesis research. And ...in those days...the pass rate was only 50%...and this exam was made out to be the be-all and end-all of your career. And so after the first semester or two of graduate school, I realized that in order to pass this exam, I had to teach myself the physics that was going to be tested. And so for six months I didn’t take any classes. I went into the library every single morning, opened up all my undergraduate physics texts and just studied them and did every problem in the book. And in the morning I would feel fine. And by lunchtime I’d have this knot in my stomach and I was, you know, living on Tums nonstop, but I took the exam and I passed it and I was burned out for the next six months. I didn’t do anything after that. ... I had to force myself to learn the physics to pass that exam. And if I hadn’t passed it, you know, okay, my life would’ve been different. I would’ve gone and done something else... Um, but for me, it worked out. Yeah. But I was going to say, this is one of the things which, um, I think may contribute to the lack of diversity in physics. And I know we’re going to get to this later, but physics is just darn hard, I think all for almost everybody. Okay. And it’s also incredibly competitive ...and you know, you were sort of told that not all of you are going to make it through and you sort of look around and try to gauge, you know, who you’re competing against and make it through. And like I said, this written exam, only half the people would pass and maybe after two or three tries, maybe two thirds of them would pass, but there was a large number of people who simply failed and couldn’t do it, or wouldn’t, you know, wouldn’t be able to pass the exam. And knowing that I think discourages a lot of people from continuing. You know, it’s not to say that other fields aren’t difficult and other fields aren’t also competitive; I think in physics it’s particularly competitive”.

Here, participant D describes his experience of taking a high-stakes qualifying exam in graduate school. He offers compelling imagery of the grueling nature of this experience: only 50% of his cohort was expected to pass the

exam, which was “made out to be the be-all and end-all of your career,” since not-passing meant that you were not allowed to continue in the Ph.D. program. He describes how taxing the preparation was for him: not only did he spend every morning in the library for six months, “doing every problem in the book,” he felt physically ill from the stress, with a “knot in his stomach,” “living on Tums nonstop”. He reflects that “it worked out” for him, but it could have gone another way.

Importantly for our analysis, participant D attributes his success on the exam to his willingness to work hard, and he theorizes that the “lack of diversity in physics” is due, at least in part, to “a lot of people” being “discouraged” by the difficulty and competitiveness of physics. Here, physics-specific notions of grit function to construct a powerful narrative whereby participant D—as an individual—succeeded in persisting through, with some amount of luck (it could have gone another way) and a lot of hard work. *He* was willing to do it; others may not be. For participant D and others, this narrative carries with it an almost-playful working of the edge between pride and humility: They have done a wild thing—something not-to-be recommended, you would be smart to avoid it!—and yet they have succeeded. (In fact, participant D compares his mindset in preparing for his qualifying exam to climbing mountains: a risky venture that skirts the edges of what is reasonable for humans to do.)

Grit also functions to mask the privilege that made this unfolding of events possible for participant D. To spend six months studying for an exam and six months recovering, to be in a position where Tums is sufficiently palliative to allow a body to continue laboring under duress, to believe in the first place that it was possible for him to succeed on an exam with a 50% passing rate... All of these are signs of the privilege that participant D and others like him hold. Yet none of these—nor the privilege they reflect—are named as what it takes to be successful.

Stories with similar themes showed up in a number of interviews. Participant G describes himself as “losing time just playing with programs,” and participant H describes herself showing her students all of the dented covers of books that she threw out of frustration as she worked on difficult problems. Faculty name curiosity, perseverance, persistence, a willingness to stick with it, a love for the discipline, being able to handle pressure, and wanting to understand (not just get a good grade) as traits that define a good physicist or good physics student. Participant H emphasizes that students have to dedicate themselves to the work, which sometimes means resisting the temptation to participate in proximal opportunities for fun: “So I think you have to, you have to not be afraid to fail. You have to persevere. You have to want it, you have to want it I think. Because I think you get, there are a lot of times when you just, your friends are out having fun and you’re in the room, working physics problems”.

Implicit in these stories of success is that Students of Color—those who do not “make it through”—fail because they were out with friends, did not work hard, or are not compelled by discovery. Grit shifts the narrative to individuals, away from structures; it is not that physics *excludes* People of Color, it is that People of Color have failed. Grit “urge[s] disadvantaged people to become resilient while social, political, and educational systems continue to abuse and neglect them” [45] and “judges the families of Black, Indigenous, and Latinx students by white, Eurocentric standards that value individualism instead of communal norms” [19].

Abstract liberalism theme: Equal opportunity and individualism.—Bonilla-Silva also describes a number of ways in which people marshal *individualism* and *equal opportunity* within the abstract liberalism frame to explain racial phenomena in race-evasive ways. In our interviews, faculty called on the story of physics as objective—free from bias and culture [81,82]—to support arguments about equal opportunity and resist organizational intervention.

As one example, when we asked participant J whether he saw any connections between how he thinks about physics (from the first part of his interview) and representation and success in physics (second part of his interview), he initially answered that

“in a purely intellectual sense, I don’t see any connections...I don’t, I don’t see any reason to think that people from any particular group are more poorly suited to be creative or, um, curious, or mathematical. So I don’t that that’s the connection. To the extent that any of those things have cultural connotations, then you start to come into play with cultural prejudice and social prejudice. Um, but...those things that I discussed...are not the first things I would talk about in terms of what physics is like that has a cultural component to it. Um, I think some of the...modes of interaction are more significant than the modes of intellectual activity”.

