JOURNAL OF CONTROVERSIAL IDEAS

Article

"White Empiricism" and "The Racialization of Epistemology in Physics": A Critical Analysis*

Alan Sokal [a,b]

[a] University College London, London, UK
[b] New York University, New York, USA; sokal@nyu.edu

Submitted: 1 March 2023, accepted: 27 June 2023, published: 31 October 2023

Abstract: I critically analyze the reasoning in Chanda Prescod-Weinstein's article "Making Black women scientists under white empiricism: The racialization of epistemology in physics".

Keywords: White empiricism; epistemology; critical race theory; feminist standpoint theory; physics

How to cite: Sokal, A. "White Empiricism" and "The Racialization of Epistemology in Physics": A critical analysis. *Journal of Controversial Ideas* **2023**, *3*(2), 1; doi:10.35995/jci03020001.

Chanda Prescod-Weinstein's article, "Making Black women scientists under white empiricism: The racialization of epistemology in physics" (Prescod-Weinstein 2020), has been widely cited and praised. It is #56 in the Altmetric ranking of the Top 100 Most Discussed scholarly articles for 2020.[1] It has been cited 37 times in the scholarly literature – including 14 citations in the Science Education literature – all of them completely uncritically.[2] There has not, to my knowledge, been any detailed engagement with the content of the article's *reasoning*.

---

* This article was submitted to *Signs* – the journal that published Prescod-Weinstein (2020) – on Friday 3 February 2023. At 9:10 AM local time on the next working day, Monday 6 February, the editor-in-chief of *Signs* decided to reject the article without sending it to reviewers. It is therefore now being published, in slightly revised form, here.

1 Of the 55 higher-ranked articles, 20 concerned COVID-19 or related issues. See www.altmetric.com/top100/2020.

2 Web of Science as of 1 March 2023. I have checked all 37 articles (except one to which I was unable to get access), and none of them contains even the slightest critical commentary on, or critical analysis of, the reasoning in Prescod-Weinstein (2020). The only critical citations of which I am aware are a blog by biologist Jerry Coyne (2019) and a brief comment in the book of linguist John McWhorter (2021, 109–110). Google Scholar, which has a wider scope than the Web of Science, shows 90 scholarly citations as of 1 March 2023.

That detailed engagement is the purpose of the present article. I will argue that the reasoning, both scientific and philosophical, in Prescod-Weinstein (2020) is deeply flawed. I will also argue that the article's main contention – that "race and ethnicity impact epistemic outcomes in physics" – is valid, if at all, only in an extremely limited sense. I will finally argue that the flawed reasoning in this article, together with its uncritical acceptance in many progressive educational circles, threaten to have negative practical consequences both for science and for science education, and in particular for the goal of attracting more women and Black people (and especially Black women) to scientific careers. For all these reasons, I believe it is of some value that the reasoning in this article be openly and rigorously debated.

I trust that readers of the present essay will understand that criticism, even harsh criticism, of the reasoning contained in a scholarly work in no way constitutes a personal attack on the author. In the same way, I look forward to criticism, even harsh criticism, of my own reasoning, and trust that it will be offered in the same spirit.

The plan of this essay is as follows: I begin, in Section 1, by addressing one of Prescod-Weinstein's key arguments, concerning the principle of general covariance. Then, in Section 2, I summarize Prescod-Weinstein's main claims and explain how I propose to address them. In Section 3 I consider Prescod-Weinstein's arguments concerning anti-empiricism in string theory; in Section 4 I consider more generally the issue of social diversity in the scientific community and its epistemic consequences; and in Section 5 I make the key distinction between social injustice and epistemic injustice. In Section 6 I address Prescod-Weinstein's assertions concerning colonialism, decolonization and "indigeneity". Finally, in Section 7 I draw everything together and assess the extent to which Prescod-Weinstein has or has not succeeded in demonstrating her main claims. I conclude, in Section 8, by addressing the question "Why does it matter?": I explain some of the negative social consequences that I argue can arise from the uncritical acceptance of Prescod-Weinstein's ideas.

1. General Covariance

In my parody article, "Transgressing the Boundaries: Towards a Transformative Hermeneutics of Quantum Gravity" (Sokal 1996), I wrote as part of my conclusion:

> [P]ostmodern science provides a powerful refutation of the authoritarianism and elitism inherent in traditional science, as well as an empirical basis for a democratic approach to scientific work. For, as Bohr noted, "a complete elucidation of one and the same object may require diverse points of view which defy a unique description" – this is quite simply a fact about the world, much as the self-proclaimed empiricists of modernist science might prefer to deny it. In such a situation, how can a self-perpetuating secular priesthood of credentialed "scientists" purport to maintain a monopoly on the production of scientific knowledge? (Sokal 1996, 229)

Put aside the (intentional) irony of an avowed postmodernist relativist labeling a philosophical claim as "quite simply a fact about the world". Put aside the fact that Bohr's and Heisenberg's philosophical claims about quantum mechanics are extremely controversial among physicists and philosophers of physics, and far from universally accepted. Those are minor points; the central fallacy in this paragraph is the bald leap from physics to social epistemology. When Bohr asserts that "a complete elucidation of one and the same object may require diverse points of view which defy a unique description" (Bohr 1934, 96), he is referring to the duality between the wave and particle

descriptions of a physical event in quantum mechanics.[3] From there to the *social* interpretation of "diverse points of view" is at best a distant analogy, founded principally on the linguistic ambiguity of the phrase "diverse points of view" and not grounded in any precise argument. (Perhaps such an argument could be given; if so, it could be debated. But no argument was given in this passage: it is just a bald leap.)

Alas, Prescod-Weinstein makes a similar bald leap at the beginning of her article – albeit this time, apparently, in all seriousness. Her claim is based on general relativity rather than quantum mechanics, but the structure of the logic is almost identical:

> Albert Einstein's monumental contribution to our empirical understanding of gravity is rooted in the principle of covariance, which is the simple idea that there is no single objective frame of reference that is more objective than any other. All frames of reference, all observers, are equally competent and capable of observing the universal laws that underlie the workings of our physical universe. Yet the number of women in physics remains low, especially those of African descent. The gender imbalance between Black women and Black men is less severe than in many professions, but the disparity remains. … Black women must, according to Einstein's principle of covariance, have an equal claim to objectivity regardless of their simultaneously experiencing intersecting axes of oppression … (Prescod-Weinstein 2020, 422–423, references omitted)

The first step in this reasoning is the elision between "frame of reference" in physics and "observer". This elision is common in expository accounts of special relativity, beginning with Einstein's original paper (Einstein 1905); the elision is harmless *provided that* one understands that the "observer" need not be a human, but could well be a machine (and in contemporary experimental physics most often is). What is relevant in relativity is not the *identity* of the "observer", but rather its *state of motion*. Discussions of special relativity (especially in textbooks) refer frequently to the "earth frame of reference" or the "train frame of reference"; it is irrelevant whether the "observer" (if any) located on the ground or the train is a white man, a Black woman, or an automated particle detector.

Secondly, in general relativity (Einstein 1915) the relevant concept is *general* covariance, i.e. the covariance of the equations under *arbitrary* smooth changes of coordinates. It is dubious whether most of these coordinate systems can be associated in any sensible way to "observers".[4]

But the fundamental and glaring flaw in this passage is, once again, the series of elisions from physics to social epistemology. In the first sentence, "there is no single objective frame of reference that is more objective than any other", the second use of the word "objective" is not wrong – the accounts of a particle collision from the earth frame of reference and the train frame of reference are indeed equally objective – but it paves the way for a more tendentious interpretation of this word in what follows. The second

---

[3] Even at this level, Bohr's assertion is controversial. For instance, in the Bohmian version of quantum mechanics (Bricmont 2016, 2018; Goldstein 2021), each physical situation has, *pace* Bohr, a *unique description* as the joint evolution of a wave function and particle positions.

