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# Science As Radicalism

William Gillis

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The science that lies at the core of and drives anything one might call “science” is characterized by a radical impulse: to search for the most deeply rooted patterns, to push beyond the existing or the immediate, into extremes, to look for what can break and how, and to not be afraid of throwing everything out, all in order to better grasp what is possible.

We need to be humble about the complexity of our world, but audacious in searching for models anyway. We must reject the traumatized mewling that “you can’t ever know anything” or the abusive “how dare you compare things” but also shy away from accepting shallow impressions.

This is the beating heart of science and it is what has driven its rise, rectified its mistakes, and continually resisted its capture by power. It is what makes it the most fecund site for resistance in our world today.

It’s no secret that a good portion of the left today considers science profoundly uncool. A slight affinity with it persists among a majority, but few asides of scorn by the continental philosophers influential in the contemporary leftist canon see spirited response and science’s most prominent champions remain dated historical figures like Peter Kropotkin and Élisée Reclus. Indeed there’s a lingering whiff of technocratic stodginess and death that the word “science” has never quite shaken. Those leftists most associated with it have a tendency to either be authoritarians looking to legitimize near-fascist narratives, or doe-eyed activists enchanted by saccharine visions of self-managed bureaucracies and *The Meeting That Never Ends*. To a great many who identify as radicals “science” appears in our lives primarily as a place our various enemies habitually retreat to conjure the authority their shoddy arguments couldn’t.

Taken in this light as a sort of nebulous divinity — spoken of with explicit capitalization and the occasional flourishing exclamation mark — “Science!” often strikes like a character in the tales we encounter throughout our life, gradually accumulating a jumble of associations and personality traits. Tales that are almost uniform across our society. Everyone knows the high school story of Science! in rough terms: The belief that the entirety of our reality can be divided up into little atoms and facts. Gleaned from numbers, brutally harvested, and then locked into little jars. Except — the story goes — it’s never quite capable of successfully reducing us to these accounting sheets; all it succeeds at is calling for xenocidal policies, unleashing catastrophes, and, in its insane pursuit of infinite knowledge (ie domination) over nature, consuming everything and everyone in its wake. Science! is surely just another way of expressing the logic of empire and capitalism. Science! is a religious institution that brokers no alternatives. Science! is nuclear weapons, GMO killer seeds, animal testing, bulldozers, nazi medical experiments, Jurassic Park, and Christopher Columbus. It

may have some more anodyne faces, but the affair as a whole is inseparable from destructive hubris and cold inhumanity.

Once you've seen this pattern or narrative it's all too easy to fit everything into it.

Chances are you don't directly experience science in your everyday life. But you do encounter its glossy logo incessantly. In the news stories trolls cite against you to "prove" something about gender roles. In the stickers on giant technological devices. If it's not sneering Dawkins fans telling you Science! says they're right then it's the horror tales repeated incessantly by a fearful popular culture. We've watched thousands of movies moralizing about "playing god" by seeking understanding, to the point where we just assume such cinematic mistakes are a realistic thing that totally happens. Someone says "the Large Hadron Collider could create a blackhole" and we partially believe them because like we've seen this movie before and further we immediately leap to our Hollywood notion of a "blackhole" where it eats the earth (rather than immediately evaporating into hawking radiation). There's literally a terrorist organization trying to murder graduate students over a fear ("grey goo") they admit they don't understand at all. But again, we've seen this movie.

Okay, sure, scientists may occasionally manage to poke their heads through the media wall and point out that pollution is happening or that actual neuroscience doesn't back patriarchal narratives, but that's clearly just them cleaning up after their colleagues, their own mistakes, their own colonizer logic. So many terrible people cite science as a justification there must be something to it. And who could deny that ozone depletion and deforestation wouldn't have happened in the first place if we weren't making pencils and measuring devices for those scientists to scribble down their findings. (Don't talk to us about scale or ridiculous differences in orders of magnitude! Numbers remind us of how much math class sucked and any reference to scale proves it's "just a matter of degree." And anyway all of industrial society surely depends entirely

gic and empathic virtues in swapping between them. But it's also important to have our terms describe the most meaningful realities or distinct dynamics they can. Gaping conceptual holes, unspoken or unspeakable realities in a given language, can end up having a huge impact in our lives and impeding our capacity to fight. Language determines what we focus on by default, what gets left as awkward addendums, and thus what loops of debate we most frequently retread trying to get at realities outside the terms we have available.

When possible it's good practice to shift our language to clearer and more conceptually distinct and workable definitions of terms, regardless of popular associations. This is after all the foundation of our redefinition of anarchy. "Anarchy" is a nebulous word whose use varies wildly. But its most widespread associations beyond the anarchist milieu bundle in the assumption that there can be no freedom from the oppressive dynamics of rulership, that our only speakable choice is between fractured or unified power structures. Anarchism was founded on a revolt against this orwellianism, and it has retained enough distinctiveness to spur resistance to appropriation of that term by neonazis, capitalists, and maoists as our respect has risen.

The situation with science is similar. There is a sharply distinct subset within what gets called "science" who few would deny qualify as science. This subset is a lot more distinct in certain ways that matter than the "any empiricism" set and unfettered by its failings. The present widespread identification of science with the merely anything empirical or data-related consistently invalidates by association the valid work of this subset, for whom there is presently no other identifying term available besides "science." Further this subset was who science was originally centered on, who it appropriated from, and it's a subset that has vehemently and vocally resisted the wider definition. It has accumulated various social institutions, cultures, and other parasites around its practice but these are obviously distinct from the core idea.

pressions.” And conversely if you wall yourself off from such investigations, if you champion the reactionary ideology that immediatism is all that matters, you can ignore anything else. However there’s a difference between these two positions. Radicalism is a stable and attractive equilibrium, whereas reactionism is unstable under perturbation. Once you start investigating you’re quite likely to encounter evidence that your immediate impressions are wrong and that deeper dynamics exist, which increases your evaluation of how useful root-seeking is.

However the way from one equilibrium to the other is not always an easy slide. If one revolts at the thought of searching to clarify fundamental dynamics then one will revolt at the very idea of investigating a definition of “science” that isn’t all-inclusive of every association, every appropriating charlatan, and every rhetorically dressed up atrocity. What one might call the postmodern instinct has been to reject breaking apart conceptual bundles to identify separable sub-dynamics and instead speak of ‘real existing science’ — the entirety of everything its name gets slapped on — and look for fuzzy tendencies across this abstraction. This approach takes the macroscopic abstraction as foundational, certain rough commonalities as characteristic qualities, and then handles any exceptions or additional complexities by means of perpetually appending footnotes and excuses. Great for justifying people’s preexisting impressions, opinions, or allegiances. Terrible at better mapping the dynamics at play. As such it’s incapable of spurring progress or meaningful change.

## Conclusion

It goes without saying that we shouldn’t waste our lives fighting a war over every preferred definition. Language is often fluid, and not every term can be redeemed. A “language” is often really forked into many simultaneous languages and there can be strate-

on all the rest of it! It’s a package deal!) Even if Science! has good parts, it surely also has a Dark Side and dare not be let free to its own desires. At best it’s a tool capable of some good (if tightly enslaved) and much evil (if embraced for its own sake). But if it is just a tool it’s totally the master’s tool. And at worst? At worst Science! is an insane power fantasy of our rulers that has motivated and facilitated the enslavement of the entire world.

Science! is — in short — accepted on face value. It is taken more or less as what we see called Science! almost everywhere. An unlucky few of us are granted closer experience, stumbling into soul-sucking engineering jobs for companies or academic sweatshops, specializing in what boils down to optimizing a single widget. Science! is on the nametag. Science! is on the diploma. Science! is on our report. Science! is how our paymasters excuse the damage our widget causes in military or economic application. Science! must surely be this.

You can tell I think this is all patent nonsense. A similar intentionally misattributed and surface-deep tale could be told about “Anarchy” from the newscaster desks to the Hot Topic stickers.

Yet the pull of such narratives are all consuming. And like any good tale, they typically have a wide enough array of moving parts to make any attempt at thorough critique prohibitively involved. Even if you were to examine every association, assumed causation, repeated lie, and misattribution it’s unlikely someone enraptured by this narrative would be able to hold it all in their attention at the same time. They’d always feel confident you hadn’t addressed enough. And in the face of such complexity, they might as well default on whatever bundle of associations they already have. In any case this narrative is dressed up as a ‘critique’ of something presently in power — what? do you oppose critiques? are you defending those in power?? surely the status quo needs no more defenders!

As with conspiracy theories, if you hold a believer’s nose to the tricks or holes in their tale they’ll sincerely retort that surely every

other possible story depends on equivalent slights of hand. Time and time again I hear from hip radicals the same derision with science dressed up as enlightenment: “All models are wrong, it’s just that some can be useful self-deceptions.” If everything’s equally just a myth, equally ungrounded, or politically suspect, you might as well settle on whatever seems like it would be the most useful story given your psychology and context.

## A Context of Unending Appropriation

Among other peculiarities I have the dubious distinction of having been raised by a true believer in “Christian Science.” If you’re unfamiliar with the religion think less Scientology than a cranky first-wave feminist sort of Mormonism. Which is mostly just to say a distinctly 19th century American invention with a tenuous Christian genealogy, conservative aesthetics, and some weird twists into philosophical idealism.