Here, participant J revoices his earlier answer about the qualities of a good physicist—curiosity, able to sense-make with mathematics—and challenges the connection between those traits and underrepresentation, saying that he does not “see any reason to think that people from any particular group are more poorly suited to be” those things. This quote positions participant J as not-racist: his analysis is that everyone is equally suited to be creative, curious, and mathematical, and thus to do physics. Participant J hesitates briefly, drawing on a physics discursive strategy, akin to ‘the sense in which that could be true is...,’ naming that it is possible that these qualities interact with cultural and social prejudice. But he poses an alternative that he thinks is more compelling: it is not that curiosity or creativity (what he names at the end of this quote as “modes of intellectual activity”) are culturally connoted but instead that there are “modes of interaction” that are significant in producing

underrepresentation. Following the excerpt above, participant J elaborates on what he means by “modes of interaction,” naming “the way that one presents themselves,...the way that one communicates,...the...attitude that one can take towards students or colleagues”. These modes can be “aggressive and condescending,” even if the “intellectual idea...in itself...[is not] prejudicial”.

He revisits his answer to this question again at the end of the interview, saying that “expressions” of “internal racism” can be

“communicated through all...sort[s] of mechanisms, institutional and social. I don’t, and going back to my previous comments about, um, intellectual activity, I don’t think that...understanding like Newton’s laws of motion...I don’t think that white people are particularly good at that and people from other backgrounds aren’t. And I think that the intellectual part is as available to anybody who is interested in pursuing it. So I would disagree that, uh, um, I think that a, um, Indigenous woman can be just as good at doing quantum mechanics as a Jewish man”.

In this series of quotes, participant J lays out a relatively robust ideological stance: he believes that racism matters for people’s experience of physics, and that it shows up in institutional mechanisms, such as hiring decisions, and in “modes of interaction” including aggressive or condescending attitudes toward students. He does not believe, however, that the *intellectual* “modes” within physics interact with white supremacy; these are equally available to everyone, regardless of race. We hear him saying that *physics itself* does not privilege any one group of people; we all have equal access to *physics*. What this analysis misses, like all analyses that draw on equal opportunity frames do, is a structural analysis of the *discipline itself*; participant J lends that structural analysis to social interactions and institutional decision making, but treats the discipline as separable from these.

Participant M, when asked the same question as participant J, says

“So, um, I guess I would say, I could...believe that [how I think about physics and underrepresentation] may be connected in some, um, abstract way. I don’t think of them as especially connected...Addressing the representation issue is important, but I don’t see that as a, as a productive avenue. Um,...that is, trying to rethink how I approach presenting physics to the students as a productive avenue for, to try to deal with the representation issue”.

Here, participant M draws on the race-evasive style of “yes-and-no-but” [17]: ‘yes, my ideas about physics are connected to underrepresentation, but no, not substantively, in that we need to address underrepresentation but not by

rethinking how I've been teaching.' "Yes and no but" is a semantic move that allows dominant actors to save face and cope with the incoherence of race-evasiveness. Participant M goes on to name what his department is doing to "deal with the representation issue," and says that "the process of formation in the classroom is not one of the things that [they] have identified as an area [they] can improve on". The "biggest thing," to participant M, is "community building," especially for "minority groups".

Participant M's opposition seems rooted, at least in part, in his belief that physics knowledge is objective. Shortly after the quote above he says that the

"idealistic version of physics that I laid out at the beginning...is really what we're trying to [teach]; that's...what knowledge is in physics, and I'm very aware of the fact that the acquisition of that knowledge is a communal process and has lots of...sociological components that include all kinds of bias and other things. But the thing we call knowledge is the outcome of that process, and that is divorced from those things... [W]hen you get to the final product where you say, okay, we actually solved this problem, or this set of problems, and now we're going to write about it, that textbook is not a white, middle-class textbook. It's a physics textbook".

In this framing, physics classrooms do not need antiracist reform because physics is not racist; it cannot be: the "final product" of the physics enterprise "is not a white, middle class textbook, it's a physics textbook" [98]. Participant M's resistance to reform is less obviously about maintaining individual choice and more about protecting the mythology of physics as objective, but it does *function* in similar ways as those described by Bonilla-Silva: it recuses participant M and others like him from the responsibility of taking seriously their role in dismantling white supremacy in physics teaching and learning. This points to the mutually reinforcing nature of the frames of race evasiveness; here, abstract liberalism supports the minimization of racism, a frame we'll discuss in more detail later.

B. Naturalization

Bonilla-Silva describes naturalization as "a frame that allows whites to explain away racial phenomena by suggesting they are natural occurrences," reinforcing the myth of non-racialism by suggesting that preferences and outcomes are "biologically driven and typical of all groups in society". Participants in Bonilla-Silva's study, for example, used naturalization to explain neighborhood segregation; rather than a structural analysis of redlining and discriminatory lending practices, participants used discursive moves like "like gravitates toward like". Participants in our study likewise used the naturalization frame to make sense of

underrepresentation in physics, in ways that make underrepresentation seem like the natural state of things, given differences in preference, aptitude, and level of comfortability. This frame was evidenced in 10 out of 12 interviews.

Naturalization theme: Certain (inherent) traits make people better at physics.—Participants used this frame in ways that were more and less clearly entangled with the discipline. For example, in naming the characteristics of a "good physicist," some participants named innate traits, reflecting the idea that some people are just naturally better than others at physics [99,100]. Participant L named the "ability...to see a complex problem...and...identify...and apply the relevant principles" as a skill that has "some, uh, inheritability". Participant D said that "some people are better at mathematical concepts than others," and this may just be about "the way your brain is wired"; "some people are very talented musically" and "some people are just better at certain aspects of, uh, academia than others". Participant C said that to be the greatest physicist alive, you would need to have been "born with like, you know, whatever brain it is that is best suited for the cause," among other things. We would call these marshals of naturalization "lightly" entangled with physics; they do rely on notions of what physics is and requires, but they are also quite close to the frames marshaled by Bonilla-Silva's participants. Importantly, such explanations, when marshaled to explain success in the context of a discipline with such marked underrepresentation of People of Color, imply that People of Color are *not* these things, connecting naturalization to the cultural racism frame.