[4] The *general* coordinate transformations employed in general relativity (Einstein 1915) contrast with the *linear* coordinate transformations – more specifically, the *Lorentz transformations* – employed in special relativity (Einstein 1905). The latter can be directly understood as the transformations relating different inertial frames of reference (a.k.a. "observers").Nontechnical introductions to special and general relativity can be found in Einstein and Infeld (1938) and Einstein (Einstein 1920/2005), among many other places. Readers not deterred by a bit of high-school algebra can find illuminating further detail in Sartori (1996) and Mermin (2005).

sentence, "all frames of reference, all observers, are equally competent", explicitly elides "frames of reference" to "observers", and then introduces the new adjective "competent": an adjective that would be bizarre for describing a frame of reference (earth or train) or an automated particle detector; it can now only be intended to refer to a *human* observer, contrary to the meaning of "frame of reference" in physics. The conclusion, "Black women must, according to Einstein's principle of covariance, have an equal claim to objectivity", is then a pure non sequitur: Einstein's principle of covariance says nothing whatsoever about any humans' claims to objectivity. Indeed, Einstein's principle of covariance says nothing whatsoever about *any* human social issues. But – it goes without saying – one doesn't need general relativity to argue that all humans, regardless of race or sex, are potentially capable of doing physics, with their work being evaluated on its merits.

2. "White Empiricism"

In the first paragraph of her article, Prescod-Weinstein states her thesis very clearly:

> In this article, I propose that race and ethnicity impact epistemic outcomes in physics, despite the universality of the laws that undergird physics, and I introduce the concept of *white empiricism* to provide one explanation for why. (421, italics in the original)

And in her conclusion she sets forth an even more ambitious claim:

> I propose that the Black feminist theory intersectionality should change physics – and not just through who becomes a physicist but through the actual outcomes of what we come to know. (440)

The key question will be whether she makes good on these claims. Does she in fact demonstrate that "race and ethnicity impact epistemic outcomes in physics"? And if so, to what extent, and in what ways, and by what mechanisms? And does she provide any reason to believe that "Black feminist theory intersectionality [will] change physics … through the actual outcomes of what we come to know"?

Having thus set out her thesis in her first paragraph, Prescod-Weinstein immediately proceeds to define her key concept of "white empiricism":

> White empiricism is the phenomenon through which only white people (particularly white men) are read as having a fundamental capacity for objectivity and Black people (particularly Black women) are produced as an ontological other. … Because white empiricism contravenes core tenets of modern physics (e.g., covariance and relativity), it negatively impacts scientific outcomes and harms the people who are othered. (421)

It is an empirical question whether there actually are significant numbers of physicists today who adhere (perhaps unconsciously) to the racist view that "only white people (particularly white men) [have] a fundamental capacity for objectivity". Prescod-Weinstein does not present any evidence that this is in fact the case; she simply assumes it. Nevertheless, in order to clarify the philosophical issues, I propose to ignore the empirical question and assume for the sake of argument that Prescod-Weinstein's assumption is correct. What would be the *epistemic* consequences for physics of this racist attitude among physicists?

The claim that such racist attitudes "contravene core tenets of modern physics (e.g., covariance and relativity)" has already been addressed: in fact, covariance and relativity say nothing at all about any humans' claims to objectivity, or indeed about any

human social issues. On the other hand, it is undeniable that racism "harms the people who are othered"; no sensible person would disagree. The key question raised by this paragraph is therefore the extent to which racism (or sexism) within science *negatively impacts scientific outcomes*. I now turn to address this issue: first in connection with Prescod-Weinstein's discussion of string theory, and then more abstractly.

3. Anti-Empiricism in String Theory

String theory has been developed since the 1980s as a candidate theory of quantum gravity, and potentially as a unified theory of all elementary-particle interactions: what its boosters have ostentatiously (and only semi-facetiously) called a Theory of Everything. But string theory requires, for its consistency, an extra symmetry known as supersymmetry, in which each currently known particle would have a "supersymmetric partner". Experiments at the Large Hadron Collider have failed to detect any of these alleged partners; and while this failure can be explained by positing that the supersymmetric partners are too heavy to be produced at the currently available energies, this explanation looks increasingly to many physicists like ad hoc special pleading. Furthermore, the hope of the early string theorists was that there would be a *unique* mathematically consistent string theory (Weinberg 1992, 219, 223, 229); instead, it now appears that there are literally zillions of equally plausible string-theory variants (perhaps 10^{500} of them), with no apparent criteria for deciding a priori which one of them should describe our universe (Susskind 2005, 411–440; Smolin 2006, 155–160; Woit 2006, 240–249). All this – especially the vast "landscape" of nonuniqueness – has led string theory to an impasse, if not a crisis.

I am very sympathetic to Prescod-Weinstein's critique of the attempt by some prominent string theorists[5] to move the goal posts: to rescue string theory by introducing beauty and conceptual unification as criteria for the *acceptance* of a scientific theory, while jettisoning (or at least weakening) the traditional requirement for empirical verification.[6] But her linking of this debate in fundamental physics to the issue of racism is highly tendentious, and not supported by any clear chain of reasoning. She says:

> Surveying what should happen next, there are at least three distinct possibilities:
>
> 1. Patience is required, and evidence is coming.
> 2. String theory has failed to succeed in expected ways because the community – which is almost entirely male and disproportionately white relative to other areas of physics – is too homogeneous.
> 3. The scientific method overly constrains our models to meet certain requirements that no longer serve the needs of physics theory.
>
> (429)

[5] I stress the word "some". I am not aware of any quantitative data concerning the philosophical views of string theorists.

[6] For similar critiques, see Smolin (2006), Woit (2006), Baggott (2014), Ellis and Silk (2014), and Hossenfelder (2018). For a partially contrary view, see Dawid (2013). And for a balanced overview, see Ritson (2021).I stress that the debate here concerns the criteria for the *acceptance* of a scientific theory, not the criteria for pursuing a scientific research program. Even the strongest critics of string theory, such as Smolin (2006) and Woit (2006), agree on the value of pursuing research in string theory in the hope that it might contribute insights towards a future theory of quantum gravity; they also agree on the value of pursuing research in string theory for its applications in mathematics and in other branches of physics. See Ritson (2021, sections 3.4, 3.5 and 5) and Cabrera (2021).

She rightly rejects explanations 1 and 3; and while she obviously prefers explanation 2, she gives no clear argument or evidence for her fundamental claim that string theory has failed to succeed in the expected ways *because* the string-theory community is too male or too white.

Although Prescod-Weinstein introduces this paragraph by saying, correctly, that there are "*at least* three" distinct possible explanations for the limited success of string theory – thereby recognizing implicitly that there might be others – she fails to note the most obvious explanation: String theory has failed to succeed in the expected ways because the problems being studied are extraordinarily difficult and the first generation of string theorists was inordinately optimistic. It should be remembered that, ever since the birth of modern physics in the work of Copernicus, Kepler, Galileo and Newton, there has been a strong link between theory and experiment. Sometimes experimental discoveries of unexpected phenomena forced theorists to rethink (radioactivity and the photoelectric effect in the 1890s, the zoo of mesons and baryons in the 1940s and 1950s, the accelerated expansion of the universe in the late 1990s). In other instances, new theories led to predictions that were later experimentally verified (Maxwell's 1865 theory of electromagnetism leading to Hertz's 1887 discovery of radio waves, Fermi's 1934 theory of beta decay leading to the experimental detection of neutrinos in 1956, the development of the Standard Model in the 1970s leading to the experimental discovery of the W and Z bosons in 1983 and of the Higgs boson in 2013). In all these cases, the interval between theory and experiment was at most a few decades. That is because, broadly speaking, theorists and experimenters were working at the same energy scale; otherwise put, the experiments needed to test the latest theories were technologically feasible, or nearly so, at the relevant moment in history.