Christian Scientists are most notable for their unique response to the problem of suffering in the presence of an omnipotent god: they respond by disbelieving in suffering. Indeed they disbelieve in the entire material world and sometimes even logic or math. It’s one of the cutest tricks in the history of religion and philosophy and I feel bears some horrified appreciation. There’s an organized religion in our world with hundreds of thousands of followers founded on an explicit version of immaterialism that would do even George Berkeley proud. If you break your back or are imprisoned by a rapist you can cope by denying that any of that actually exists. The entire material universe in fact is a vicious lie, an error caused by the mistaken thoughts of “mortal mind.” There is only God and Her love, everything else is a shared delusion, a consensus reality. Thus, if you’re in suffering, disassociate. If you face obstacles, work harder at convincing yourself they’re not a problem. If you’re privileged,

The language of subjective experience and introspection is riddled with errors that it alone is incapable or dramatically inefficient at recognizing. Whereas cognitive science provides us with another useful vantage point to integrate and rectify these mistakes. At the end of the day the presumption of fully a priori meditation is simply not as good a framework as the neurological model and any question you want answered in the former can be revealed through the later as either more efficiently and directly answerable or poorly posed and thus ultimately unanswerable in any model. Consciousness, the self, and the ideological edifices built in the language of subjective experience are in many ways spooks, errors, narrative simplifications with fraying edges to their usefulness upon any close investigation, akin to when marxists talk in mystical ways about Capitalism or primitivists about Civilization as a moving spirit more than the sum of its parts. The entire cartesian assumption of an a priori vantage point is ultimately a faulty model when examined from all angles or pushed to its breaking points.

Of course someone could retort in a Zerzan-esque vein that the only real reality is immediate sensation and any conceptual processing of that — any modeling of any kind — is the “abstraction.” Nevermind how easy it is to verify things like our blind spots and optical processing defects, our immediate sensations or qualia are not just often wrong, they have to be heavily processed by neural columns for us to make sense of them in any way that corresponds to the world we interact with. Indeed the less “modeling” we do the less we’d be able to see or hear. And if you attempt to discount those wellworn insights of neuroscience the number of other things you must discount to do so spreads in effect quite rapidly and dramatically. Especially if you have any instinct towards intellectual vigilance.

There is a kind of circularity here, but it should really be viewed as a matter of feedback. If you’re interested in parsing through your sensations in pursuit of deeper relations, you’ll discover that any rigorous examination reveals the superficiality of “immediate im-



ing them is too exhausting. Through this process you can marshal armies whenever you like.

There are infinite possibilities when you abandon coherence, simplicity and empiricism. But the infinite is boring, it's a quagmire. What science represents is the winnowing down of the infinite, the pursuit of the most fascinatingly unique possibility (or possibilities).

The problem with Christian Science isn't that it's unfalsifiable; falsifiability, while certainly a useful indication, isn't absolutely critical to science, and there's nothing unscientific about postulating that the entire world might be an illusion. Even though we may label extensive thinking about it as unfruitful, we still note the possibility and are honest about it. And — as with Boltzmann brains — there are even fringe considerations that could have ramifications or relevance or testability. Thinking about models involving reality being simulated, for example, has prompted people to narrow down possible signatures given certain assumptions regarding the hidden reality that can be compared with experiment. The unscientific leap is just how wildly arbitrary the claims are once you get beyond the mere statement that our entire impression of material reality could be a lie. There's a very large infinity of possible configurations of hidden realities, of which Christian Science's claims about God etc are but one. They say suffering is an illusion but why not claim that non-suffering is the illusion? Why not postulate that we're all in the dream of a cosmic green sheep? Etc.

A model with infinite arbitrary parameters is a bad model. Or at least it's uninteresting, or a bad model on which to predicate communicating or collaborating with others. Hell, we need to find unique points within the space of possible models that everyone else can identify just to be able to meet each via those frameworks.

'Christian Scientists' love to claim that their conclusions follow from a priori introspection, but the more broadly and vigilantly one engages with the world the more one sees just how limited introspection can be and prone to confusion or accidental self delusion.

bask in the knowledge that you must be doing something right as a matter of character. It's basically *The Secret* for 1880s housewives.

Rarely is the core of faith exposed so openly. Christian Science caters to the poor, the mentally ill, and rich conservatives with hippie inclinations. Washington DC is filled with them. My impoverished family was once bizarrely taken yachting by a former assistant director of the CIA.

So if you're going to invent a stripped down version of Christianity that resolves its incoherencies by claiming the universe doesn't exist and expressing distrust if not intense hostility to any sort of hands-on engaging with material reality or even consistent bayesian logic — if you're going to become famous for letting children die rather than concede to basic science — why adopt the label "Science"? Well put simply, in the 1800s when the church's founder Mary Baker Eddy was trying to win over the world, "science" was a popular buzzword with a lot of awe but little public comprehension. (So exactly like today.) The founding saga of Christian Science is that a middle class schizophrenic white girl addicted to morphine slipped and hurt herself, some doctors allegedly told her she would never heal and in a few days she did. Bam. New religion.

There's a couple things to note here.

Even before Baker appropriated the term for herself, the dastardly representatives of "science" in this story, the "doctors" (they were actually homeopaths) had just as brazenly appropriated said mantle for themselves. Little about practiced medicine at the time involved anything remotely close to the kind of knowledge of root causes and relationships that had driven the public stature of "science." Physics and mathematics, with chemistry and some limited realms of biology dogging at their heels, had seen a stunning burst of conceptual developments and dramatic evidence over three centuries. We were old hats at advanced calculus and were sending electric signals across the transatlantic cable — but we didn't even really have the germ theory of disease. Would-be doctors, like everyone else, were trying to position themselves as inheritors and

compatriots of if not indistinguishable from physicists. Such bald-faced appropriation of anything garnering respect is venerable tradition and those in power were well-versed long before Baker. From the days of Newton there've been rich statesmen like Francis Bacon leaping to define what those folk garnering respect were really all about and how it could be applied to other things. In fact the barrage of quacks, cultists, con-men, and politicians so dwarfed the numbers of those they were emulating that very quickly they managed to seize the mantle of "science" in the public's eye for all manner of pet projects. It didn't matter that the people five-seconds prior considered scientists emphatically dismissed nonsense like phrenology and other such 'sciences of peoples' as ridiculous, the establishment showered any halfbaked fool willing to defend patriarchy, white supremacy, and capitalism with money and displays of respect. Neither her neighborhood "doctors" nor Mary Baker Eddy herself (the original name she chose for her religion was "Science of Man") were doing anything different than most people throughout modern history; they found something respected or liked for whatever underlying reason and mischaracterized that reason or offered a different explanation so they could hitch their own stuff to it.

But Baker didn't just ride this popular wave of appropriation, she took advantage of the way it muddied the waters to discredit and disregard the original scientists. The rhetorical tactics common in bible study when I was a kid will be familiar to anyone today: Stripping merely brilliant and unparalleled models or insights of their explicit context and assigning them strawman pretensions as Absolute Knowledge; using the shoddy results of appropriators to slander by association the original endeavor; belittling anything too far outside the everyday concepts, experiences, and concerns of those in a certain cultural/economic space... it was a by-the-numbers affair; the same sort of rhetoric you hear from theocrats or nihilist burnouts today. (If the ideologies that use such defenses vary so wildly it's because once you chuck pursuit of coherence and the

extended and implausible alternative explanation of how the scientific consensus is rife with somehow systematically unseen failures. Soon you've added piles and piles of redundant or unnecessary complexities, even magical interventions. You are pulled more and more towards solipsism.

And yes, sure, this can feel freeing. People with little agency in their world often find any sensation of 'possibility' freeing, even incorrect or deluded possibility. There's an unlimited number of models incoherent internally or with one's experiences, and they're all relatively easily morphable into one another. This freedom of mind can be exhilarating, but it offers a false and limited freedom, because a failure to understand the world around you means an inability to move it.

The radical impulse is critical. It's long been noted that people with some basic intelligence but no deep drive often realize they can "argue" anything and, upon such realization, stop, failing to examine the meta-characteristics and topologies to such expanses of possible "arguments." Because the utility of vigilance is not immediately obvious their instinct to rigorously examine atrophies and they get away with it by simply upping the complexity until no one can manage to call out all their mistakes. I once heard an 80 year old professor sincerely argue that — never mind their individual persuasiveness or coherency — because he had more distinct arguments for creationism it was therefore correct.

We're playing the "how can we use words to figure dynamics out" game, but so much of society is instinctively playing the "how can we use words to manipulate and get what we want" game, habits that have been adopted by the naive as well. That sort of thing is not a conversation and it's certainly not worth bothering with. You can always arbitrarily increase the complexity of a stupid argument to fend off critique. The formula is simple: start with some loud populist appeals to common everyday abstractions, models, or language (however unfounded) and pour on supporting claims and excuses with increasing complexity until challeng-

Particularly common in our society is the strategy of enforcing rituals and spectacles of public modesty that aggressively drag yourself and everyone else down to avoid any one of you ever being challenged. Obviously this is the case most of the time when the outraged howls start of “How can you claim to know anything? No one knows anything! You’re just a confused slob like the rest of us! How dare you put on airs!” Too frequently people in this situation start talking past each other with entirely different notions of humility.