Naturalization theme: "Like gravitates toward like".—Faculty sometimes marshaled the naturalization frame in ways very consistent with Bonilla-Silva's original study, but in ways that relied on physics-specific discourses. For example, participants drew on "like gravitates toward like" reasoning to argue that there are few People of Color (or women, transgender, and nonbinary folks) in physics because "there are few people who look like them". When asked whether underrepresentation could be explained, at least in part, by women having to alter their appearance or conduct to fit in to local physics culture [13,14], participant M responded

"...[Y]es, that's definitely an issue and that, I think that is part of what makes it hard to bring up numbers [of women in physics]...Um, I think of it more as a, as a consequence of the gender imbalance than a cause, but it does create, it does create a barrier...That it's, it's not that, um, physicists are, um, more sexist than the culture as a whole. It's just that if you have a working environment that's 90% male, it's gotta be tough for the 10% who are female. Um, and so if that's more or less appropriately correct analysis, then it's, it's an effect of 90/10, not a cause of 90/10, but it might be

part of why once you get to 90/10, it's hard to get back to 50/50".

Here, participant M distinguishes between (1) the “cause” of the gender imbalance in physics and (2) its “consequence[s],” saying that “part of what makes it hard to bring up the numbers” of female physicists is the existence of a majority-male environment. Participant M seems to think this logic a compelling alternative to sexism as the reason for the underrepresentation of women in physics; he says, “it’s not that physicists are more sexist than the culture as a whole,” “it’s just” about the numbers—“it’s tough” for women when there are so few of them. The structure of participant M’s logic *sounds* science-y; he uses numbers and distinguishes between cause and effect. However, notably, participant M does not problematize *how* physics got to be 90% male; it just is, and that’s just hard for women. The continued gender imbalance is a natural outcome of this (unquestioned) state.

Naturalization theme: Physics draws people who like a challenge.—Participants also used the naturalization frame in ways consistent with a story of physics as characteristically hard: because physics is, by nature, hard, it is only natural that it would draw people who like a challenge. For example, in the quote referenced above, participant D says

“...physics is just darn hard, I think all for almost everybody. Okay. And it’s also incredibly competitive ... and you know, you were sort of told that ‘not all of you are going to make it through’ and you sort of look around and try to gauge, you know, who you’re competing against and make it through. And like I said, this written exam, only half the people would pass and maybe after two or three tries, maybe two thirds of them would pass, but there was a large number of people who simply failed and couldn’t do it, or wouldn’t, you know, wouldn’t be able to pass the exam. And knowing that I think discourages a lot of people from continuing. You know, it’s not to say that other fields aren’t difficult and other fields aren’t also competitive; I think in physics it’s particularly competitive”.

The logic of participant D’s reasoning goes something like: “physics is just darn hard,” by nature; it is hard for “almost everybody”. Participant D is someone who likes a challenge; earlier in his interview he said that he “wanted to climb Mount [name]...and [he] did it”. Others, though, are “discourage[d]” by the difficulty and competitiveness of physics, and that is why they choose not to do it. Importantly, for participant D, this is not just about ability; it’s about *preference*—it’s about *liking or not liking* a challenge.

Similarly, participant G draws on a deep story about the nature of *discovery* to naturalize (racialized) success in physics:

“I remember hearing...something to the effect of like no great discovery was made by someone wanting to make a great discovery. They essentially come from just being overly interested and curious about a thing and wanting to know more about it, you know, and then you figure things out when you’re interested in them. But that’s kind of a cop out answer because everyone’s interested in different things. I think one of the things that I’ve found when I’ve been successful at things in physics...is being...comfortable in just like the ignorant. You know, like learning something new by definition [you] don’t know it, which is an uncomfortable feeling of like, yeah, I feel stupid. I want to get away from it. Right. And just being able to sit there and...not know that they’re doing this calculation or this derivation or whatever might get the answer, but just, I’m going to see it through to see if I learn anything and not run away from that discomfort of not knowing, I think is one of the big things. And I think curiosity kind of masks that if you’re really interested, you’re going to spend the time to go through”.

Here, participant G describes the nature of discovery in science: by definition, discovery means “you do not know it,” and thus it requires doing calculations or derivations without knowing they will work out. For participant G, curiosity and interest sustain this process, which takes time and discomfortability: “If you’re really interested, you’re going to spend the time to go through”. Not everyone has that interest, so naturally, not everyone will do physics. As with participant D, participant G does not name the privilege, racialized and otherwise, associated with “being comfortable,” being (or seeming) ignorant or trying things that may not work; a growing body of scholarship exposes the hostile academic environments wherein Faculty of Color, and women faculty of color, in particular, must navigate and work against presumptions of incompetence to generate knowledge in the classroom [101].

Here, as elsewhere, participants D and G’s descriptions of success, when applied to underrepresentation in physics, imply that Students of Color do not like challenge. Importantly, race evasiveness allows participants to uphold a white supremacist status quo by *indirectly* insulting People of Color.