In fundamental physics, that is no longer the case. The world's largest and most powerful particle accelerator, the Large Hadron Collider (LHC) at CERN in Geneva, measures 27 km in circumference and was built between 1998 and 2008 at a total cost of approximately US$6 billion; it reaches energies of roughly 10 TeV (teraelectronvolts). The unification of the weak, electromagnetic and strong interactions, by contrast, is predicted to take place at approximately 10^{13} TeV – that is, an energy a *trillion* times higher than the LHC. The unification with gravity is predicted to take place at the so-called Planck energy, approximately 10^{16} TeV – that is, a further thousand times higher. It is completely implausible that such ultra-high energies can be *directly* probed anytime in the near future, or perhaps ever. If theories of quantum gravity are to be tested experimentally, it will have to be by *indirect* tests that measure their subtle effects at lower energies. This is not impossible, and many physicists are working today to dream up such experiments[7]; but this task is undeniably difficult, and there is no guarantee of success in any of our lifetimes.

"Why are string theorists calling for an end to empiricism rather than an end to racial hegemony?", Prescod-Weinstein asks (422). What on earth does one thing have to do with the other? If Prescod-Weinstein is contending that the present-day impasse in fundamental physics is due in significant part to "racial hegemony", then she needs to be clearer about the alleged causal link from the latter to the former.

[7] Or new *theoretical* ideas that would allow us to distinguish between alternative theories of Planck-scale physics through their consequences for *already-observable* phenomena of elementary-particle physics or astrophysics.

> Later, she writes:
>
> > Postempiricists have been given the benefit of a hearing and a substantive call and response with wide investment from the particle theory community. While many in the community may disagree with such thinkers, their epistemic agency is recognized as legitimate. Black women speaking up about their experiences with discrimination are simply not offered the same platforms or axiomatic acceptance of their agency in discourses about race and gender/sex. (430, reference omitted)

But this, once again, mixes apples with oranges. "Black women speaking up about their experiences with discrimination" may or may not have been given adequate consideration "in discourses about race and gender/sex"; but what relevance does this have to discourses *about elementary-particle physics*? Prescod-Weinstein does not say.[8]

4. Social Diversity and Its Epistemic Consequences

As Brown (2001, 184–186) and other philosophers of science have emphasized, theory-testing in science is *comparative*. Or to put it another way: much scientific reasoning consists of inference to the best explanation (Lipton 2001); but we can only choose the best explanation *among those that are available to us*. The correct theory might be one that has not yet been conceived (Stanford 2006). All this points to the importance of having a sufficiently large pool of plausible alternative theories. And this points, in turn, to the value of having a sufficiently diverse pool of *scientists*, to create that large pool of theories.[9]

But "diverse" in what sense? The relevant sense here is not social diversity per se, but rather *viewpoint diversity* – more precisely, viewpoint diversity in those specific senses that are relevant to the topics under study. No one doubts, for instance, that the scientific objectivity of some branches of social science would benefit from recruiting researchers from a wider spectrum of social groups, since researchers' life experiences can be directly relevant to the social topics they study.[10] The question then arises: Which types of viewpoint diversity are relevant in *physics*, and in particular in *fundamental physics* (i.e. elementary-particle physics and cosmology)?

It is difficult, of course, to guess what sort of ideas will be needed in the future; but the history of physics shows that innovators have many different styles of work, and in particular different approaches to:

- the importance of being guided by experiment vs. being guided by conceptual analysis;

---

[8] But see Thesis 1 in the next section, which explains why discrimination against any talented person can hinder progress in science.

[9] For a variety of views on the epistemic relevance of diversity within the scholarly community, see Harding (1986), Longino (1990), Kitcher (1993), Solomon (2001), Brown (2001, chapters 8 and 9), Wylie (2006).

[10] See, for instance, the very interesting article of psychologists Stanovich and Toplak (2019), in which they explain why their own previous efforts to measure "actively open-minded thinking" were biased because their own liberal/secular worldview prevented them from seeing the different connotations of the word "belief" to religious people. More generally, Duarte et al. (2015) and Stanovich (2021, chapter 5) give numerous examples to show how research in social psychology has been biased by the near-absence of conservatives among researchers. These examples do not, of course, negate the failures of viewpoint diversity lamented by liberals, leftists, feminists, antiracist and queer activists, but they do provide a relevant complement.

- the importance (or lack thereof) of deep conceptual and even philosophical analysis – and *which* conceptual or philosophical ideas to incorporate;
- the importance (or lack thereof) of unifying many different sources of data (e.g. elementary-particle physics with cosmology);
- the importance of solving specific examples vs. creating general theories;
- the importance (or lack thereof) of mathematical rigor;
- which branches of mathematics to deploy;
- the inclination to work in teams vs. working alone;
- the inclination to follow current research trends vs. to strike new paths;

and probably many other factors that will become obvious only in retrospect.[11] All these factors might be correlated in some way with the researchers' social backgrounds (nationality, age, sex, sexual orientation, race, economic class, religion, political ideas, …), but the correlation is likely to be weak; individual variation probably swamps any "macroscopic" social influences.

For example: Were Albert Einstein's remarkable contributions to physics – including three revolutionary articles in three different subfields (special relativity, photoelectric effect, Brownian motion) in a single annus mirabilis at the age of 26 – due in part to his outsider status, as a Jew, within German culture and German physics? (The Nazis certainly thought so: Einstein practiced *Jüdische Physik*.) Or were they due in part to his outsider status, as an assistant examiner in the Swiss Patent Office with no academic affiliation? Or were they due simply to his own brilliant and idiosyncratic mode of thought, unexplainable by any macroscopic social associations? Historians can adduce relevant evidence, but the honest answer is probably that we will never know exactly which combination of these causes played out, or in detail how.

One can imagine two possible theses on the epistemic importance of social diversity:

- Thesis 1: Excluding or discouraging *any* talented person from a career in scientific research reduces the pool of available ideas.
- Thesis 2: Excluding or discouraging talented people from specific marginalized social backgrounds (e.g. Black women) reduces the pool of available ideas in a distinctive way.

Thesis 1 is clearly true; but it should be noted that while the loss of talented scientists *hinders* the progress of science, it does not, according to this thesis, *bias* it in any particular direction (in contrast to Thesis 2, which could entail directional bias). Furthermore, Thesis 2 is certainly true in at least some branches of the social sciences: even if one does not accept the claim of standpoint theory that members of certain social groups are epistemically *privileged* (Harding 1986, 1991; Medina 2013), it is nevertheless clear that they can be epistemically *different* in distinctive ways that are relevant to the topics under study, and that suffices for the conclusion.

But is Thesis 2 true in physics? Prescod-Weinstein oscillates on this question. Citing feminist standpoint theory, she asserts:

> Standpoint theory correctly identifies that there are contexts in which Black women are epistemically privileged observers, and I argue that a refusal to accept this fact translates into modified epistemic outcomes in physics, not because the laws of physics are different but because which parts of the universe we understand, and

[11] See also Smolin (2006, chapters 16 and 18) for a thoughtful discussion.

> even the very nomenclature we develop to describe our understanding, are impacted by social forces. (426–427)

But then she immediately backtracks and concedes that "Black women are not naturally epistemically privileged when it comes to uncovering universal laws of physics" (427). In view of this, it is unclear why "a refusal to accept" that "there are contexts [in social science?] in which Black women are epistemically privileged observers" should "translate into modified epistemic outcomes *in physics*".