People are deeply afraid of science’s potency. Scratch that, it’s much broader: People are deeply afraid of intellectual vigilance. They’re afraid of fields they haven’t studied. They’re afraid people will come at them one day with something from beyond their horizons that overturns and shakes up their core perspectives or narrative of self.

The reason commentators try to fence in science, make it trivial or incidental to our lives is because they can feel the magnitude of its philosophical impacts lurking. There are, after all, no a priori truths. Just deeply seeded priors that can be overruled by sufficient conditions. Physics might very well reveal that causality or time itself don’t work the way we develop a working assumption of at a very young age. Physicists are unafraid of overturning the kind of intuitions biology or our formulative experiences have built into us, but for lots of people there’s a catastrophic sense of vertigo — and soon after, rage. How dare you!

Yet all we humans ever do is model the world. Even logic and the most cherished axioms are just models that have to be chosen. We see patterns and look for stronger patterns. To discount the search for the strongest possible patterns is to cast oneself to the winds of happenstance. And ultimately it risks unmooring one from any good reason to even believe in other people’s existence. If you have some kind of deep assumption about the universe or even how you think and science reveals deep failures of your model or better alternatives you have to postulate an increasingly conspiratorially

roots of dynamics you can “argue” any arbitrary position.) The thing is, it worked. It’s one thing to latch onto a bigger phenomena in hopes of becoming indistinguishable from it, quite another to use it as a ladder to reach respect and then turn around and try to set that ladder on fire.

Mary Baker Eddy’s wild success is a testament to human weakness and oppression. People who have no power, who are trapped or locked out, will go through all kinds of mental gymnastics to avoid coming to terms with their reality. Minds are always looking for avenues of exploration and the only thing more painful than being fundamentally barred is not knowing where to start. Conscious minds can’t figure out how to live in stasis and the result of trying is always insanity. To minimize this as best we can we turn to escapism, we shrink our horizons, we frantically model alternatives in hopes of finding a useful perspective. And when that grows weak we simply deny. There’s no way they could know something we don’t. No way our abuser or a person with more privilege could have legitimately discovered realities by virtue of their situation. To admit this is to come face to face with the full nature of power and either strip us of hope or open yet another exhausting frontier of conflict.

I single out Christian Science as an illustrative example of the disingenuousness surrounding use of the word “science” in particular because it arose simultaneous with an array of more influential appropriations, from “Social Darwinism” to Comte’s “Sociology” to Marx’s “Scientific Socialism”, at a historical moment when most of the academic categories we know today were being hashed out.

To understand the tangles of philosophical attempts over the last century to define “science” it’s important to grasp the context surrounding exactly who got in and who didn’t when the modern lines were drawn. In the mid 1800s the explosive cultural force of the Enlightenment had been mostly spent and the social prescriptions of its political ideologues were undeniably losing cachet amid the complexities of industrialization. Mathematics and physics were

still accelerating at a breakneck pace but the days when political theorists could pretend to be of the same cloth were fading. Studies were moving out of social halls and into an increasingly segmented academia. In the thereto standard academic distinction social concerns that we'd today classify as economics and sociology were commonsensically denoted as "moral philosophies" — ie. inherently political — while the real drivers of undeniable advances in knowledge like physics and mathematics were "natural philosophies." This distinction within academia brought a clarity that threatened to undermine those forces looking to appropriate intellectual authority.

Thankfully for them there were distinct aesthetic qualities to the arguments of Enlightenment thinkers like Thomas Hobbes that resembled the mathematical proofs and rigorous surveys of early physicists or sought to tenuously extend models within natural philosophy into normative social theories. That was after all the whole game of Hobbes and company. And so eventually the term "science" was settled on as a means by which economists, sociologists and the like could be grouped together with the natural philosophies.

Over the previous centuries, with the decline of tradesmen and the rise of industry, "science" had quietly shifted from an adjective describing the individual cleverness and experiential know-how of craftsmen and artisans to a noun mainly signifying the systematic collection of data. "Science" thus provided an effective way to re-define what exactly was the source of success in the early cluster of physics fields, and to blend them with certain moral philosophies (usually wed to the kinds of state power or capital that could perform extensive data collection) into a intentionally hazy and exploitable bundle of popular associations, primarily characterized by an air of inevitability and absolute knowledge.

It's this last impression that still galvanizes people today, often quite violently.

are "educated" would require the space of a book, so I won't bother trying. But that is only one component of a wide array of ways our present society suffocates and denies access to deep and incredibly important concepts or experiences regarding how the world functions that are necessary to build better intuitions.

And even chucking those is not enough. It would not be enough to burn this horrid system to the ground because many of the monsters impeding access to or understanding of science have sown the ideological seeds of their own upkeep and reestablishment.

It is, after all, not just an education or accessibility problem, it's also a vigilance problem.

## So What's The Hold Up?

So why do people fail to even set out on paths of exploration that would eventually lead them to catch up and recognize science? Why do people turn away from radicalism to reactionary perspectives?

What we must remind ourselves is that people will be prompted by their contexts to grow into different cognitive strategies. A child that's beaten for exercising inquisitiveness will quite rationally decide that thinking is a bad strategy in life. It's often quite rational to stop being rational, or at least to abandon intellectual vigilance. (There are many competing popular definitions of "rationality," some expansive to the point where they describe literally all possible developments in a neural net and others far more specific and aspirational, I am not deeply wedded to any one.)

Sometimes when the goal is feeling smart rather than actually being right, the most optimal strategies are postmodern rationalizations that add more and more complications and slippery fallacies of association in a kind of fractal way until it's turtles all the way down and your interlocutor can't vanquish them as fast as you can generate them.

cause I have many points of contact with it, and thus I know how difficult it would be for a lie to propagate or persist. Further I've compared theories and considerations myself, followed them down into their nitty-gritty and seen just how elegant and more realistic an account is.

And yes there often really is a universally accessible or "objective" direction of "better theory." Although it can be hard to precisely compare two theories roughly close to each other in virtues, a broad gradation between possible models is strongly apparent upon any fucking due diligence.

All this is maddeningly hard to convey to people with a limited vocabulary of experiences to draw upon. You have to go digging around in the systemically impoverished lives of those deprived meaningful contact with science and find the one experience that will make such dynamics clear. Someone to whom all discussion of say 'complexity' is meaningless hot air with no connection to anything in their lives cannot really be expected to fathom any talk of scientific legitimacy outside of experimental validation, and even that is likely to be tough going. Many people in our world lack critical qualia, have never even experienced basic things we take for granted, and it is fiendishly difficult to catch them up. Try explaining turbulence to someone who has never played with water or watched clouds fly by. I've listened to multiple people in various contexts demonstrate that a system is non-linear in a trivial way and then promptly sit back under the impression that such equates unsolvability.

Part of the solution is obviously — as most scientists know and will angrily rant to you at length about — destroying the prison system masquerading as "education." The "disgustingly boring gymnastics used only for punitive purposes," as a mathematical physicist I'm friends with characterized them, that comprise all contact with supposed "mathematics" most students ever have bares as little relation to the actual practice as spelling bees do with literature or poetry. Of course to merely list the myriad failings of how we

## Collecting Facts & Marking The Territory

As you might expect with stakes this high philosophers promptly spent much of the twentieth century squabbling in direct and tangential ways over what qualifies a statement or claim as "scientific", or what counts as a "scientific fact." I'd argue that this approach, while understandable, is ill-conceived.

The project of drawing a boundary between the inside and outside of Science! — a project called the Demarcation Problem — has mostly played out as contests over the mantle of science as an adjective denoting a kind of truth value. Thus for the philosophers and demagogues who have invested so heavily in this battle "science" is primarily viewed in terms of its service or danger as a rhetorical weapon. As something that might be slapped on a statement to make it a certain type of unassailable.

It should thus come as no surprise that virtually none of the most prominent voices in this debate and resulting commentary have been scientists themselves (not that we haven't had strong opinions). And even when the intention of those involved has been good — like finding clear definitions that get evolution and global warming accepted as truthful but not homeopathy — the attempts invariably trend greedy in their praise or dismissal. Either way they often end up claiming fields like psychology and economics as being of the same primary category or essential nature as physics. At the same time almost all of these philosophers and demagogues have felt the need to hobble science lest it get too uppity and say more than they want it to say. There's a widespread and frequently vocalized fear of science ceasing to function as a highly limited tool and instead getting unleashed as an orientation, motivation, or desire.

And so we get the simplistic Baconian picture taught in high schools since the Cold War: Where a limited methodology or proceduralism is almost entirely divorced from context or analysis and held up as the single defining characteristic of Science!. The almost

entire process of theory or model development and comparison is handwaved away, and all that's left is data collection and calculation of error bars.