Naturalization theme: Physics retains people who enjoy competitive argumentation.—In addition to drawing on narratives about the nature of physics and discovery—physics is hard and discovery is uncertain—faculty also drew on narratives about the *process by which* physics knowledge is refined. In particular, physics knowledge is *made rigorous through competitive argumentation*; ideas are made better as they are subjected to critique and counter-arguments. The ideas themselves are thought to be abstract (disembodied) and objective (without feeling), thus the process is also thought to be such. In this model, it is natural that some people would enjoy (or be able to tolerate) this, and others would not. For example, participant M says

“[E]ven in our upper level [physics undergraduate] classes, you have to be pretty comfortable with...our approach to, um, talking about, about problems where we really believe there’s a right answer and there’s only one, and, um, and we should all be focused on getting that. And so there’s ... a certain dryness to it, and, uh, almost, um, uh, what do I want to say. You know, it’s not, uh, it’s not touchy feely, it’s not warm and fuzzy. Um, and it doesn’t, it should not be in any way, um, antagonistic, uh, or, um, or unfeeling, but it’s more a-feeling. Um, and, you know, and I think there are, uh, some types of people who gravitate towards that more naturally than others. And then course there are, um, situations where it becomes a little bit, uh, more antagonistic than it should be. And I do think, um, it’s easier to be successful if that doesn’t bother you. You know,...when you do something wrong on the board, and somebody says, that’s wrong, there’s different ways to say that’s wrong. And it’s probably helpful if you don’t take it too personally, when somebody says that... uh, inelegantly”.

In this quote, participant M describes an “approach to talking about problems” in physics, “where we really believe there’s a right answer and only one, and we should all be focused on getting that”. Because (“And so...”) the focus is on the right answer, which is objective and disembodied, the process itself is “a-feeling”—it is not touchy feely or warm and fuzzy. For participant M, not only do “some types of people gravitate towards [this a-feeling process] more naturally than others,” some people just take things less personally when this “a-feeling” process becomes “antagonistic” or “unfeeling”.

Participant D layers on to this in his interview, describing what happens in his research group when someone takes a “pointed” question personally. He says

“And so I would try to jump in and say, you know, what we’re after here is trying to understand the physics of this. And, you know, don’t take it personally. This is just the way physics often proceeds. And I tried to indicate that for better or worse, at least from my experience in physics, this is kind of the way physics gets conducted. And maybe that’s something we need to change if we want to attract a more diverse group of people into the field...I don’t know how to do that, in a way. And again, I don’t mean to sound arrogant about this, but, you know, somehow we want to keep a very high level in our physics, in our science. Okay. We don’t want to dumb it down. And what I get a little concerned about is, you know, if you make it all touchy-feely, then you are dumbing it down at some level, and I don’t want to do that. I don’t think anyone in physics really wants to do that. Um, but we want to make it more attractive to people”.

Here, participant D highlights that pointed questions are “just the way physics often proceeds”; they are not personal, so should not be taken personally. He names that this may be part of what contributes to a lack of diversity in physics, but he expresses concern that changing this—“making [physics] all touchy-feely”—will “[bring the level of physics] down,” and nobody “wants to do that”. Earlier, when describing the nature of argumentation in physics, participant D adds that “some people may have a hard time dealing with” the criticalness of it, and that “perhaps women find that more, um, offensive than men”. Participant D is not alone in his analysis; “technical and analytical forms of confidence” are often associated with masculinity and men [92]. Participant D layers on not just race evasiveness but also minimization of racism, saying that for People of Color, “especially if the criticism is coming from a white person, they take it as somehow being racially motivated, at least in part. At least in my experience, I’ve never seen that”.

Both participants D and M take the position that a-feeling, competitive argumentation is *the* mechanism by which rigorous physics is done.¹¹ The a-feeling-ness and pointedness is necessary to produce the best physics, the one right answer. The natural outcome of this is that some people will either not be drawn to physics or not be able to tolerate it. When contextualized in a conversation about representation in a discipline that is predominantly white and male, the implication is both that People of Color who object or feel this deeply are hypersensitive [102] and that People of Color and women and non-binary folks “just need to grow thicker skin, conform to the way things are, and deal with it, no matter how much it hurts” [7]. Importantly, this logic relies heavily on binaries—right and wrong (correct and incorrect), rigorous and not rigorous, rational and emotional. It also draws on the *styles* of race evasiveness—“slippery, apparently contradictory, and often subtle” [17]. For example, for participant M, physics knowledge is both separate from the social processes that create it (“the thing we call knowledge is the outcome of that process, and that is divorced from [the

¹¹Importantly, some participants overtly disagreed with this position, stating that the competitive and a-feeling nature of argumentation in physics is not necessary and is in fact problematic. For example, participant F talks about the book *Beantimes and Lifetimes*, saying, “I mean, everything’s framed as if, like, if you have a problem with physics, like it’s your problem”. A. D. R., the interviewer, reflects back that this means “there’s no responsibility for constructing a particular kind of environment,” and participant F clarifies that “there’s this conflation of, like, the products of physics research with, like, the physics culture that creates it,” adding that “that culture of physics is almost seen as essential”. A. D. R. revoices something participant F said earlier, “Yeah, like...the aggressive culture that you’ve been talking about”. participant F agrees, and when ADR asks if participant F thinks this culture is essential, participant F says no, adding that what is essential “is much more like a sense of shared purpose and collaboration”.

communal process of creating it, which has bias],” and it cannot be created apart from the a-feeling process of competitive argumentation.