Similarly, Prescod-Weinstein observes that "the culture of physics limits participation via racist and sexist gatekeeping" (427) and she approvingly cites particle physicist Howard Georgi (2000) saying that "unconscious discrimination [against women in physics] arises because the application of our tools for discrimination between different scientists selects for many things, including qualities that are at best very indirectly related to being a good scientist, and that clash with cultural pressures" (436). She observes in particular that "making aggressive behavior a requirement for academic success is especially harmful to Black women, since Black women are demonized for engaging in behaviors that even hint at aggression" (427). All this is true and important, but the key question for Prescod-Weinstein's thesis is: What are the effects of these discriminatory social practices on the *content* of knowledge in physics? Here the argument suddenly goes thin. Prescod-Weinstein comments:

> In my view, Georgi comes close to suggesting that the construction of "physicist," entwined as it is with social pressures and determined by qualities typically only acceptable in white men, has meaning for epistemic outcomes in physics. (436–437)

But it is not clear whether she is here endorsing Thesis 2 or only Thesis 1 (and if the former, then on what evidence). She laments that Georgi only "proposes what now constitutes a fairly predictable set of solutions to the problems women face, such as avoiding unnecessarily narrowing the search parameters during hiring" (437), but she does not herself propose any deeper analysis or any other remedy.

Physicist Lee Smolin (2006, chapter 16) has cogently criticized the "groupthink" (286–287) that was prevalent, at least at the time of his writing, in the string-theory community, in which large numbers of researchers would jump in unison onto a series of ephemeral bandwagons (271–272).[12] Smolin argues quite plausibly (267) that the principal cause of this phenomenon was the conformation of power relations within the community, in which a large cohort of postdocs and untenured assistant professors were dependent, for their career progression, on positive recommendations from a small group of senior physicists (267, 271–273) – a dependence exacerbated in string theory by the absence of experimental input, which magnifies the importance of subjective judgments of cleverness, beauty and fruitfulness.[13] Even so, it is at least arguable that the social composition of the string-theory community – which, like the rest of physics, is 80–90% male (COST 2017) and, though extraordinarily international (Bradlyn 2009), also overwhelmingly white and Asian – played some role in sustaining this homogeneity of thought.

---

[12] Leading string theorists have, however, disputed this account; see Ritson and Camilleri (2015, 212–222) for a balanced overview.

[13] The same issues arise, of course, in the humanities and some branches of the social sciences. Indeed, one might expect this dependence on powerful senior figures to have *stronger* effects in the humanities and social sciences than in the natural sciences, because of the higher ratio of candidates to available positions, and the lesser opportunities for well-paid employment outside of academia.

Perhaps, if the community were to include more women and Black people, groupthink would be less likely. (This is, however, far from clear, since the power relations would impinge at least as strongly, if not more strongly, on women and people of color.) These considerations provide some evidence, in my view, in favor of a very weak and tentative version of Thesis 2.

Finally, one can imagine situations in which people with a particular cultural background might be more disposed than others to discover particular scientific ideas. For instance, historian Loren Graham and mathematician Jean-Michel Kantor have argued (Graham and Kantor 2009) that the creation of descriptive set theory – a branch of mathematics that involves, among other things, assigning "names" to sets of real numbers according to certain constructions – by the Russian mathematicians Suslin and Luzin was inspired in part by Luzin's adherence to a heretical current in the Russian Orthodox Church known as Name Worshipping. However, others are skeptical of this thesis (Shalizi 2009; Glutsyuk 2014, 65). As with the case of Einstein, it is almost impossible to disentangle in any definitive way the factors that led to a particular scientific discovery. Nevertheless, considerations of this kind could, if sufficient further details were provided, potentially form the basis of an additional argument in favor of a very weak version of Thesis 2.

5. Social Injustice versus Epistemic Injustice

Emmy Noether (1882–1935) was one of the greatest mathematicians of the twentieth century; she is rightly revered as "the mother of modern algebra" (Dick 1981; Brewer and Smith 1982; Srinivasan and Sally 1983). Noether's theorem on the connection between symmetries and conservation laws is also central to modern physics. In 1915 Noether was denied a lectureship at Göttingen because of her sex (she was awarded a paid professorship only in 1923); in 1933 she was fired by the Nazis because of her Jewish origins. These acts of sexist and racist discrimination were grave injustices to Noether personally, and indirectly to all women and Jews. But their epistemic effect was nil: Noether's contributions to mathematics were immediately recognized as ground-breaking. The only epistemic injustice here was perpetrated by the bacteria that cut short her life, and thus her contributions to mathematics, at the young age of 53.

A classic (albeit fictional) example of epistemic injustice[14] was given by Antoine de Saint-Exupéry in *The Little Prince*:

> I have serious reasons to believe that the planet the little prince came from is Asteroid B-612. This asteroid has been sighted only once by telescope, in 1909 by a Turkish astronomer, who had then made a formal demonstration of his discovery at an International Astronomical Congress. But no one had believed him on account of the way he was dressed. Grown-ups are like that.
>
> Fortunately for the reputation of Asteroid B-612, a Turkish dictator ordered his people, on pain of death, to wear European clothes. The astronomer repeated his demonstration in 1920, wearing a very elegant suit. And this time everyone believed him. (Saint-Exupéry 1943/2013, 9–10)

Perhaps similar examples exist, in real life, in contemporary physics; if so, it would be useful to make them public so that the details, and their philosophical implications, can be analyzed. One can, in fact, imagine two distinct situations:

[14] More precisely, "testimonial injustice" in the taxonomy of Fricker (2007).

1. A good scientific idea is ignored or given insufficient consideration because the proposer is a Black woman.
2. A good scientific idea is proposed by a Black woman but is subsequently attributed to another person (for instance, a white man who takes it up and develops it).

The first case would constitute an epistemic loss to the entire community (analogous to Saint-Exupéry's fictional situation); the second case would constitute a serious injustice to the original proposer but no epistemic loss to the community.

But have any of these things actually happened, and if so, how often? In particular, is there any evidence in favor of Thesis 2 of the preceding section (*distinctive* contributions from members of specific social groups)? It would be useful to know. In the absence of concrete examples, however, Prescod-Weinstein's claims of *epistemic* consequences from the marginal status of Black women in physics are just that: claims without any empirical support.

6. Colonialism, Decolonization and "Indigeneity"

Prescod-Weinstein, in her conclusion, links her claims about "white empiricism" to further historical and philosophical claims concerning colonialism, decolonization and "indigeneity":

> White empiricism … actively harms the development of comprehensive understandings of the natural world by precluding putting provincial European ideas about science – which have become dominant through colonial force – into conversation with ideas that are more strongly associated with "indigeneity," whether it is African indigeneity or another. (439)

There is, alas, much to criticize in this one sentence.

To begin with, it is grossly inaccurate to characterize modern science and its methodologies as mere "provincial European ideas". Modern science may have arisen in Europe four centuries ago, but it has by now become thoroughly global, with Chinese, Japanese, Indians and people of many other nationalities counted among its leading practitioners. It is deeply disrespectful to these scientists to imply that they are mere carriers of "provincial European ideas".

Furthermore, is it really true that modern science has become dominant over premodern theories – whether Western or non-Western – "through colonial force"? Without a doubt, the development of modern science – and in particular modern physics – occurred within a social process that was motivated in part by practical ends (for instance, understanding astronomy as an aid to navigation) that in turn were related to the ideologies of the era (i.e. conquest and colonization). But – as Prescod-Weinstein repeatedly recognizes – the laws of physics are universal.[15] Asian and Latin American and African physicists

[15] "[R]ace and ethnicity impact epistemic outcomes in physics, *despite the universality of the laws that undergird physics* …" (421, emphasis added).
"All frames of reference, all observers, are equally competent and capable of observing *the universal laws that underlie the workings of our physical universe.*" (422, emphasis added)
"[A]lthough there has been some scholarship on feminist theory and physics, it seems the primary feminist epistemology axiom has been that physics is unusual because *the laws that underlie it are universal* and not determined by people." (424, emphasis added)
"[P]roponents [of feminist standpoint theory] have always treated physics as exceptional because *its laws are both observer-independent and universal* …" (426, emphasis added)

today use the inverse-square law of gravitation – initially discovered by an Englishman, Isaac Newton, three-and-a-half centuries ago – not because of "colonial force" or European politico-ideological hegemony and cultural imperialism, but simply because of the massive observational and experimental evidence that has been amassed in its favor in the centuries since Newton. Prescod-Weinstein, who is an astrophysicist, surely knows this.