Under this regime science is — at least officially — limited to the smallest of inductive steps forward. There is no space for analysis or models that require a complicated hashing out before data collection. The vast array of analysis of probabilities, bayesian dependencies, contextual considerations, limits, etc. that good scientists crank through — or any serious comparison of differing models, paradigms or lines of investigation prior to data-collection — is waved away as not really core to science. In the methodology picture a miracle occurs whereby some arbitrary hypotheses emerge fully formed — each more or less as a priori good as the next. There is no room for nuanced contextual considerations or the extended development of analysis that does not immediately offer experimentally falsifiable or verifiable predictions, nor any explicitly preferred direction in the winnowing down or comparison of such analysis. All that matters is the data collection and everything else is ultimately treated as a kind of handwavey excuse for it. “Signals” are then found, but how fundamental they are is anyone's guess. Indeed, as an exercise, it can be illustrative to survey the notoriously horrid headlines of pop science and see how many times phrases like “science says” could just as well be replaced with “data says.”

This preposterously limited model of science obviously parallels the various currents of panopticon-aspiration we know all too well today, but it has its roots in classical imperialism — not just in the obvious necessity of taking censuses and mapping shorelines, but in the competitive collection of superficial “curiosities” by the upper classes to strengthen hierarchies at home.

It's a sadly underemphasized fact that the aristocracy pioneered aspects of consumerism long before industrialism. In particular many fields that came to be considered “sciences” in the 1800s like lepidoptery were originally launched as fields of curio collecting whereby members of the aristocracy hunted down rare items from

researchers toward the same underlying root dynamics. That's the ideal at least. But it's a coherent and substantive ideal that many discourses asymptotically approach and that we are all the better for having a term for.

When alleged ‘radicals’ these days rail against science what they're typically arguing against — or at least what they get started rallying against — is having to integrate with the social and institutional structures mediating such ‘facts’. The semi-ironic embrace of mysticism and the occult among the queer community and twentysomethings more broadly is such a successful sociopolitical signalling game not just because of the boogeyman of Dawkinsite atheists and the broader STEM vs humanities culture war, but because it publicly demonstrates a rejection of the authorities and institutions that have positioned themselves between scientists and just about everyone else.

The error here isn't not trusting the account of those with the right magic words. It's — again — not investigating more thoroughly or proactively. A stark case of Gell-Mann Amnesia whereby people recognize when the institutions of power appropriate and drastically misrepresent one's own team, but then immediately assume those same institutions and media gatekeepers are more or less honest about everyone else. Anarchists are happy to recognize how poorly “anarchy” is represented in the media and how many appropriators are out there, and yet so many of us embarrassingly turn around and take representations and claimants of “science” at face value.

Modern liberalism asks us to wrap ourselves in as many flags as possible, to feel entitled to the sense of identity provided by a strong opinion. Doing due diligence by looking at depth into the subject is in no way seen as a prerequisite, and since the goal is social positioning there's no impetus for such investigation.

However I don't highly trust someone's account of a mixing angle because it's spoken in the magic tongue of science, but because I've done a lot of looking into the social and cultural context, be-

about Game Theory, it was invented by a paranoid schizophrenic who worked for the government and feared communists.” (Nevermind its parallel discoverers or that game theory has ultimately provided some of the strongest arguments for anarchism and clearest insights into the landscape of challenges we face.) Similarly it’s quite popular today to talk about “cybernetics” and criticize anything that touches information theory by cherrypicking the ideologies and rhetoric of associated parties — an approach that quickly grows so disconnected from the actual reality of the material and field that it starts to sound like conservative rants about “cultural marxism.”

(Although quite a few authoritarians have spun out hopes that it would provide tools for absolute control, cybernetics’ objective success in grasping root dynamics has also revealed profound limits to the information processing capacity of power structures and computational neuroscience has enabled a much richer and more productive ethical discourse. “Cybernetics” in fact is a sweeping term mostly used by its critics. The actual fields bundled up in absurd polemics like Tiqqun’s do not easily fit in the grand ideological narratives claimed by these critics. Additionally, since every essay on how the ‘inherent logic’ of cybernetics somehow inexorably saddled us with our current surveillance state loves to point to the reactionary associations of a couple famous researchers, let me point out that one of computational neuroscience’s most influential early pioneers, Walter Pitts, was a homeless runaway from a poor family who’d joined a commune of radical supporters of the Spanish Revolution.)

There can be — of course — a sliver of relevance to who the original discoverers are and what assumptions or constrained perspectives may get subtly baked in, but an even remotely scientific field is quite a bit different from say endless discourses on the writings of Heidegger; models and paradigms in science are frequently replaced rather than merely appended with footnotes and there are a multitude of very strong pressures in scientific practice driving

around the world and displayed them as one might today display a record collection. The key to understanding this dynamic is that anything with barriers to entry and scarcities can be used as currency to prop up a hierarchy. When the things we might otherwise value become less scarce those invested in social hierarchy itself respond by culturally promoting the valuing of other scarce things.

When — as is common in the modern era — information is made the scarce good, the resulting data collection or generation of lingo & taxonomies need not bare any real relation or insight into what true underlying dynamics are involved, and can happily countenance the most superficial or limited models.

## The Roots Of Science

The problem with identifying science in terms of all this is that data collection unto itself doesn’t really signify any concept or dynamic of substance. It’s hard to realistically speak of there being a passionate movement or culture or ideology or idealism of data collection. And data collection is not in any real sense descriptive of what motivated those original scientists everyone else appropriated from. Any old pile of data might show how particulars happen to be arranged, but alone it offers little insight into how or why. Some statistical analysis on that data might make for good predictions, but only within a certain given context, whose bounds we remain entirely ignorant of. At least without a serious sort of thoughtfulness, the contours of which are blithely ignored by the methodology tale. Incorrect surface-level impressions and models might well be falsifiable, verifiable, etc, yet remain unchallenged outside a given context; how and where we search matters. As do our motivations.

It’s easy to apply the trapping of the scientific method — even the broader definitions of science promoted by many philosophers — and end up with little in the way of deep insight. Indeed that’s of-

ten the point of much that the sticker of “Science!” is slapped upon: to map the world as it is and hide how else it might be or how it might change. Those who are invested in existing systems have little interest in mapping alternate possibilities. And those preoccupied with their own situatedness have little desire to look beyond it or press beyond the effective realm of their understanding.

Thankfully outside a few caricatures in some hilariously detached postmodernist polemics few people widely accepted as scientists today pursue data for data’s sake — as the sort of currency or fetishized commodity that so attracts aristocrats, bureaucrats, middle-managers, and hipsters. What motivates us is typically the search for deeper insights and models that might be made clear — to hack our way through the muddled chaos of first impressions, intuitions, and naive beliefs and find the real underlying dynamics of a phenomenon.

This strong, persistent, and near-uniform tendency among scientists is, I would argue, a good starting point for sorting out a clearer perspective on the whole affair.

Sure “science” as a term was championed to facilitate a disingenuous blurring and appropriation — a campaign that created a hazy umbrella of uses in practice, filled with more contradictions and tensions than any clear commonality — but a great deal of shaking-out has occurred since the 1800s. And further many important traits of those originally appropriated from have begun to be internalized by the appropriators. Not enough, obviously — the journals of medicine and the social sciences are still infamously rampant with irreproducible crap — but enough to warrant notice. In no small part because there really was a unifying tendency in the fields everyone else sought to steal legitimacy from. Something deeper than a mere tactic or procedure.

Few would deny physicists are located at the dead center of whatever ‘science’ supposedly is. (Well okay, the most absurd appropriators like Mary Baker Eddy and Auguste Comte eventually did, but their claims have fared poorly at undermining the historical cen-

long cemented and reinforced. And the few scientists in this whole affair tend to sigh and keep their heads down rather than contest every nonsense. Meanwhile expecting someone whose gone through the theoretical and social conditioning of academic fields that practically define themselves by suspicion and hostility to science — someone whose social connections are almost certainly overwhelmingly in the same boat — to just cede before the overwhelming consensus within the scientific community is like telling a FOXnews troglodyte to adopt queer terminology because everyone in San Francisco is doing it. It’s just totally disconnected from the realities of social pressures, and it expects magic from human trust networks.

Why on earth should you trust what one teacher says? Or wikipedia the time you strayed over to it? You don’t have knowledge of the immense amount of work it would take to maintain a false belief within say mathematics journals, so both sides appear roughly equivalent. Science appears to most as just a codification of what’s popular in certain circles except with those people saying “it’s extra true because someone somewhere totally tested it, whatever that means.”

Smart people come up to me and express derision or discomprehension of science all the time. A skilled hacker asks me bemusedly at a party, “so you actually think there’s like truth??” Brilliant girl in my high school chemistry explains why she doesn’t pay attention in class, “Theories in science are always changing, why bother learning one, it’ll be totally different in two hundred years anyway.”

These express themselves as philosophical critiques and sometimes develop into more challenging ones, but they’re grounded in a sense of social alienation and a rebellious dismissal of seemingly arbitrary authority.

It’s not for nothing that one of the most instinctive ways Leftists have interacted with science has been by critiquing sources or playing games of slander by association. “Don’t get me started



But there are many more holes people dig themselves into, and some are quite relatable.

## Who You Trust Is A Legit Question

The reality is that people not trusting scientists or scientific consensus is in many regards reasonable. What are you going to trust, your eyes and everyday lived experience or a single teacher in school and some nerds online?