A Critical Race Theory analysis would highlight that the outcomes of the physics teaching and learning process—underrepresentation of People of Color (and women, transgender, and non-binary folks) in physics—points to the racialized (and gendered) nature of the discipline [17,27,28]. Yet the quotes in this section reflect stories that evade race, treating success in physics as the natural outcome of the match between (i) *essential qualities of physics and/or knowledge-generating processes in physics* and (ii) *people’s interests, preferences, and comfort levels*. The quotes do not name the privilege that supports success in any of the examples, instead attributing success to *individual traits*, and so they imply deficit narratives of People of Color and women, transgender, and nonbinary folks, reinforcing cultural narratives of such people as, for example, overly emotional or lazy [103,104]. In these ways, this frame overlaps with both abstract liberalism (grit) and cultural racism, the latter of which we turn to next.

C. Cultural racism

According to Bonilla-Silva, cultural racism is “a frame that relies on culturally based arguments such as ‘Mexicans do not put much emphasis on education’ or ‘[B]lacks have too many babies’ to explain the standing of [People of Color] in society”. Cultural racism sometimes draws on aspects of the white racial frame [105], which (falsely) links physical characteristics (e.g., skin color) to cultural characteristics (e.g., work ethic, family structure) and uses this (false) linking to justify notions of superiority, rationalizing the “concentrat[ion of] an array of material and other resources in the hands of the supposedly superior group”.

In contrast to a race-conscious analysis that locates inequity in systems, the race-evasive cultural racism frame explains differential outcomes in terms of a deficit in students and communities, deemphasizing systems. Participants in our study often attributed underrepresentation at least in part to perceived cultural or group traits; 10 of 12 interviews evidenced the cultural racism frame.

Cultural racism theme: “Uninvested families”.—As in Bonilla-Silva’s original study, faculty draw on stereotypes about Families of Color to explain underrepresentation in physics. For example, in answering the question of whether underrepresentation could be explained by the investment families made in students’ education, participant B says, “Like, is it the fault of, you know, underrepresented groups that, you know, well, their parents didn’t care about education? I–, no I don’t think so”. Participant E answers the same question by saying

“I mean coming from a family background which gives you that starting point absolutely helps, but that’s not to

say that if you don’t have that, that you can’t have a chance, but you’re dealing with a [disadvantage] from, from day one. And I think that’s where, you know, the attitude of saying, we need to give these people opportunities, we need to open doors for them, you know, we can’t immediately give up and say, well, you’re just not cut out for this. This is where that kind of support structure is”.

Here, participant E marshals imagery of running a race: students who come from a particular “family background” have a “starting point,” whereas students who do not are at a disadvantage. Both participants B and E identify that it is the right thing to help such students; notably, though, the cultural racism frame positions participant B, participant E, and others as offering their help from a position of charity. It simultaneously positions the students as inferior, their “disadvantage” as something to be “dealt with”. Race evasiveness hides that participants B and E are in a position of *privilege* and instead narrates them as in a position of *generosity*.

Cultural racism theme: Lack of knowledge about what a physics degree affords.—Some faculty drew on a specific narrative of family that intersected with stories about physics. That is, faculty argued that Families of Color want their children to graduate from college with high earning potential, and (according to our interview participants) these families do not know enough about physics to recognize its earning potential (participant L), perhaps because physics is “esoteric” (participant J), or because there’s not as “clear” a “pathway to a well-paying job” (participant M). For example, participant L sense-makes about underrepresentation in physics by saying

“Um, ... you know, the white, suburban, middle-class students, um, ha[ve] the ability to think more broadly about what they want to do with their lives. Whereas, uh, a student from a poor background, no matter what...uh, race or ethnicity, um, is more focused on, um, getting through, being able to do it, ... and what is going to be the return on investment. Where–, what is the job? How, how sure is it I’m going to get that? ... Um, and I think they come in with a view where they don’t really know, and maybe the people in their life don’t really know... what it means to be a physicist, or a scientist as a career. Whereas they know what a doctor is, and ... they recognize that as a status. So questions of how they view status of different career paths and different degrees. And, uh, so they just come in, um, often with, for a variety of reasons: their, their, their, um, um, their family history, their–, the schools they’ve gone to, their, their, their–, the community–, the culture in their communities–, you know, a certain narrower view of what their options are and, and how to evaluate those is what’s important...”

The American dream, a personification of upward mobility in a meritocratic society, asserts that anyone, regardless of class or country of origin, can be successful with hard work [106]. Here, participant L differentiates between white families and Families of Color in terms of their understanding of physics as a pathway for upward mobility, evoking imagery consistent with the American dream. He draws on multiple examples within the cultural racism frame: family history, schools, culture, and “narrower view[s] of what their options are”. This analysis, like other analyses within the cultural racism frame, positions physics as fixed—available to be known—and “students from a poor background” and their families as deficient in their understanding. It lacks the structural analysis of physics as *exclusive*—made available to a select few students to know—and locates the blame in group traits.

Cultural racism: “Poor high schools”.—Faculty often attributed underrepresentation in physics to Students of Color going to “poor high schools”. Participant A says

“I think what happened is that they—, they didn’t have the luck for example, of having a very good teacher at the high school that get them in love with the topic. And, uh, and when that happened and that happens usually in the schools where the teachers are not very engaged with the learning of the students and usually happen in those, in these communities where there is not any—, much money that they can pay very good salaries to teach or something like that”.

Here, participant A draws in part on the physics-specific grit narrative we described above: to succeed in physics, you have to *love it enough* to stick with it through the grueling nature of the discipline. Students of Color do not have the benefit of engaged teachers “who get them in love with the topic,” because they go to schools where teachers are not paid “very good salaries to teach”. Similar to participant A, participant K says that the primary reason for underrepresentation in physics is “the socioeconomic background of the school that [students] came from”.