Finally, Prescod-Weinstein wants to put "European" science "into conversation with ideas that are more strongly associated with 'indigeneity'", but she is vague about which "indigenous" ideas she is championing and what, precisely, they would bring to the conversation.[16] There are only two concrete references to "indigenous" ideas in her article, and in neither case does she give any details; the reasoning, such as it is, has to be pieced together from the references that she cites:

1. Prescod-Weinstein writes:

> For the descendants of kidnapped and enslaved Africans, responding requires recognizing the way African epistemologies are invisibilized. Jonathan Chimakonam shows that there is a significant injustice associated with the exclusion of African philosophies from global epistemology discourse. (435)

But Chimakonam's article (2017) is entirely concerned with "global justice", that is, with questions of *ethics* in a global context. His article does not address at all questions from science or the philosophy of science. Perhaps some of Chimakonam's ideas might be adapted to that context; and if Prescod-Weinstein were to do that in some future work, then her arguments could be debated. But for now there is nothing.

2. In her final paragraph, Prescod-Weinstein introduces a new example:

> [I]n the debate about the Thirty Meter Telescope on Mauna Kea, Hawaii, the question of which epistemologies merit legitimate consideration is intimately tied to white empiricism. White empiricism can help explain why the Thirty Meter Telescope was evaluated so differentially by Mauna Kea protectors and telescope-using scientists, resulting in a specious debate over who was for and who was against science. Protectors, who do not subscribe to white empiricism, have been forced to repeatedly challenge press coverage that tends to assign a higher knowledge prestige to the role of nonindigenous scientists than to cultural knowledge holders of indigenous communities. (440)

Fox and Prescod-Weinstein (2019) explain the situation:

> A consortium of several international universities backed by six countries wants to build a $1.4 billion Thirty Meter Telescope (TMT) on Mauna a Wākea, a dormant volcano in Hawai'i that, measured from its base, is the tallest mountain in the world. This observatory will allow scientists to peer deep into the far reaches of space and time, perhaps to see galaxy formation as it was just getting underway. But it will also disturb hallowed ground, a spot of deep cultural-spiritual resonance as well as ecological sensitivity for Kanaka 'Ōiwi. [Native Hawaiians]

"Black women are not naturally epistemically privileged when it comes to uncovering *universal laws of physics* …" (427, emphasis added).

[16] See also the illuminating debate in Widdowson (2021) concerning the proposal to incorporate "Indigenous ways of knowing" into university curricula in Canada. In particular, the articles of Peat and Gorelick argue for the value of incorporating Indigenous ideas into physics and biology, respectively; the articles of Trefil and Pigliucci dispute that assessment.

The controversy thus concerns the control of land that was stolen, in the late nineteenth century, from its Indigenous inhabitants; it pits the claims of those inhabitants' present-day descendants, who hold a variety of views about the best use of the land, against the claims of the wider present-day community, who also hold a variety of views. These ethical, political and legal conflicts do not admit of any easy solution.

But one thing should be clear: nothing is gained by mixing these ethical, political and legal debates with flawed philosophical and scientific arguments. Whatever can be said in favor of the "cultural knowledge" of the Indigenous Hawaiian communities – and undoubtedly much can be – that knowledge certainly cannot compete with modern science *in the domain of astronomy and cosmology*. To point this out is not to engage in cultural arrogance; it is simply to state facts. *No* premodern belief system – whether Western (e.g. fundamentalist Christianity) or non-Western – can compete with modern science as an account of reality. Indeed, even modern science 100 years ago – after the development of general relativity (1915) but before the modern understanding of galaxies (1920s), the discovery of the expansion of the universe (1930s), of the cosmic microwave background radiation (1965), and of the accelerated expansion of the universe (1998) – is vastly inferior to our present-day understanding of cosmology.

Prescod-Weinstein's reference to "which epistemologies merit legitimate consideration" is, alas, gravely ambiguous. If she is referring to epistemologies concerning *questions of fact* – that is, the philosophy of science, broadly understood – then she needs to explain specifically which Indigenous epistemologies she believes "merit legitimate consideration" as an alternative to the methods of modern science, and on what grounds. If, on the other hand, she is referring to questions of *ethics*, then once again she will need to explain specifically which Indigenous ideas she is defending, but the discussion will be on a very different plane.

When all is said and done, the defenders of Indigenous land rights would do well to steer clear of easily refutable (or fatally ambiguous) scientific and philosophical claims. As I observed in a similar context a quarter-century ago,

> [W]e can perfectly well remember the victims of a horrible genocide, and support their descendants' valid political goals, without endorsing uncritically (or hypocritically) their societies' traditional creation myths. Moreover, the relativists' stance is extremely condescending: it treats a complex society as a monolith, obscures the conflicts within it, and takes its most obscurantist factions as spokespeople for the whole. (Sokal 1997)

7. The Bottom Line

Does Prescod-Weinstein succeed in demonstrating her main claim, that "race and ethnicity impact epistemic outcomes in physics"? It seems to me that the answer is both yes and no, but mostly no.

Yes, in a limited sense at least, because Thesis 1 – that excluding or discouraging any talented person from a career in scientific research reduces the pool of available ideas – is manifestly true. And to the extent that some talented people are excluded or discouraged from entering physics research on account of their race or ethnicity (or their sex), this could affect epistemic outcomes in physics, at least in principle, because some good theories (or good experiments) might fail to be discovered. On the other hand, it is important to note that the same logic applies to *any* social factor that reduces the pool of talented people entering physics research: for instance, mediocre pre-university schooling (and its correlation with economic class), the creeping corporatization of university life, insufficient

funding for research, high salaries for alternative professions, the lack of child care, a general culture inimical to critical thinking, … . So Thesis 1 is by no means limited to racism and sexism. Furthermore, even in this more restricted sense, Thesis 1 is not novel; quite the contrary, it is by now a commonplace, which is regularly asserted in the official documents of professional associations (National Academies 2011, 24–28; American Physical Society 2020; American Mathematical Society 2021).

On the other hand: No, because Prescod-Weinstein did not give any evidence that Thesis 2 – that excluding or discouraging talented people from specific marginalized social backgrounds reduces the pool of available ideas in a distinctive way – is true *in physics*. However, this "no" should perhaps be replaced by "conceivably a bit", because, as I have explained, there *might* have been *slightly* less tendency towards groupthink in string theory had the community included more women and people of African descent; and people with particular cultural backgrounds *might* be more predisposed to discover certain scientific ideas.

Finally, what about the more ambitious claim, made by Prescod-Weinstein in her conclusion, that "Black feminist theory intersectionality should change physics – and not just through who becomes a physicist but through the actual outcomes of what we come to know"? Alas, this claim is simply plucked out of the blue in the conclusion; not the slightest argument or evidence is provided, in the body of the article, that Black feminist theory, or indeed any feminist theory, has had or will have *any* consequences for the *content* of physics. And why on earth should it? The subject matter of feminist theory is human relations; it is very remote from the subject matter of physics. The relation between the two subject matters could be, at best, one of distant analogy. In fact, Prescod-Weinstein concedes (424) that, despite four decades of trying, feminist ideas have not yet had any significant effect on the substantive content of physics (Schiebinger 1999, 178–179; Rolin 1999; Bug 2003). The claim that feminist theory (intersectional or otherwise) will in the future change the *content* of physics – and not merely the social structure of the physics community – is nothing more than a promissory note, unbacked by any assets.