Most arguments over catching people up to scientific knowledge usually come down to 1) how integrated a person is with a relevant culture, society and institutions, and 2) how unoppressed they are. There are many other logjams and twisted arguments that can occur, but these tend to be the most primal. If no one you know can in any meaningful way vouch for the stranger thumping on the Particle Data Group book their claims of peer review and the like will appear no different than a theologian claiming to be correct because other theologians have checked. And of course, if you're locked in modern versions of chattel slavery, exploring the workings of the universe is not really a good strategy for survival; nor will your first instinct be to trust the claimed findings of those who do have that privilege.

Honestly the only reason a good number of folk these days would sneer at anyone saying sun goes round the earth, that Jesus rode dinosaurs, or that the universe is 6,000 years old, or that anthropogenic global warming isn't real, is that they recognize these claims as cultural cues of being on 'the wrong side.' It's a not-popular thing. A shun the "outgroup" thing. As such appealing to the spirit of social consensus and democratic moralism is a weapon that will almost always backfire on scientists.

To most of the kids that get shuffled into 'radical politics' or the like scientists are the outgroup. The cultural divide that takes root in college between STEM majors and humanities majors has been

trality of physics.) And yet physics is also at the center of a wide and deep tradition within science that is not motivated by shallow data collection and labeling but by getting to the roots. Hence physicists' uniform frustration towards people attempting to derive general rules from surface data on complex systems. And our fury historically at psuedosciences like phrenology that the rest of the world happily accepted as science. Ernest Rutherford's famous cry that "All science is either physics or stamp collecting!" arose deeply embedded in this context.

Our famed "arrogance" in this matter is better understood as an annoyance at the lack of humility or diligence on the part of those making such sweeping statements about macroscopic aggregate systems like human beings. In practice "political science" and the like have often functioned like cargo cult physics, and much of the literature of social science and biology has remained in a continuing crisis as a direct result of their failure to doggedly look for deeper root dynamics and instead just catalog surface impressions. Not to mention their corruption by economic interests seeking to derive useful tools or actionable prescriptions, pressuring them to behave as technologists or engineers rather than inquirers. And so we see within these broken fields an attachment to the scientific method, rather than to what I would term the heart of science. When you don't actually really know why and how something works, just that it in a certain context does — or kinda does — from a bunch of data, you don't have scientific knowledge so much as mere empirical knowledge.

Of course there's certainly space for speaking substantively about messy abstractions like humans and human social relations, and data collection can of course facilitate this. But the frequent lack of humility in the social sciences & chunks of biology— the lack of any honest appreciation and accountability for just how insanely hazy and attenuated most of it is, often dealing entirely in immediate surface impressions — remains stark. While things have certainly gotten better as the rigor of physics and the like

has leached out (in particular see Scott Alexander's impassioned defenses of modern psychiatry and nutrition), significant currents within these fields remain happy to speculate in shallow terms and collect data without any diligent root-seeking or explicit recognition of how tenuous and overly-simple their hypotheses are likely to be.

## Digging For The Roots

The fact of the matter is that the remarkably successful phenomenon that the term "Science!" has wrapped itself around is not so much a methodology as an orientation. What was really going on, what is still going on in science that has given it so many great insights is the radicalism of scientists, that is to say their vigilant pursuit after the roots (or 'radis'). Radicals constantly push our perspectives into extreme or alien contexts until they break or become littered with unwieldy complications, and when such occurs we are happy to shed off the historical baggage entirely and start anew. To not just add caveats upon caveats to an existing model but to sometimes prune them away or throw it all out entirely. Ours is the search for patterns and symmetries that might reflect more universal dynamics rather than merely good rules of thumb within a specific limited context. As any radical knows "good enough" is never actually enough.

To be sure there are naturally going to be certain tactics and strategies that are generally quite useful in such pursuit — some in very deep and inescapable ways — but never any single magically simple and always efficient procedure or methodology.

Kuhn and Feyerabend pointed out half a century ago that no simple set of rules of procedure could explain numerous important instances in the actual history of scientific discovery. Galileo's heliocentric model for example was among other failings easily and immediately falsified by the astronomical data of the time. Its

circus that leads to horrid phrases like "god particle" and all the narratives that get validated as a result. And there's an ounce of truth to that. Not in the sense that we scientists presently feel anything other than murderous rage at the pop science media machine, but that there are still many wars for us to win. Thankfully we're clearly up for the task. I will never forget the day the head of my old department discovered Wikipedia. With bags under his eyes from an all-nighter editing articles he animatedly and earnestly beseeched his statistical mechanics class "Did you all know about this? Why are you all here when you could be at home learning on your own? I wanna blow off my next class to adopt some of my lecture notes! Oh! I guess this means I'm out of a job. Huh. Oh well! Good riddance actually." All good scientists hunger for the death of academia, in the sense of our present institutional context, this gross distortion, this unnaturally frozen battlefield in the struggle to expand science to everyone. It is unfortunate our relatively recent treaty with the state and other appropriative forces led to an abrupt freeze in the previously exponentially increasing ranks of scientists. We don't always appreciate this violent pruning of science, the prison signified by our still small numbers, but the loss is astonishing when you plot it out.

I delight at the inevitable accusations of "imperialism!" I will receive for the crime of desiring to persuade people or even make arguments more accessible, but outreach does have to be nuanced. Instead of outright declaring "you should want this" we need to go after the biggest traps people get themselves into. I find myself having to tackle the old "anyone can argue anything!" quite frequently: Well that's quite a surprisingly strong statement! How do you know every possible perspective is perfectly and evenly mappable into all others? How can you be so certain that when considering every possible meta structure for 'argumentation' there are not emergently inferior and superior ones? You seem to be extrapolating very vigorous results from a very small dataset of personal experience!

Often however we utilize existing barriers to entry as a kind of wall slam in people's face. Someone repeats the well popularized woo that quantum mechanics has anything to do with conscious "observers" or the poorly defined notion of "consciousness" itself and we quickly snap that quantum mechanics is just a theory of complex probabilities, of operators in a hilbert space, and continue rattling off mathematical context until the wingnuts feel sufficiently browbeaten or at least leave us be.

This is highly understandable, and often there's no better tool available to make the frothy nutjob or haughtily ignorant continental philosopher go away, but it is unfortunate. Exploiting unfair existing barriers to scientific knowledge to harangue those on the outside is hardly in keeping with the core idealism of science.

Thankfully there are presently many projects on various levels to restructure every aspect of science as an institution. Peer review, journals, even colleges themselves are under constant criticism and attack in the core of science. And while physicists led the push decades ago to open source everything and bypass or abolish intellectual property, it's well past time to make that material not just available but accessible. Doing this, replacing peer review with more organic, open, and situationally nuanced associative networks of trust and decentralized certification, is no simple task, but many are working on it. Just as many are working to replace the astonishingly primitive technology of pdfs with a richer more deeply tagged and accessible literature, ideally leading to fields of knowledge as mindmapped wikis where dependencies and sources are instantly visible. The solution to people with smugly uninformed opinions is to take away any excuse for their ignorance. To build a culture where our instincts are to just look something up if you're interested in it rather than to try and accumulate 'opinions' from shallow data as though building a record collection.

I've heard people in the left or the supposedly post-left milieu sneer and argue that the deplorable filters of pop science reporting are the fault of scientists, that we are complicit in the whole

greater pull lay not in perfectly matching the data, but in an underlying conceptual critique of the arbitrariness of the perpetually added circles-within-circles necessary to prop up a geocentric model. That's a meaningful critique in terms of the free parameters and kolmogorov complexity, but it's not reducible to a simple and universally valid procedure or tactic.

Science, in short, is not just mere empiricism, not merely collecting data and doing statistics. Science most critically involves an exploration of possible models, their dependencies, and the many possible vectors by which they might be winnowed down, all in search for the deepest roots. The most universal symmetries, most unique patterns and attractors in the relations of a system. Those often hidden but least moving foundations from which everything else in all its grand complexity can be grown. Our probings are not randomly directed, we pull and tug on our models, see what doesn't shift about, and re-focus our efforts on it directly.

So for example theories that have internal logical inconsistencies aren't necessarily dismissed absolutely but they do get focused on far less because such a characteristic (inconsistency) is not rare among possible theories: there are infinitely more possible incoherent theories than possible coherent theories. Incoherency in a theory provides a lot of flexibility — quite a bit of freedom to wriggle it about. Sometimes upon investigation the inconsistent theory will entirely unravel, a phantom temporary knot, not actually a deep root. But sometimes the inconsistency will turn out to be patchable if we give the theory some more attention.

Similarly — in a more practical direction — if an expanse of theories under consideration predict that it's infinitely more likely that all our memories are lies and we will cease to exist in another instant, we can in some sense abandon such theories. That's an absolutely real example by the way. There are certain (otherwise perfectly empirically valid models) possible in particle physics wherein it just so happens that as a consequence of a possible model (with particular field strengths, a geometry of spacetime, etc)

it'd be infinitely more likely for a bowl of petunias or a human brain with all of your memories etc to be spontaneously generated out of the quantum vacuum at some point in the infinite history of the universe than for a brain with your memories/feelings/etc to arise in the causal fashion those memories and feelings would suggest. This reductio ad absurdum is called "Boltzmann Brains" and it's engaged with quite seriously and rigorously. It may well be that you have never existed before this moment and will never exist after it, but if so there's no consequence to attempting to spend time modeling that reality or thinking in any direction really. All desires or motivations a mind might have would instantly dead-end in that reality. Thus we consciously mark off those possible physics models that imply such as "not worth dwelling on", invest our attention in other possible models, and call a theory a certain type of 'failed' when it ends up predicting that you're infinitely more likely to be a Boltzmann Brain than a regular one in a regular universe. But we are explicit about that step, and this is what marks scientific knowledge: not a claim about a single true model, but rather an understanding of varying possibilities and their dependencies.