Though participants A and K point to the important role of white supremacy in school outcomes—differential resource distribution among schools that is, in fact, racialized [107–109]—this analysis (and thus the imagined solutions and Participants A and K’s role in them) misses the ways in which *all* schooling in the U.S. is racialized [110].¹² In positioning underrepresentation as the result of “students going to [specific] poor high schools,” participant A and others *evade* race as a guiding force in *schooling as an institution*, including higher education, relinquishing their responsibility to address the impacts of racism in their departments and

¹²It is in this way that race evasiveness again functions as “slippery, subtle, and apparently contradictory” [17]—these participants are marshaling one structural analysis in service of hiding another.

classrooms, and instead locating the “problem” elsewhere. Further, the active subject in many of the examples from our interviews is the student—they did not go to or have the benefit of a good school—rather than the system—schooling fails our Students of Color—which is why we characterize this as an example of the cultural racism frame.

D. Minimization of racism

According to Bonilla-Silva, minimization of racism is “a frame that suggests discrimination is no longer a central factor affecting [People of Color’s] life chances”. This frame includes stories about things being “better now than in the past” or resistance to reparations on the basis of “slavery ending 300 years ago”. It also includes dismissals of racialized events as nonracialized. Bonilla-Silva argues that this frame affirms (i) analyses that locate racism in individuals and (ii) discursive moves that accuse People of Color as “hypersensitive” or “using race as an excuse”. This frame was evidenced in 10 of 12 interviews.

Minimization of racism theme: Rational, thinking people are less likely to be racist.—When asked whether they thought that People of Color experience more severe and frequent, less severe and frequent, or about equally as severe and frequent racism in physics departments as in their everyday lives, participants in our study often answered less, arguing that *rational, thinking people*—i.e., people in physics—are *less likely to be racist*. This answer draws on the culturally-endorsed story of physics as objective and rational and on a narrative of racism as intentioned, treating physics epistemologies and white supremacy as mutually exclusive, by definition. For example, participant B says

“I would hope most of the people in physics departments are...thinking, rational people... Yeah, it’s, it’s me assuming that other people who do science, you know, behave like rational, normal people. And...certainly, all the people that I know—, when I look at events during the last year [surrounding the murder of George Floyd], there was, you know, uniform feelings about how people reacted to things, you know. So I think, at least in terms of thoughtful racism, I would hope it would be much less than in the community, cause I think it’s a group of people who I hope, think more about their actions critically...So in terms of feeling, you know, or wondering, ‘Do I belong here?’ Physics departments, you know, in that sense may feel like a very unwelcoming place. But if you talk to the individual people in the department, I think that they are people who—, they would—, they would think that they were, uh, pretty against, you know, being racist or judging people by their group...”

Here, participant B marshals a deep story about physics: physics is objective, and thus those who succeed in physics

are rational, thinking people—they are practiced in separating themselves from their feelings in a sustained way as they work toward a shared purpose. Racism, on the other hand, is irrational and driven by feeling. Therefore, people who do physics are less likely to be racist. Evidence that physicists are not only rational when they think about physics but also when they think about race is in participant B's colleagues' reaction to the police murder of George Floyd, which was “uniform” and “against being racist”. Participant B's move here may be a version of a “racial story;” e.g., “some of my best friends are Black”—here, “all of my faculty colleagues were mortified by the murder of George Floyd”—used to signal that the speaker is not racist [17]. DiAngelo [111] calls this “credentialing,” where “a white person mak[es] claims about themselves that mark them as antiracist”.

Participant E uses similar logic to participant B in answering the same question:

“Um, I would say probably less. Um—, and I think, you know, that's where I give some credit to scientists, you know, tend to focus, you know, and physicists in particular, would tend to focus, you know, very much on the scientific merit and not on how you look. You know, it doesn't matter whether you're beautiful or whether you're well dressed. Um, it's, you know, how do you handle yourself in a conversation, in a discussion, and I think there is a lot of, I think there is some—, there's a lot of inherent fairness there. Um, but again, there's also a lot of unawareness in departments. So I would lean towards maybe a little bit less, um, because it is a science that, you know, you know, is—, is—, is very comfortable with people from different cultures, people from different backgrounds, you know, as long as they share in this, in this, you know, what I call sort of a common worldview of how to—, you know, how to, how to describe, you know, how to describe natural phenomena, how to think about them”.

Participant E draws on the deep story of physics as disembodied and acultural: it does not matter “whether you're beautiful or whether you're well dressed,” and it does not matter what culture you come from or what background, what matters is the “common worldview” of science, which is separate from all of those things. Scientists—and “physicists in particular”—are focused on the “scientific merit” of what you say; science is “inherent[ly] fair” in that way.

Both participants E and B draw on deep stories about what physics is—a rational, disembodied pursuit of understandings of the natural world, with well-established and fair practices—to justify their sense that Students and Faculty of Color would experience less racism in physics departments. Though both participants E and B hint at the possibility of there being something unconscious happening, their analysis treats racism as acts of individual

meanness. Hodari *et al.* [7] describe the function of credentialing *physics* in the ways that participants E and B do: “since [physics is not racist], (white) physicists are exempt from any consideration of racism or doing antiracist work,” harming People of Color “via a denial and erasure of their experiences”.