8. Why Does It Matter?

When all is said and done, Prescod-Weinstein (2020) does contain some correct claims, even if they are correct only in a very limited way and are anyway not novel. Why, then, do I think it important that the ideas expressed in this article be openly debated – important enough to bother writing a detailed critical analysis?

My worry is the one articulated by George Orwell (1946/1953) in his celebrated essay "Politics and the English language": that sloppy thinking engenders further sloppy thinking; and that the uncritical acceptance of ideas, not because the reasoning is sound (or even examined) but because the conclusions are politically congenial, leads to a further degradation of thought.

The uncritical reception of Prescod-Weinstein (2020) in the scholarly and popular literature illustrates this phenomenon. In the wake of the George Floyd murder, academics in all fields, including physics, have been rightly spurred to address long-standing problems of underrepresentation of people of African descent. Many are working to reduce the barriers to participation of African-Americans in science – barriers that include unconscious racial prejudices as well as numerous aspects of both pre-university and university education, including economic considerations and pedagogical practices (American Institute of Physics 2020). Other scientists are taking a more global view, and are participating in important efforts like the African Institute for Mathematical Sciences.

But some of the recent literature on antiracist pedagogy has gone on to adopt controversial – and in my opinion highly flawed – philosophical ideas about the "social construction of science" or the "decolonization of science", almost always based on a superficial engagement with the philosophical questions at hand, combined with a stunning ignorance of, or at least disregard for, published dissenting views.[17] As I have demonstrated in detail in the foregoing, the article of Prescod-Weinstein (2020) provides one example of this; and some even more extreme examples can be found among her followers. Here, for instance, are some citations of Prescod-Weinstein (2020) from the recent Science Education literature:

> "Neutral" epistemologies of objectivity in STEM shape curricula that uphold racialized and cisheteronormative formulations of science, limiting access to identity-affirming educational opportunities for QSOC [queer students of color] (Prescod-Weinstein, 2020). Perspectives from Black queer studies orient intersectional inquiry through the WCHPS [White cisheteropatriarchal space] ideological dimension to explore how dominant constructions of STEM knowledge and learners that reinforce White cisheteropatriarchy are upheld and resisted in Black queer students' educational opportunities. (Leyva et al. 2022, 877)

> Excluding Black ontological realities in the development of science epistemology inherently suggests that the "authors" of science epistemology believe that how Black people perceive and understand the natural world is illegitimate and unworthy of being incorporated into how everyone should understand science because Black people and subsequently Blackness is not human … These attempted regulations have led to the reinforced belief of "kitchen science" being solely recognized as the culinary arts, and "healing sciences" as religious practices, often positioned as the antithesis of the western Eurocentric version of Christianity and deemed immoral. Attempts to incorporate Blackness into conceptions of science epistemology, therefore, would prompt the contamination of "pure" science; a perspective that "science" could not and will not tolerate (Menon 2021; Prescod-Weinstein, 2020). (Morton et al. 2022, 139)

A full critique of these articles would be tedious; suffice it to say that they conflate pedagogy with epistemology, and fail to explain the pertinence of "Whiteness" and "cisheteropatriarchy" to the content of the physical sciences. Of course, it goes without saying that Prescod-Weinstein is in no way responsible for the views of her admirers, which she may or may not endorse; each author is responsible only for her or his own writing. But these quotations do show, I think, the issues that are at stake in this debate.

Beyond the purely intellectual flaws of half-baked philosophies of science, these "antiracist" screeds may also have a negative practical effect: namely, *discouraging* some talented Black students from entering or remaining in physics. Obviously, any exaggerated portrayal of racism in a particular community is likely to deter Black students

---

[17] As John Stuart Mill observed a century-and-a-half ago:

> "He [*sic*] who knows only his own side of the case, knows little of that. His reasons may be good, and no one may have been able to refute them. But if he is equally unable to refute the reasons on the opposite side; if he does not so much as know what they are, he has no ground for preferring either opinion". (Mill 1859/2003, 104)

from entering such a purportedly inhospitable environment. Since, I stress, I do not have any hard data about the degree of racism (including unconscious racism) that currently exists in the physics community, it would not be appropriate for me to assert that Prescod-Weinstein's account is indeed exaggerated; I remain agnostic on that score. But the accounts given by some of Prescod-Weinstein's admirers are clearly over the top:

> Through a lens of anti-Blackness, the exclusion of Black voices and perspectives in supporting fundamental conceptions of science content and procedural knowledge is an attempt to foster Black suffering and death. Black suffering and death in this instance reflect the explicit and implicit attempts to kill Blackness – Black people, minds and being – by deeming their specific understandings of and interactions with life as not real or legitimate and forcing them to contend with an anti-Black reality (Morton et al. 2019; Prescod-Weinstein, 2020). (Morton et al. 2022, 138)

No sane Black student would want to enter a field in which the "fundamental conceptions of content and knowledge" form part of "an attempt to foster Black suffering and death".

There is another way in which the ideologically motivated flawed thinking in the work of Prescod-Weinstein and her admirers may be counterproductive to their own professed cause of increasing the representation of African-Americans in physics (a cause which, it goes without saying, I share). As sociologist Musa al-Gharbi (2019) has observed, African-Americans and Hispanic-Americans are, as numerous surveys have shown, more socially conservative and religious on average than white Americans. But this conflicts with liberal whites' expectations:

> [F]ew [from the dominant group] seem interested in actually listening to or engaging with underrepresented populations on their own terms, for their own sake. Instead, diversity is "curated" to avoid meaningful challenges to the social position, priorities or worldview of the people at the top. …
>
> This reality is not lost on many people of color, and people of other underrepresented groups in the academy: our continued social capital is in many ways contingent on playing a certain role here. Students from underrepresented backgrounds often describe how they are expected both to speak on behalf of their entire minority group – and also conform to a very particular set of expectations about what they are *supposed* to believe, or what their interests are *supposed* to be, on the basis of their group identity.
>
> Those who challenge the preferred narratives too fiercely find themselves marginalized (even further). Meanwhile, those who give the dominant class what it is hungry for – whether because they are true believers in the prevailing ideology or are just trying to get ahead (or get along) – … are celebrated as the "authentic" representation of their group (despite often being demonstrably *un*representative), with all the socio-cultural benefits entailed thereby.
>
> When we try to understand why it is that so many students of color, low-income students, and/or first-generation students feel as though they don't "belong" in our institutions of higher learning – this is likely a big, and underexplored, part of the story. (al-Gharbi 2019, emphases in the original)

If al-Gharbi is right, then significant numbers of African-American students are likely to be *turned off* by cutting-edge "antiracist" and queer theory, particularly if they encounter it in

science classes, where they may feel it is disguised indoctrination (and in any case out of place); and they may conclude that they do not "belong" in a community where their actual beliefs conflict so sharply with the persona they are expected to adopt.[18]

Furthermore, those science students and young researchers (of any race or sex) who do buy into the cutting-edge theory will inevitably be disappointed when "strong objectivity", "indigeneity" and "Black feminist theory intersectionality" fail to yield the promised *scientific* insights.[19]

Last but not least, the activists' proclaimed epistemological credos – vague invocations of "social construction" allied to pleas for "decolonization" and "intersectionality" – threaten to undermine their real-world aims. This unacknowledged conflict between professed philosophy and social-political goals was pointed out a quarter-century ago by philosopher Harvey Siegel, a noted advocate and defender of critical thinking in education. Siegel (1995) begins his article by stressing