The atomist framework, for instance, bore a lot of fruit and so we sought to push it as far as it could go. And yet in field theory and string theory certain dualities make "fundamental elements" unclear — when two different representations are exactly equivalent to each other in results we arguably can't speak as to which is the "correct" portrait. The nouns we've wrapped as metaphors around the mathematical relationship fall short in their description — these can be either reveal a redundancy in our metaphorical description or a limit to our experimental capacity. But the fundamental relations that duality uncovers is clear as day. This requires a nuance between what the public views as 'reductionism' and what many reductionists view it as. The reductionism of scientists is not a caricature of atomism where all simplified macroscopic layers of abstraction, intuition or practical use are entirely erased. After all having the word "finger" doesn't invalidate our use of "hand" but it

mate change denier or quantum mystic is already subject to social pressures of consensus within their more immediate community of fellow wingnuts.

The root problem with the people "contesting" evolution or the big bang or whatever isn't that they're doing it the wrong way or using the wrong tools of argumentation; it's that they don't actually care about understanding. They care about the sensation of knowing, or the appearance of iconoclasm, or a fantasy of the gold star they might wrest away from the establishment. Our pluralist liberal society obsesses over the equality of all opinions, in which my ignorance is as good as your knowledge, and consequently in which abusers can never be pinned down because "everything's subjective." We leap to find opinions and then raise them as identity-banners. And so we bristle at the notion of better or more objectively reachable accounts that might disrupt our most fond self-deceptions. The ugly reality is that if people put even the faintest effort into vigilant inquiry we wouldn't be having these debates.

## **Tackling that means tackling a huge array of social ills.**

First and foremost we should be focusing on making the models or arguments we've discovered more accessible. As we lower barriers dramatically there will cease to be any excuse for the smug 37 year old punk with a theory of gravitation as friction. Or the endless barrage of numbskulls in the anarchist milieu — from oogles rejecting treatment for scabies because "science is a religion" to Wolfi citing wildly off base secondhand misaccounts of quantum mechanics and getting lauded for it. Point them to the mappings. Quickly call out the particulars: "Okay, how do you account for \_\_\_?" Scientists already do this by habit.

fied Scientist front. A definition of science centered on radical analysis would undermine the “we’re all in this together perspective” that a lot of science communicators have pushed to rally solidarity against attacks and to give disparate researchers a sense of ownership or investment in work beyond their own field. But honestly we shouldn’t have solidarity with many people in the STEM world. We could all do with more clarity about people’s varying underlying motivations and less fuzzy-wuzzy collective identity. If those STEM minds in conservative, religious or anti-intellectual contexts want to huddle around each other for warmth they can surely do so without obscuring important distinctions over motivations and degrees of rootedness. Our language should not be defined in reaction to the Kansas school board.

## Tackling Militant Ignorance

Yes, in some immediate sense stepping back from the shallow litmus tests for science weakens our rhetorical toolbox when it comes to rejecting pseudoscience. But I don’t think it’s worth risking our clearheadedness by twisting our conceptual language just to more quickly win some short term battles. We can still grapple with these people directly. Not with “it was peer reviewed! 99% agree!” badgering appeals to democratic morality, but by directly calling out the intellectual laziness of denialists. It’s unfeasible to personally tackle each and every anti-vaxxer, chemtrailer, or cartesian dualist; the amount of energy necessary to generate bullshit is always orders of magnitude less than the amount of energy necessary to refute it. There are maybe ten thousand times more wingnuts with strong opinions about particle physics or neuroscience than there are particle physicists or neuroscientists in the world. We will never beat back all their diverse nonsenses one-on-one in Facebook comment sections, and implicit appeals to social pressure via arguments from ‘scientific consensus’ fail when a cli-

does help us remember that there’s no magical emergent platonic “handness” resisting or orchestrating the existence of fingers — it’s just useful to have language for differing contexts or scales of abstraction. Similarly the objective of reductionism is not to break everything into nounish-pieces or to simplify away complexity, but to unearth fundamental relations/patterns from which everything else can be grown. Whether for instance these patterns take the form of particles, fields or things like symmetry relations.

(Incidentally this is oft repeated in my circles but it really is a goddamn crying shame that few outside of physics have any clue just how dramatically Emmy Noether affected our field. Outsiders talk of Newtonian and Einsteinian paradigms, but the more refined Noetherian paradigm of the universe as a bundle of symmetry relations has ruled physics for almost a century. This injustice to one of the greatest mathematicians of all time is certainly a result of patriarchy but also partially a matter of how much harder her insight is to explain to a general public that has, through a tyrannical, alienating and deeply anti-science education system, been denied familiarity with even basic calculus.)

It’s ludicrous to assume that a single hammer, a single obtuse strategy of sharply limited meta-complexity would be capable of entirely mapping the structure of our reality much less narrowing down fundamental roots. There will of course be complications to our search — things like the Boltzmann Brains — that we must take into consideration in order to do science with any efficiency. But those who want to somehow consign science to empiricism alone do so to artificially preserve their own domains from contact with the scientific drive, from explicitness and analytical rigor in mapping the probabilities and dependencies of different possibilities.

That is not to say that that experimentation, falsifiability, verifiability, etc, don’t play quite important roles in practice, but rather that they should be repositioned in our language as strategies we’ve developed or come to recognize as highly useful in pursuit of science.

The physicist approach — seen to various degrees in other fields — to speak explicitly in terms of what gives rise to the plausibility of a model or research branch rarely bothers with the cartoonish notion of steps and laws taught in high schools. Physicists enjoy an excuse to have a go at the strongest absolutes like entropy or the speed of light. We just keep in mind the complete chain of things implying them. And so while a few have fun going off and publishing some “let’s chuck half of everything we know and try over in this direction” papers, even they know it’s unbelievably more likely an experimental result indicating a violation of the speed of light reflects a hidden wiring problem in the experimental apparatus than a true violation of special relativity. One can frame this in terms of induction, as “no particle yet observed has gone faster than  $c$ ”, but that’s not remotely close to how the arguments go down in practice which take into account the root complexity of various models, their many meta-dimensioned bayesian dependencies, etc.

This might be thought of as a kind of Feyerabend Part II. Yes, ‘anything goes’, but to varying degrees. In ways deeply dependent upon context. Statistically speaking there’s a strong inclination to certain strategies and tactics, and that’s good. That’s because the radical impulse of science is grounded in bayesian learning, an optimal approach it turns out our neural networks also follow at the smallest level. As in any bayesian system comparisons between models are not arbitrary decisions hidden behind a veil of subjectivity about which we can say nothing. Examining meta-decisions does not oblige suddenly throwing up one’s hands and allowing charlatans free reign to claim anything about global warming; we can still trace everything, our entire network of assumptions and weightings, or relations. What defines science — or rather what is the single most important and fundamental dynamic of note within the hazy cluster of shit called “science” — is not so much the strategies and models it has accumulated at any meta-level but the goal of root-pursuing, a drive that hashes through the infinite possible

or political inclinations almost entirely opposed to the interests of science’s current benefactors/enslavers.

This recognition is of profound import to anyone looking for allies and fecund frontiers of resistance, and presents a powerful way to push back against those corruptive or appropriative forces that have been exploiting the situation.

I’m interested in this restructuring of our language and narratives around science because as an anarchist I come at science from a stridently idealistic and radical perspective and thus am attracted to those currents within it. But also because — having consequently developed a background in high energy theoretical physics — it’s continually astonishing to me the vast disconnect between the analyses of “science” popular within the left and the actual reality in the many fields close to my own work. A lot of what I’m saying is mainstream in physics and has been for a long long time.

While “purity” within the sciences is a widely recognized dynamic and common joke fodder, somehow few philosophers or pundits of science have felt any need to build any recognition of this into their definitions of science, or even mention it. (Richard Dawid deserves special mention here for recently taking some rarely listened to perspectives on science not being equivalent to empiricism common among theoretical physicists and finally giving some of our perspectives a voice in philosophy departments.)

The abusive and unproductive wall erected after the erasure of “natural philosophy” between science (as any immediately testable hypothesis) and philosophy (as literally any theorizing) has pressured scientists to be shortsighted and shallow in their theorizing and given bad philosophical models sufficient buffer from rigor and the march of new discoveries. And when philosophy does come up with anything concrete it’s immediately no longer classified as philosophy! Not only is this unfair but obviously it has a terrible influence upon philosophy!