Minimization of racism theme: Physics is not racist.— Similar to the notion that rational, thinking people are less likely to be racist, many faculty insisted that *physics*, as a discipline, is not racist. In each instance of this, faculty drew on race-evasive frames to construct a work-around: it is not physics that is racist, it is people, or funding, or the system of schooling. Physics is innocent; physics is rational and objective and thus free from social influences or feeling. For example, when asked whether he agrees with the statement “what we think of as knowledge in physics... centers white, middle-class, masculine ways of knowing,” participant L answered

“I mean, there are some challenges to that in the—, in the broader community, right? I mean, uh, where some saying that science, scientific method by its very nature, um, ... is racist, basically, or something like that... And so there are people who would—, who would say that there's an inherent thing. And if I believe that, I think that would be, I would, I would have very—, very much of a struggle with that. Um, as opposed to, we're always going to have to—, the scientific method and scientific approach, and what, what science is, is an enterprise—I mean, it, it, it sits within a culture. And, um, that culture is, is changing and so, um, and can be changed. ... So I don't think it's an inherent thing. I don't—, I don't believe the scientific method to be an—, uh, or the assumption that, that we can for the most part say, use science and mathematics to understand the physical world, um, uh, is—, it disadvantages anybody, but then that's just the abstract piece of it. Then how does it actually work out in practice? That certainly, uh, can, um, um, uh, have—, work itself out in many ways, which, um, um, advantage or disadvantage, you know, people in lots of ways”.

When the interviewer (A. D. R.) clarified, “So it's not... the science itself, it's the practice and the people doing the science where...the issue is located,” participant L answered, “Yeah. Yeah”. In this quote, participant L echoes a sentiment expressed earlier by participant J—that physics as a disciplined way of understanding the natural world is equally accessible to everyone, and so *physics itself* does not center particular ways of knowing. For participant L—and for participant J—it is the *practices* and the *social dynamics*, which are seen as separate from the physics, where the bias or the racism may be located. Sentiments like this one, which were common across interviews, significantly narrow the parts of physics that racism impacts and thus the parts of the enterprise that need antiracist

reform. This logic draws faculty attention—like participant M’s, described earlier—away from systems-level change (e.g., “rethinking how he approaches presenting physics to the students”) and toward things like “community building”. (To be clear, in our view, it is not that community building is unimportant; it is that it is *all* important.)

Minimization of racism theme: I do not have evidence of racially motivated harm.—Finally, some participants used physics discursive practices to minimize experiences of racism reported by People of Color. We saw this in the naturalization section above, where participant D shared that “*he’s never seen competitive argumentation practices be racially motivated*” (emphasis ours). We also see it in participant B’s reflection on the question of whether we could explain underrepresentation on the basis of Black, Indigenous, and Latinx students having to suppress aspects of themselves to participate in physics culture. He answers

“I mean, I guess I’m answering whether perception might make, whether it would feel that way? Yeah, I could imagine that. I mean, you know, whether it’s a real thing or not, that’s much more complicated, but that certainly...”

When the interviewer asks him to “say more about that,” he hesitates, saying, “I could certainly imagine that’s an issue”. The interview presses further, saying, “Can you say more about, like, what you mean by ‘whether it’s a real thing or not, you’re not sure.’” He then continues

“Well, I guess whether it’s a real thing is not something—, it would not be something for me to judge. But, you know, would someone coming into, uh—, you know, would the only Black person, you know, coming into a department, feel like there were aspects of, of them being Black, that they would have to suppress. I mean, certainly they wouldn’t have to suppress anything, I don’t know... And I think that same situation, if you walk into a room where you stand out in some way, I think it immediately makes you turn in a little bit...I think there’s a, you would feel some pressure to somehow—, whether it’s warranted or not is irrelevant”.

In this extended quote, participant B makes a distinction between “whether it would feel” necessary for Students of Color to suppress aspects of themselves and “whether they would have to”. He makes a connection to a race-neutral example: any time a person “stand[s] out in some way,” they will be inclined to “turn in a little bit”. He uses language like “real thing” and “warranted,” suggesting that there are forms of evidence that one could marshal to be convincing. Hodari *et al.* [94] and Fricker [112] call this “testimonial injustice, the unwillingness of whit[e people] to listen to and believe the testimonies that BIPOC people give about racism and discrimination”. Though participant

B does check himself, saying that whether or not “it is a real thing...would not be for [him] to judge,” and that “whether it is warranted or not is irrelevant,” his language points to mainstream discursive practices within physics, where claims are subjected to critique and issuers are expected to provide a particular form of evidence. Here, participant B is applying these discursive practices to an analysis of People of Color’s *experiences*.

VI. DISCUSSION

Taken together, the narrative constructed by the themes in our interviews is one in which

- People succeed in physics because they love the discipline enough to make sacrifices in pursuit of discovery, like a challenge, and enjoy (or can tolerate) competitive argumentation.
- Physics is neutral and separate from social processes and therefore equally (and abstractly) available to all.
- Physics departments provide a rational and thus less racist environment for People of Color.
- Underrepresentation is partially or largely a product of a lack of investment on the part of students’ families and local communities (including local schools).

This race-evasive narrative constructs a very different world than the one experienced by People of Color in physics, where Students and Faculty of Color

- Are repeatedly asked why they are in physics courses, discouraged from pursuing physics, and/or told to change their major [3,9,113].
- Have their ideas co-opted and credited to other students or faculty [10,15].
- Are excluded from study groups [11].
- Experience racial bias in the form of tone policing, not being acknowledged as experts in places they have expertise, disparagement by colleagues, not being looked in the eye, and not being seen as capable of objective thought [3,9,10,12,67].
- Must fragment themselves to participate in local physics culture [13,14].

It is also a different world than the one constructed by the literature, which names a variety of ways in which physics content and practices embed cultural values that align with colonialism, whiteness, patriarchy, and ableism [7,67,82,84,88], and which documents challenges to or complexifications of prevailing race-evasive narratives that attribute success (or lack thereof) to, e.g., the investments made by families or the amount of work a student expends [110].