> that education ought to respect all students/persons, regardless of their race, gender, class, sexual orientation, etc.; and moreover that education ought to be particularly, and scrupulously, sensitive to the needs and interests of minority and other "marginalised" students. (Siegel 1995, 33)

But he goes on to observe that

> this moral/political perspective is often conjoined with a related epistemological perspective … that knowledge is culturally determined and/or relative; that different cultures endorse their own epistemologies, e.g. their own conceptions of truth and views of the nature or criteria of epistemic justification; that the obligation to respect cultural differences extends to respecting those alternative epistemologies as well; and so on. … I will argue not only that that perspective is of dubious epistemic merit, but, additionally, that honouring it has the unfortunate consequence of undermining the moral/political commitment to which it is routinely related. … I will argue, that is, that liberal, leftist, and/or radical educational views require for their satisfactory articulation and defence a traditional, or 'conservative' underlying epistemology, which fully embraces and utilises traditional conceptions of truth, rationality, justification, and the like.
>
> If I am right, then it is imperative that defenders of radical pedagogy distinguish their embrace of particular moral/political theses from untenable, allegedly related, epistemological ones. They must reject the latter for two reasons: first, the epistemological theses are false or unjustified; second, failure to reject them undermines any argumentative effort to defend the former. (Siegel 1995, 34)

Of course, Prescod-Weinstein and others are perfectly entitled to disagree with Siegel's philosophical arguments, which are set forth in the body of his paper. But in that case it would be helpful for them to address those arguments – as well as those of other authors such as Noam Chomsky (1995), Barbara Ehrenreich (1995), Susan Haack (1998, 2003), Meera Nanda (2003) and myself (Sokal 2008) – and explain in what way they disagree, and why.

---

[18] On the other hand, one can also imagine such a person choosing to work in physics or mathematics *precisely because* it is relatively apolitical, compared to other academic fields. Numerous testimonies attest, for example, that this was often the case in the former Soviet Union.

[19] This was pointed out a quarter-century ago by Gross and Levitt (1994, chapter 9, especially 251–252).

Funding: This research received no external funding.

Acknowledgments: I wish to thank three philosophers, three physicists, one mathematician and one linguist for helpful comments on drafts of this manuscript. I also wish to thank two reviewers at the Journal of Controversial Ideas for critical comments that helped to improve this article. It goes without saying that none of these people bear any responsibility for what I have written.

Conflicts of Interest: The author declares no conflict of interest.

References

al-Gharbi, Musa. 2019. "'Viewpoint diversity' is about much more than politics." *Heterodox Academy Blog*. April 29. https://heterodoxacademy.org/blog/viewpoint-diversity-transcends-politics.

American Institute of Physics. 2020. "The time is now: Systemic changes to increase African Americans with bachelor's degrees in physics and astronomy." https://www.aip.org/sites/default/files/aipcorp/files/teamup-full-report.pdf.

American Mathematical Society. 2021. "Towards a fully inclusive mathematics profession: Report of the task force on understanding and documenting the historical role of the AMS in racial discrimination." March 22. https://www.ams.org/about-us/Towards-a-Fully-Inclusive-Mathematics-Profession.pdf.

American Physical Society. 2020. "Board statement on racism in physics." July 24; amended September 21. https://www.aps.org/policy/statements/racism-physics.cfm.

Baggott, Jim. 2014. *Farewell to Reality: How Modern Physics Has Betrayed the Search for Scientific Truth*. New York: Pegasus.

Bohr, Niels. 1934. *Atomic Theory and the Description of Nature*. Cambridge: Cambridge University Press. [Reprinted 1961 with a new preface].

Bradlyn, Barry J. 2009. "String theory: A controversy in ten dimensions. History." http://web.mit.edu/demoscience/StringTheory/history.html.

Brewer, James W. and Martha K. Smith, eds. 1982. *Emmy Noether: A Tribute to Her Life and Work*. New York: Marcel Dekker.

Bricmont, Jean. 2016. *Making Sense of Quantum Mechanics*. Cham, Switzerland: Springer.

Bricmont, Jean. 2018. *Quantum Sense and Nonsense*. Cham, Switzerland: Springer.

Brown, James Robert. 2001. *Who Rules in Science? An Opinionated Guide to the Wars*. Cambridge, MA: Harvard University Press.

Bug, Amy. 2003. "Has feminism changed physics?". *Signs: Journal of Women in Culture and Society* 28(3): 881–899. [CrossRef]

Cabrera, Frank. 2021. "String theory, non-empirical theory assessment, and the context of pursuit." *Synthese* 198(Suppl 16): S3671–S3699. [CrossRef]

Chimakonam, Jonathan O. 2017. "African philosophy and global epistemic injustice." *Journal of Global Ethics* 13(2): 120–137. [CrossRef]

Chomsky, Noam. 1995. "Rationality/Science." *Z Papers Special Issue on Postmodernism and Rationality*. https://chomsky.info/1995____02.

COST [European Cooperation in Science and Technology]. 2017. "An initiative in gender in string theory." https://genhet.web.cern.ch/talks/initiative-gender-string-theory and http://www.weizmann.ac.il/stringuniverse/sites/stringuniverse/files/summarysurveygender-onlymalevsfemale.pdf and www.weizmann.ac.il/stringuniverse/group/outreach-wg5.

Coyne, Jerry. 2019. "Is 'white empiricism' hindering physics?". *Why Evolution is True*. December 10. https://whyevolutionistrue.com/2019/12/10/is-white-empiricism-destroying-physics.

Dawid, Richard. 2013. *String Theory and the Scientific Method*. Cambridge: Cambridge University Press.

Dick, Auguste. 1981. *Emmy Noether, 1882–1935*. Translated from the German by Heide I. Blocher. Birkhäuser: Boston–Basel–Stuttgart.

Duarte, José L., Jarret T. Crawford, Charlotta Stern, Jonathan Haidt, Lee Jussim and Philip E. Tetlock. 2015. "Political diversity will improve social psychological science." *Behavioral and Brain Sciences* 38: E130. [This paper is followed by 33 commentaries from a wide variety of viewpoints, and a response from the authors]. [CrossRef] [PubMed]

Ehrenreich, Barbara. 1995. "For the rationality debate." *Z Papers Special Issue on Postmodernism and Rationality*. https://physics.nyu.edu/faculty/sokal/ehrenscience.htm.

Einstein, Albert. 1905. "Zur Elektrodynamik bewegter Körper." *Annalen der Physik* 322(10): 891–921. English translation at https://einsteinpapers.press.princeton.edu/vol2-trans/154. [CrossRef]

Einstein, Albert. 1915. "Die Feldgleichungen der Gravitation.". In *Sitzungsberichte der Preussischen Akademie der Wissenschaften zu Berlin* 844–847. English translation at https://einsteinpapers.press.princeton.edu/vol6-trans/129.

Einstein, Albert. (1920) 2005. *Relativity: The Special and General Theory*. Translated by Robert W. Lawson. With an introduction by Roger Penrose, a commentary by Robert Geroch, and a historical essay by David C. Cassidy. New York: Pi Press.

Einstein, Albert, and Leopold Infeld. 1938. *The Evolution of Physics*. Cambridge: Cambridge University Press.

Ellis, George, and Joe Silk. 2014. "Scientific method: Defend the integrity of physics." *Nature* 516(7531): 321–323. [CrossRef]

Fox, Keolu, and Chanda Prescod-Weinstein. 2019. "The fight for Mauna Kea is a fight against colonial science." *The Nation*. July 24. https://thenation.com/article/mauna-kea-tmt-colonial-science.

Fricker, Miranda. 2007. *Epistemic Injustice: Power and the Ethics of Knowing*. Oxford: Oxford University Press.