Of course when philosophy and science aren’t defined in contrast to one another it’s much harder to present some kind of uni-

tion.” (To be sure, as a physicist I make the obligatory sneers and jokes about the aesthetic inferiority of discrete math to continuous math, but come on.) There are clear reverberations of lingering PTSD motivating these defensive obsessions and in some sense that’s quite understandable. There has, after all, been a good few centuries of those in power referencing or extending popular scientific frameworks or theories to prop up terrible ideologies. But to characterize ‘science’ in terms of those ideologies is akin to characterizing an elephant by the leeches, ticks and flies on its hide. They may have swallowed some tiny bits of it, but that doesn’t make them the elephant. And at the end of the day they don’t decide where the elephant roams.

Yes, the political, economic, social, and cultural commitments of scientists as a class have in many ways been largely captured and constrained by today’s most dominant power structures; just as those unions most critically situated at points of weakness in the system were long ago bought off, lumpenproles defanged with welfare, artists by commerce, etc. Although ‘pure science’ is constantly being whittled away as capitalism attempts to reshape and replace it by more easily predictable, controllable and overseeable fields of engineering — and basic science education is suppressed or replaced by tradeschool-style training — those who remain have been urged in a multitude of ways to identify with the status quo. It’s a simple fact that fewer scientists today face murderous repression from the establishment’s fear of disruptive effects. For a first in history the power structures ruling our societies have come to uneasily rely on certain predictable marches of development (although curveballs are still strongly discouraged). And since the creation of the modern academic system most scientists have come to rely on government funding in deeply problematic ways that impede a shift to alternatives. But once identified — less as a structured procedural commitment than a cognitive inclination or orientation of desire — science is exposed as having intense social

configuration space and gravitates towards a single locus, or sometimes merely to more unique regions or sets of loci.

One might approach this looking for traditional philosophical claims, and say that such an orientation assumes the existence of universal patterns and thus is making a truth claim about reality being consistent, but I think the orientation is better stated as an emergent line of exploration.

If there are literally no universal consistencies then pattern searching is useless because there cannot even be local consistencies. To give an impression of how this works consider if  $1+1=2$  was only local to some neighborhood: Then you could continuously transform to some other neighborhood where  $1+1=$ ”duck” and then transform back. If the transforms are always perfect pull-backs such that  $1+1$  continues to equal 2 upon returning locally then you’ve exposed a universal consistency on some meta level that has structure. If not then local consistency dissolves entirely. (In general I abhor mere arithmetic examples as violently misrepresenting the nature of mathematics and implicitly bundling in certain philosophies of mathematics; “ $1+1=2$ ” should be read as serving in this context only as a loose and popularly accessible metaphor for some manner of local consistency.) My point is that consistency or lack-of-consistency in thought is ultimately radically infectious; there is no middle ground. Upon any motion things either collapse in one direction or the other. And since all intentional action explicitly requires an assumption of some level of consistency, it implicitly assumes a universal consistency — regardless of whether or not the agent has full access to its nature.

We can, in a certain trivial sense, never know anything truly — in an a priori sense. Even Descartes’ ‘*cogito ergo sum*’ provides no firm ground. The qualia of the act of thought is in many substantive respects suspect; every way we might frame it is laden with baggage of assumptions. The formation of conscious narrative is itself an abstraction that fails at points and dissolves under examination. Even the recursive knowledge of the motion of our own thoughts

and self-experience doesn't happen instantaneously, and requires an assumption that our memory or state of mind an instant prior in the loop of recursion is real. There is no winning epistemology. What we can do is identify patterns, make models of dependencies.

Science in no way condemns postulating outside the assumptions that the "external" world is real, that nature really is uniform, etc. Rather scientific or radical thinking very quickly notes just how much of a formless uninteresting arbitrary muck happens beyond those assumptions. As with the Boltzmann Brains we put up a sign and move on.

Similarly the 'problem' of induction is only a problem if you are interested in stating things as though they were laws rather than symmetries, 'absolute truths' rather than patterns. We don't have to make that jump to do science. It's a faint distinction, but one that reveals many confusions that plague philosophy of science. The difference is intent: between understanding/modeling a reality and achieving an ends. Science's goal is not so much to be useful as to give a map of more unique, simple but descriptive, accounts of reality. We may happily mark off some of those accounts as not useful but science retains those accounts. And if multiple theories of similar complexity and arbitrariness give identical predictions or no predictions then they are of less interest than the theory that gives the same predictions but derives such from simpler roots, with less arbitrariness.

## An Artificial Distinction

I haven't been making any real distinction so far between mathematics and the sciences, and the above description of science as radicalism obviously places mathematics as a science. This fits the historical arc where "science" was adopted to more widely appropriate the prestige of advances in physics and mathematics, but the saga goes back further. The notion of a distinction between

change and trying to control and divert the development of science. But even this is often laughable and is certainly unlikely to be sustained.

## The Social Context To Our Definitions

This restructuring of how to view science is geared not just at defending science from charges of reactionism from leftists, but at more broadly clarifying how we might view that much looser bundle invoked by the word "science" as a political force. Because the array of things popularly associated with "science" is so wildly varying and hazy most of the political claims surrounding science that don't slice it away to near irrelevance or neutrality as a formulaic procedure have sought to identify underlying ideological commitments and then define "science" in terms of them.

The problem of course has been that those undertaking this kind of analysis (aristocrats, industrialists, liberals, marxists, & continental philosophers) very rarely have a radical bone in their body, and so we see writers lazily claiming that certain popular scientific models or paradigms that emerged briefly and with attendant explicit qualifications are in fact the core driving ideology of science. And of course — if they even note them — the emergence of alternative scientific models is presented as science conceding defeat or pulling itself apart from within. But it's not as though newtonian mechanics were some motivating religion, rather science's drive for the roots ended up legitimately judging newtonian mechanics as overwhelmingly promising for an extended period of time.

This kind of rabid preoccupation with things like positivism, atomism, and determinism (although almost always wild strawmen thereof) is rife among those coming from an academic or political lineage whose contact with science is Nth-hand at best. See in particular the ongoing cringeworthy hazy-association-fest of lazy psychology leftists have formed around the the word "quantifica-



Some scientists persisted nonetheless, but few could be so fortunate or tolerate the poverty and ignominy that would accompany it. Many tried to find excuses or shields against public derision, and thus many fell into collaboration with imperial, capitalist, and aristocratic power systems. You see currents like this again and again throughout the fight between science and power in history, with those in power deeply opposed to hypotheses. Only desiring details.

Physics is intimately aware of this deep and bitter conflict. The second world war saw most of the world's physicists either forced to work as engineers and technologists on weapons or at best starved of funding. And this was paralleled and followed for decades by the widespread blacklisting of the great number of physicists who'd been inclined to radical politics. The legacy of those who embraced their service to the state or crumpled under its thumb has been a vicious hostility towards too sweeping of curiosity, imagination, and extended theorizing within STEM practice. Physicists are today still split between those who approve of or revile the bootlicking slogan from the Manhattan Project: "Shut up and calculate." Variants of this hostility and anxiety towards theory permeate STEM culture, visible in some hackerspaces in the form of "shut up and hack." The cowed timidity and institutional allegiances of engineers and data collectors versus the sweeping and unrelenting audacity of the theoreticians.

The historical arc is clearcut: Whatever complicated entanglements momentarily emerge in their long war, science and power are unavoidably at odds. "I would rather discover a single cause than become king of the Persians," declared Democritus. What science represents is the sharpest sort of radicalism possible, a kind of thinking and a desire in-itself that is indomitable. The externalities of scientific inquiry overturned established power structures and created immense instability and complexities that are hard for power structures to navigate. Those power structures that survived did so by awkwardly clinging to certain predictable processes of

physics and mathematics has always been rather ludicrous and has persisted in the west mostly as an artifact of Greek mysticism and Christian theology. In fact this mistaken deep division between the supposedly "a priori" patterns of math and the a posteriori patterns of physics is arguably partially responsible for the general paralysis of science in Europe for over a thousand years until Newton and Leibnitz got audacious enough to challenge it. The great advances of math and physics that started in their era on were in no small part tied to the blurring of the two into a single tradition of diligent radical inquiry.

Yet in the great academic reshuffling and sweeping appropriations of the nineteenth century mathematics was rather quietly pushed out of the nest while physics was kept. The broken language that has resulted continually makes for very frustrating conversations. One person declares that obviously mathematics is a science because it involves vigorous modeling and pursuit of elegant fundamentals (in short, because it's radical). Whereas the other person declares that obviously math is part of the humanities as it is not grounded in empirical experimentation "in the physical world."

But of course our brains are part of the physical world. Exploration of all possible theories of formal patterns comprehensible to humans is itself a form of experimentation — essentially a form of experimental computer science — and data collected from such exploration is widely taken as meaningful proof. Mathematicians for instance probe problems of computational complexity and the meta patterns to how these explorations have turned out has been taken as strong evidence of the complexity classes and the incompressibility of the polynomial hierarchy. This is perfectly reasonable bayesian inference, but it often shocks and offends those outside math and the other hard sciences who've accumulated a very limited notion of what can constitute evidence.