How, then, do physics faculty come to this understanding of racialized outcomes in physics? What we have shown in this paper is that physics has adopted discipline-specific race-evasive frames—frames that are instantiations of the prevailing racial ideology in present day United States [17]. In fact, physics epistemologies and discourses *strengthen* and *reify* these frames, such that race evasiveness becomes

part-and-parcel of how we think about *physics*. In some cases the relationship between the race-evasive frames and physics discourses and epistemologies is in the *content* of the discipline-specific frame—e.g., the notion that *physics is equally available to all* (abstract liberalism) is conceptually linked to the notion of physics as abstract, universal, and disembodied. In other cases the relationship is in the *form* of the discipline-specific frame—e.g., the assertion that *I do not have evidence of racially motivated harm* draws on a particular (abstract and disembodied) conceptualization of evidence within physics to minimize People of Color’s experiences (minimization of racism). Broadly, the link between (i) physics epistemologies and discourses and (ii) race evasiveness in physics is made sensible within a world where both *whiteness* and *physics* are both thought to be neutral—white people tend to see themselves as free of race [30,60,114], and physicists tend to see physics as a “culture of no culture” [81]. A critical analysis, on the other hand, sees the “supposedly objective” nature of physics as a “form of racialized subjectivity”. Calls for race-neutral science should be “understood...as a thinly disguised directive for assimilation to a particular racial position rather than culture-neutral absence of racial position” [115].

Revisiting the quote from our Introduction, we are now in a position to highlight how race evasiveness is functioning there. The participant, in reflecting on whether being white is an advantage in physics, says

“Yeah, I think so. I mean, the main reason why I would, um, have trouble with the question is that, um, it’s at least, at least thinking about it from a physics perspective of what experiment are we talking about? Suddenly change the color of my skin and ask what happens. That’s not a thing, right? You can’t do that. Um, and, and you can’t do the controlled experiment, um, where you take five babies who are white and five babies who are Black and put them in exactly identical circumstances—same family, same schooling—how are they going to do as physics majors? You know, we can’t do that. And so the issues, the challenges that we face with representation are, um, all about, uh, the entire process. Um, and so you can’t separate them. And so, um, you know, the advantages, the advantages that I have, the disadvantages that I have, I mean, mostly the main advantage I have is my mother. She was just awesome. She’s still awesome. Um, has nothing to do with my skin color. Um, so, um, it comes out that we’re all individuals”.

Through the lens of race evasiveness, this participant uses physics discursive practices to minimize the role of racism in conferring advantage to white folks. He draws on cultural racism as he names variables that might affect success in physics, citing schooling and families as primary factors. He ultimately lands on individualism as the guiding force, reifying the abstract liberalism frame. The incoherence of his answer—in expressing a hesitancy to accept

race as a determining factor in success, citing a need for a controlled experiment, while also asserting with certainty that it is his mother that has conferred advantage to him (without doing a controlled experiment)—is consistent with race evasiveness but not with the expectation of coherence in scientific explanations.

Anytime we present results that challenge the race neutrality of physics and name some of the ways in which white supremacy marks our disciplinary practices and discourses, we are inevitably asked (often by white folks) what there is to be done. Folks—and white folks in particular—often want concrete, pragmatic things that can be implemented immediately, in many cases with the goal of quickly ending the discomfort felt when confronted when one’s complicity in perpetuating racism, intentional or not. We do not have that to offer, mostly because *we do not think it works that way*; if you are new to these thoughts, there is a lot between this moment and the moment in which you are in an informed position from which to reimagine your classroom and disciplinary practices as decolonized, antiracist praxis. That’s not to say there is nothing you can do right now, but many of the things you can do will require deep reflection and unlearning before they are effective and harm reductive. Scholars and Activists of Color have been doing this work for ages, and have offered frameworks for how to begin, including a framework for the variety of locales of transformation we can act within. One such framework points to the “four I’s”—ideological, institutional, interpersonal, and internalized—as places where action is needed to dismantle white supremacy [116]. This paper largely addresses the ideological, where action includes identifying and illustrating dominant ideologies, unlearning, counterstorytelling, and dismantling. In physics, the *first* task in this realm, in our view, is to *acknowledge that racism matters for things we have historically thought of as race neutral in physics*. From that location we can engage in a *race-conscious* analysis of physics, identifying the ways in which how we think, how we act, and who we include are all entangled with white supremacy.

Refusing race evasiveness in physics is an invitation to ask a different set of questions about core beliefs that have maintained a racial hierarchy in the field. Race consciousness encourages us to become aware of the ways in which white supremacy shapes physics classrooms, relationships between faculty and students, and departmental culture, and allows us to see ways in which we can *reshape* them, and imagine how physics might become a liberatory space. This does not feel impossible to us; though not the focus of this paper, interviews also evidenced faculty *challenging* white supremacy within physics, disrupting the status quo, and describing overlaps between qualities essential to physics and qualities essential to antiracist self-reflection, such as sitting with the discomfort of not knowing and being skeptical of one’s own intuition.

This is a long struggle—some would say a forever struggle, given the permanence of racism in the United States [27,28,117]. In the meantime, we can build coalitions within the discipline to actualize “worlds within the [physics] world” [118]—smaller, liberatory spaces of thriving that draw on principles of justice. And as we wait for that, we can use our (always) emerging racial consciousness to reduce harm in the spaces we move and work. Harm reduction acknowledges that white supremacy, patriarchy, classism, fatmisia, transmisia, heterosexism, ableism, xenophobia, and myriad other systems of oppression infuse space and structures and are a part of our socialization. Paired with real-time repair, harm reduction provides support and accountability in the midst of this reality, inviting us to be humans in process and humans in community and offering space and support to see and respond to harm [119]. Harm reduction, then, lives in the

interstitial space between not yet, without giving up on what could be.

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