Georgi, Howard. 2000. "Is there an unconscious discrimination against women in science?" *APS News* 9(1): 8. https://www.aps.org/publications/apsnews/200001/back-page.cfm.

Glutsyuk, Alexey. 2014. "Review of *Naming Infinity*." *Notices of the American Mathematical Society* 61(1): 62–65.

Goldstein, Sheldon. 2021. "Bohmian mechanics." In *Stanford Encyclopedia of Philosophy*. https://plato.stanford.edu/entries/qm-bohm.

Graham, Loren and Jean-Michel Kantor. 2009. *Naming Infinity: A True Story of Religious Mysticism and Mathematical Creativity*. Cambridge, MA: Harvard University Press.

Gross, Paul R. and Norman Levitt. 1994. *Higher Superstition: The Academic Left and its Quarrels with Science*. Baltimore, MD: Johns Hopkins University Press.

Haack, Susan. 1998. *Manifesto of a Passionate Moderate: Unfashionable Essays*. Chicago, IL: University of Chicago Press.

Haack, Susan. 2003. *Defending Science – Within Reason: Between Scientism and Cynicism*. Amherst, NY: Prometheus Books.

Harding, Sandra. 1986. *The Science Question in Feminism*. Ithaca, NY: Cornell University Press.

Harding, Sandra. 1991. *Whose Science? Whose Knowledge? Thinking from Women's Lives*. Ithaca, NY: Cornell University Press.

Hossenfelder, Sabine. 2018. *Lost in Math: How Beauty Leads Physics Astray*. New York: Basic Books.

Kitcher, Philip. 1993. *The Advancement of Science: Science without Legend, Objectivity without Illusions*. New York and Oxford: Oxford University Press.

Leyva, Luis A., R. Taylor McNeill, B. R. Balmer, Brittany L. Marshall, V. Elizabeth King, and Zander D. Alley. 2022. "Black queer students' counter-stories of invisibility in undergraduate STEM as a White, cisheteropatriarchal space." *American Educational Research Journal* 59(5): 863–904. [CrossRef]

Lipton, Peter. 2001. *Inference to the Best Explanation*. London: Routledge.

Longino, Helen E. 1990. *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry*. Princeton, NJ: Princeton University Press.

McWhorter, John. 2021. *Woke Racism: How a New Religion Has Betrayed Black America*. New York: Portfolio.

Medina, José. 2013. *The Epistemology of Resistance*. New York: Oxford University Press.

Menon, Binuraj R.K. 2021. "The Missing Colours of Chemistry." *Nature Chemistry* 13(2): 101–106. [CrossRef]

Mermin, N. David. 2005. *It's About Time: Understanding Einstein's Relativity*. Princeton, NJ: Princeton University Press.

Mill, John Stuart. (1859) 2003. *On Liberty*. Edited by David Bromwich and George Kateb. With essays by Jean Bethke Elshtain, Owen Fiss, Richard A. Posner and Jeremy Waldron. New Haven, CT: Yale University Press.

Morton, Terrell R., Destiny S. Gee, and Ashley N. Woodson. 2019. "Being vs. Becoming: Transcending STEM Identity Development through Afropessimism, Moving toward a Black X Consciousness in STEM." *Journal of Negro Education* 88(3): 327–342. [CrossRef]

Morton, Terrell R., Monica L. Miles, ReAnna S. Roby, and Nickolaus A. Ortiz. 2022. "'All we wanna do is be free': Advocating for Black liberation in and through K-12 science education." *Journal of Science Teacher Education* 33(2): 131–153. [CrossRef]

Nanda, Meera. 2003. *Prophets Facing Backward: Postmodern Critiques of Science and Hindu Nationalism in India*. New Brunswick, NJ: Rutgers University Press.

National Academies. 2011. *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*. Washington, DC: National Academies Press. http://nap.nationalacademies.org/12984.

Orwell, George. (1946) 1953. "Politics and the English language.". In *A Collection of Essays*, pp. 156–171. New York: Harcourt Brace Jovanovich.

Prescod-Weinstein, Chanda. 2020. "Making Black women scientists under white empiricism: The racialization of epistemology in physics." *Signs: Journal of Women in Culture and Society* 45(2): 421–447. [CrossRef]

Ritson, Sophie. 2021. "Constraints and divergent assessments of fertility in non-empirical physics in the history of the string theory controversy." *Studies in History and Philosophy of Science, Part A* 90: 39–49. [CrossRef]

Ritson, Sophie, and Kristian Camilleri. 2015. "Contested boundaries: The string theory debates and ideologies of science." *Perspectives on Science* 23(2): 192–227. [CrossRef]

Rolin, Kristina. 1999. "Can gender ideologies influence the practice of the physical sciences?". *Perspectives on Science* 7(4): 510–533. [CrossRef]

Saint-Exupéry, Antoine de. (1943) 2013. *The Little Prince*. Translated from the French by Richard Howard. Boston and New York: Houghton Mifflin Harcourt.

Sartori, Leo. 1996. *Understanding Relativity: A Simplified Approach to Einstein's Theories*. Berkeley, CA: University of California Press.

Schiebinger, Londa. 1999. *Has Feminism Changed Science?* Cambridge, MA: Harvard University Press.

Shalizi, Cosma. 2009. "Review of *Naming Infinity*." *The Bactra Review*. July 19. http://bactra.org/reviews/naming-infinity.

Siegel, Harvey. 1995. "'Radical' pedagogy requires 'conservative' epistemology." *Journal of Philosophy of Education* 29(1): 33–46. [CrossRef]

Smolin, Lee. 2006. *The Trouble with Physics*. Boston, MA: Houghton Mifflin Mariner.

Sokal, Alan. 1996. "Transgressing the boundaries: Towards a transformative hermeneutics of quantum gravity." *Social Text* 46/47: 217–252. Reprinted with annotations in Sokal 2008, chapter 1. [CrossRef]

Sokal, Alan. 1997. "A plea for reason, evidence and logic." *New Politics* 6(2): 126–129. Reprinted in slightly revised form in Sokal 2008, chapter 3. https://archive.newpol.org/issue22/sokal22.htm.

Sokal, Alan. 2008. *Beyond the Hoax: Science, Philosophy and Culture*. Oxford and New York: Oxford University Press.

Solomon, Miriam. 2001. *Social Empiricism*. Cambridge, MA: MIT Press.

Srinivasan, Bhama and Judith D. Sally, eds. 1983. *Emmy Noether in Bryn Mawr: Proceedings of a Symposium Sponsored by the Association for Women in Mathematics in Honor of Emmy Noether's 100th Birthday*. New York and Berlin: Springer-Verlag.

Stanford, P. Kyle. 2006. *Exceeding Our Grasp: Science, History, and the Problem of Unconceived Alternatives*. New York: Oxford University Press.

Stanovich, Keith E. 2021. *The Bias that Divides Us: The Science and Politics of Myside Thinking*. Cambridge, MA: MIT Press.

Stanovich, Keith E. and Maggie E. Toplak. 2019. "The need for intellectual diversity in psychological science: Our own studies of actively open-minded thinking as a case study." *Cognition* 187: 156–166. [CrossRef]

Susskind, Leonard. 2005. *The Cosmic Landscape: String Theory and the Illusion of Intelligent Design*. New York: Little, Brown.

Weinberg, Steven. 1992. *Dreams of a Final Theory*. New York: Pantheon.

Widdowson, Frances, ed. 2021. *Indigenizing the University: Diverse Perspectives*. Winnipeg: Frontier Centre for Public Policy.

Woit, Peter. 2006. *Not Even Wrong: The Failure of String Theory and the Search for Unity in Physical Law*. New York: Basic Books.

Wylie, Alison, ed. 2006. Special issue: Epistemic diversity and dissent, Part 1. *Episteme: A Journal of Social Epistemology* 3(1–2): 1–136.