And it's worth pointing out that physicists have always taken doing math to be both a valid realm of experimentation and the twin discipline of physics. V.I. Arnold said it best: "Mathematics

is the part of physics where experiments are cheap.” In fact the biggest discoveries in physics have often been mathematical reformulations of existing knowledge, from action principles to symmetry relations to modern thermodynamics. Physics often involves momentous discoveries that are not a prediction of empirical data, but a restructuring of how to construct models. Indeed the last couple decades have rapidly dissolved whatever lines had been drawn between mathematics, computer science, and physics. These somewhat separate academic communities are still reeling from the force of dramatic reveal after dramatic reveal. It’s been hard for many blindsided specialists to eat humble pie but there’s now a widespread awareness that the three fields will have to become deeply interwoven if not altogether indistinguishable in the future.

While there are certainly purist traditions within mathematics clinging to the sort of Diophantine work in the tradition of the Greeks and making snide remarks about calculus, it’s even unclear what could possibly constitute a truly “pure” math as there are unlimited possible formalisms or models one can work with. The inescapable fact of the matter is that the various underlying foundations we’ve gravitated towards choosing (like ZFC Set Theory or the increasingly popular Homology Type Theory) are chosen because the models they generate are better at integrating with our experiences of the world.

When John Preskill said that, “I favor the view that ‘Mathematics is Physics’ over ‘Physics is Mathematics,’” he was expressing a relatively common perspective from the trenches that is nevertheless shocking and transgressive to the peanut gallery commenting on science from without. In no small part because the division is useful to those in power.

In his work *The Utopia of Rules* David Graeber traced the evolution of popular notions of “imagination” from first being seen as something deeply tied to navigating reality to later something escapist and almost irrelevant. Mathematics has followed a similar arc — redefined partly by the powerful and partly in self-defense

wide array of deeply conflicting historical currents and dynamics, and what elites emerged in most (but not all) city societies often worked hard to suppress science. Frequently as the first step in undermining radicalism more broadly.

We’ve covered how “curiosity” was taken by the Victorian aristocracy and draped over shallow and exploitative consumerism. But this attempted appropriation followed another, more dramatic reversal: It was only in the seventeenth century that curiosity had transformed from being seen as a vice to a virtue. Before that watershed “curiosity” had been consistently condemned by western civilization. The Greeks were actually highly critical of curiosity, a tendency they felt was useless, intrusive, and disruptive. Inquiry for its own sake, the hunger for knowledge, was correctly identified it as uncontrollable or prone to wildness. Curiosity was a force in conflict with the ossified and sedentary structures of their civilization. The Christians continued this prohibition and condemnation of curiosity, the desire for knowledge was marked as fundamentally sinful. Rejecting the hunger of inquiry is the very foundation of the myth of The Fall, a narrative repeated in many societies riven with power structures. Once Authority ruled divine and the natural order was unchallenged, then some damned girl got too inquisitive for her britches and God could no longer maintain things the way He liked.

Today’s primitivist ideologues emerged from a long genealogy of complaints by the elites that the masses’ inquisitive desires constituted a horrifying monster that had to be suppressed at any cost lest it run amok. During the “Enlightenment” Bacon made the argument to his fellow elites that by promoting a rigid systematizing, curiosity after the roots could be harnessed by the state. But Hobbes’ contemporaneous attack on scientists for their abstract theories and pursuit of understanding for understanding’s sake reflected wider social forces seeking to suppress curiosity and that repeatedly ridiculed them as boffins.

Mary Baker Eddy's "scientist" "doctors" were certainly far less rigorous or vigilant than many Chinese experimenters in medicine. Indeed Iroquois or Chinese medicine would have been arguably better than the best western doctors of the day. The atomic and fundamental element models postulated by both Indians and Greeks obviously turned out to be pretty close to the mark, but given how little there was to work with back then early Chinese cosmology deserves appreciation as an also ran — the yin-yang and wu xing mode were valid attempts to model the world. And Bacon's methodology and paradigm of experimentation? Alberuni, an Indian Arab, had pushed for this in the middle ages and the 8-18th centuries in India saw systematic experimentation too. Three thousand years of science in northeast Africa burnt to the ground with Alexandria (the word "chemistry" likely has its roots in a word meaning the knowledge of "the black land"). On and on it goes, the astronomy of the early Chinese, the navigational techniques of Pacific islanders, the ancient medical knowledge of sub-Saharan Africans... Upon any investigation it's simply impossible to paint a picture of a discrete "western science" that is disconnected from this global tendency.

Humans have always played with symmetries and metaphors, trying to internalize better impressions of the world. Much of scientific reasoning is so natural to us because we've been constantly doing it since we were hunter-gatherers. Primitive cosmologies like animism and panpsychism were quite reasonable early hypotheses. We're a social species with brains built primarily to navigate social relations and model psychological dynamics; of course we would search for metaphors there. And those that did should be lauded as doing a decent job in the limited context they had access to.

The deeper regularities immediately visible in things like astronomy have long been interesting to hunter-gatherers, but it was civilization that happened to provide the scope, intellectual permanence and continuity necessary to get further in our investigations. Of course "civilization" is an absurdly simple way of bundling a

as a kind of solipsistic poetry for the boffins whose dreaming we can't control, regulate, or demand immediate results from. In the end this attempt to pluck mathematics out of the heart of science has left it as the only refuge for truly advanced modeling, while those historical forces attempt to suppress such everywhere else.

This artificial exclusion of mathematics from science serves a vision of "science" that ultimately wants scientists to function as nothing more than mechanics and sees the only meaningful exploration as that which can be visibly embodied in a physical experiment. It wants to treat theory as a kind of afterthought or fig leaf, and all twists and turns in the process of theorizing as more or less equivalently suspect, equivalently random flights of fancy. It should be no wonder this kind of categorical framework has been gobbled up by those academics whose experiences are largely limited to those humanities where all theorizing away from immediate experience/experiment is often reasonably seen as more or less equivalently tenuous, or equivalently suspect.

## A Universal Current

Under this lens that I have been presenting in a certain sense everything is science and nothing is. The radical inquiry at the core of science doesn't reflect a collection of claims or practices with tightly policeable borders, but a direction, an arrow of struggle or direction of development. And when we recenter 'science' on this current we find it to be a constantly resurgent throughout human history. From the conceptual modeling used by hunter-gatherers to some of those used by the social sciences.

While neuroscience, for example, may not have always been consistently scientific it's clearly become more so over time. Appropriation is a complicated thing; many fields that started out as absurdities have gradually integrated the tools, instincts and ideals of those they were appropriating from. On the other hand chemistry

was a science for a long while, and yet is increasingly turning into a technologist discipline interested in engineering particulars, as little in the way of relevant root dynamics remain unferreted. Science and technology have a complicated interplay in practice, a given scientist or technologist or a given research project or development team will sometimes have to switch directions repeatedly. But they still denote distinct vectors, distinct inclinations of thought. One burrows down to the roots, the other takes the simple nutrition from these roots back out and blossoms it into a million applied particulars.

All human thought involves induction or rather association into models. Those instances that feedback into more engagement — rather than defensive mechanisms of retreat to a limited context — are surely in the scientific or radical direction, however tentatively they end up pushing.

I could even sing a sweet song here about how love and empathy should be properly seen as representing the spirit of science in human one-on-one relations; constantly pursuing better models, better impressions of one another, and updating our models of self to grow more expansive in response. Science and love are very closely related, and a number of jokes in physics and math reflect on the parallels between these hungers. A longing for a deeper intimacy than a shallow surface modeling. That many lovers and scientists shy away or abandon their pursuit past a certain point by no means makes the point at which they end up settling a great reflection of “science” or “love” — the point is the general thrust of their efforts.

It’s important to note that every historical moment in every society was alive with flickers of radical exploration, modeling, and discovery. It’s easy to gloss over the studious play of crafting that discovered so damn many things, but we are in many unappreciated ways standing on the shoulders of giants. Every single society is thick with knowledge accumulated through experimentation

and record. From first hacking our audio cortex with musical notes to developing stronger ropes.

We should be open about the fact that much of the European explosion in science emerged not so much from the onset of a single procedure but through the scrabbling for deeper insights, even through abortive attempts within the tradition of magic and the occult. Those currents that most resemble modern science in Europe, like the development of optics and telescopes, were for a while using the term “natural magic” like Naples’ Academy of Secrets. The core element that drove such advances was a suspicion that nature was governed by hidden forces and that these that could be understood. That the secrets could be pried open, deeper underlying patterns revealed. It was this radical drive and fervor in the fringe communities of Europe that helped drive the scientific revolution and really flourished when they were coupled with the printing press’ distribution of journals to tradesmen and poor tinkers who leapt at the chance to contribute theories and findings back.

In resistance some have taken to demonizing everything since the European explosion as “western science” while validating virtually any other explanation of the world as also “science.” And while their conclusions that the cosmological models of some random witchdoctor confined in experience to the Kalahari are equivalently valid to those of a modern cosmologist is absurd liberal pluralism, it can be legit to mark both as scientific. Models generated in other cultural or historical contexts certainly count to varying degrees as reflective of the arrow of radicalism. Although it’s no small point that any sort of vigilance in today’s context should quickly reveal the failings of such models, just as it quickly reveals the failings of those early European “natural magic” theorists. There have absolutely been many brilliant insights around the world and the portrait where “science” doesn’t officially start until Francis Bacon decided to lecture physicists on what they were doing is clearly a shitty imperialist narrative.