Epistemic communities and their situated practices: Perspectival realism—a primer

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Over the past three years, the COVID pandemic has highlighted two, prima facie opposite, stances on science. On the one hand, scientists have attracted headlines and public attention as never before using models and model-based evidence to make projections about the course of the pandemic and to inform policy recommendations about when to close or re-open schools, restaurants, and venues. We witnessed politicians and governments around the world promising to "follow the science" in public health measures. On the other hand, the pandemic also shone a light on widespread resistance to science among large swathes of the public—diverse groups of people expressing hesitancy to getting vaccinated and reluctance complying with public health measures based on epidemiological models, with questions such as "Why trust model-based projections?"; "Why trust new vaccines?"; and more concerning, "Why trust the experts?"

Notwithstanding the—jarring—dissimilarity, these two stances are related. To declare, as some politicians and governments around the world have done, to "follow the science" has sometimes been a powerful preventative measure against public discontent with restrictive lockdown measures. On occasion, "follow the science" has also been a convenient way of discarding political responsibilities and tacitly passing the epistemic buck to scientists and their projections, models, and public health recommendations. Likewise, vaccine hesitancy and wider resistance to comply with public health recommendations have often been another way of indirectly blaming the scientists for coming up with solutions to problems that the public was unwilling to follow.

Both stances can be seen as opposite responses to one and the same well-entrenched image of science that takes different names in the philosophical literature. Sometimes it goes by the "God's eye view of science" or the "View from Nowhere". I am going to refer to it here as "science *sub specie aeternitatis*" (the Latin meaning "from an eternal viewpoint"). According to this view, the aim of Science (hereafter with a capital S to denote the *sub specie aeternitatis* view) is to understand the natural world distilled from its historical contingencies and cultural happenstances: scientific models deliver exact (or as exact as possible) projections; experiments derive and utilize precise (or as precise as possible) measurements.

The problem with this view is that scientific theories come and go historically. Ptolemy believed in a geocentric system with planets moving in epicycles and deferents. Newton believed in gravity as an action at a distance force. J.J. Thomson, recipient of the 1906 Nobel Prize for Physics for the discovery of what we call the electron, referred to it as a "corpuscle" in his Nobel Prize speech and believed that it was a negative charge at the end of a field-theoretical vortex structure called, at the time, the "Faraday tube".[1] Expecting theories in mature science (i.e., *our* current theories *now*) to tell us the truth about the natural world *sub specie aeternitatis* invites the question as to whether Thomson, the miasma theorists, or Newton might have entertained similar thoughts—of *sub specie aeternitatis*—about their own scientific theories at their time.[2]

Instead of putting science on a *sub specie aeternitatis* pedestal from which it can easily be dislodged with historical counterexamples, we would better served—as would scientists themselves—by situating scientific knowledge in its myriad historical contexts as a way of appreciating *from within scientific history* what makes science the reliable epistemic feat that it is.

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To return to my opening point, faced with the reality that definitive truth, exactitude, and precision from Science are illusory, politicians and the public alike tend often to blame the experts: the epistemic buck gets passed on to the scientists rather than holding responsible the politicians for their policy decisions. And scientists' expertise is attacked by those who avowedly confess not to trust the experts at all.

I hold that the idea of Science is not inevitable. Nor does it serve particularly well scientists who are embroiled in the delicate interplay between public trust and policy making. I have endeavored[3] to articulate in some detail an alternative philosophical image of science, one that takes the historical and cultural standpoint of epistemic communities as unashamedly central in asking the question of how we come to reliably know the natural world in the absence of Science.

The wonderful epistemic feat that we call science (not Science) is not the distilled, aseptic outcome of a deracinated view *sub specie aeternitatis*. If anything, it is the historically and culturally

[1] See M. Massimi (2022). *Perspectival Realism.* New York: Oxford University Press. Ch 10.
[2] This is by no means to invoke defeatism, skepticism, or pessimism about science (in philosophy of science, such a move has been unfortunately branded "pessimistic meta-induction" from the history of science). Rather, it is, if anything, an invitation to exercise some degree of historical caution and epistemic humility when assessing the remarkable successes of scientific knowledge and prediction across different fields over millennia. It is also a reminder (if one is needed) that engaging with our scientific past is not like rummaging through the dustbin of long forgotten ideas and falsified theories.
[3] M. Massimi (2022). *Perspectival Realism.* New York: Oxford University Press.

situated product of myriad epistemic communities that, through time and across different interlaced and intersecting *scientific perspectives*, have produced reliable scientific knowledge of phenomena. What, then, is a scientific perspective?

Scientific perspectives and windows on reality

Perspectival realism—the philosophical view I develop in my recent book—offers an antidote against the aforementioned view of Science. In the book, I tell a story of how the reliability of scientific *knowledge* is made possible by a plurality of scientific perspectives that have *methodologically intersected* and *historically interlaced* over time. These are terms of art in my view, and I explain them below.

Scientific perspective is a much discussed term in philosophy of science since Ron Giere's 2006 seminal book *Scientific Perspectivism.*[4] Giere understood 'scientific perspective' in terms of hierarchies of scientific models. He gave the example of the Newtonian and Maxwellian perspectives, among others—the former would include, for example, higher level theoretical models based on Newton's laws; intermediate representational models (say, the harmonic oscillator); and lower-level data models of the object being modelled (e.g., a pendulum). For Giere, a scientific perspective was akin to Thomas Kuhn's *disciplinary matrix*,[5] although the latter was "much broader than a perspective" (Giere, p. 82) in encompassing beliefs, values, and techniques endorsed by a community. Giere explicitly saw Kuhn's work as an example of what he called *perspectival realism,*[6] the ability to use families of models to "see" the world as being thus and so—although he was adamant that scientific perspectives do not shape or mold or carve the world at its joints.

The helpful notion of scientific perspective, however, does not have to be tied so firmly to Gestalt switch analogies familiar from Kuhn's work on incommensurability and "living in a new world" thesis. More to the point, one can (and should) resist the temptation of thinking of scientific perspectives as isolated silos; or, worse as shared membership of some conceptual tools or theoretical resources that identify particular epistemic communities as *the* repository of scientific knowledge. Such restrictive readings would lose sight of a number of distinctive features of scientific perspectives and would tacitly buy into distinctive varieties of epistemic

[4] R. Giere (2006). *Scientific Perspectivism.* Chicago: University of Chicago Press.
[5] T. Kuhn (1962/1970 2nd ed.). *The Structure of Scientific Revolutions.* Chicago: University of Chicago Press.
[6] R. Giere (2013). Kuhn as Perspectival Realist. *Topoi* 32: 53-57.

injustices. I will return to this below. But for now, let me unpack what I take to be distinctive of a scientific perspective.

I think of a scientific perspective in broad terms as the *historically and culturally situated scientific practice* of a community at a given historical time. Scientific practice includes the theoretical tools but also the experimental and technological resources available to the community to *reliably advance* their claims of knowledge, as well as general methodological-epistemic principles that are useful to justify the reliability of the scientific knowledge claims so advanced. In my use of the term, what makes a scientific practice a 'scientific perspective' is the fact that the *knowledge produced* is situated: it is the knowledge produced by that community at that time in that cultural context within the boundaries of the resources available to them (rather than *sub specie aeternitatis*).

Importantly, this feature does not make scientific knowledge the solipsistic outcome of any isolated community. Scientific perspectives *methodologically intersect with one another* in the production of knowledge. No particular community can sanction the reliability of their *own* claims of knowledge or justify such reliability by their *own* lights. Typically, a number of epistemic communities (and their situated scientific perspectives) are at play in producing any piece of scientific knowledge. It is the ability of this plurality of communities to compare data, to enter in dialogue, and to make relevant and appropriate inferences from data to the phenomena in question that ultimately allows for increasingly reliable knowledge about the phenomenon of, e.g., global warming.[7]

This social and collective aspect of scientific knowledge production—being generated from a number of methodologically intersecting scientific perspectives—is a distinctive feature at great distance from the view of Science. The metaphor of drawing in perspective in art and architecture is relevant to my analysis. Think of architectural blueprints as series of perspectival drawings of, for example, a house used by teams of architects, carpenters, joiners, and masons to make relevant and appropriate inferences necessary for constructing the building. Very often the blueprints reflect in their overlaid inscriptions how different people contributed over time to the design of the house by altering or tweaking or amending some of the details.

[7] For example, knowledge about global warming is the product of several communities: from the paleoclimatologists who collect paleo proxy data to reconstruct past global temperatures, to scientists studying glaciers and collecting borehole data and those measuring ocean heat temperature, to climate modelers at CMIP who model historical global temperature up to the industrial age and make projections about future global warming trends, among many others.

Similarly, I argue that within intersecting scientific perspectives, the specific role of scientific models is that of acting as "inferential blueprints".[8] Scientific models are what enable different epistemic communities to come together, compare their data, and make reliable inferences from several datasets to the relevant phenomena in question (be it global warming or the stability of the atomic nucleus or children's difficulties with learning how to read and write). Rather than indulging in the old analogy of the passive spectator of nature, the metaphor of perspective from art is central to capturing the situated, dynamically evolving, and ultimately collective nature of scientific knowledge production that I see as the best remedy to Science.

The dynamically evolving aspect is another crucial feature of scientific knowledge seen through the lenses of a plurality of scientific perspectives. For the relevant perspectives are not just those in contemporary scientific research (be it in climate science, or developmental psychology, or any other example). The historically and culturally situated nature of scientific perspectives invites us to treat the past as an integral part of an ongoing polyphonic dialogue of epistemic communities. This is where the second distinctive feature of scientific perspectives becomes evident—they *historically interlace with one another* in the production of knowledge:

> 'interlacing' captures how historically a number of situated scientific perspectives have encountered and traded with one another some of their tools, instruments and techniques. As a result of these encounters and trades, some of these tools changed their *use*, so that tracking the particular history of any such tool via interlaced scientific perspectives becomes a way of tracking the evolution of knowledge concerning particular phenomena elicited by that tool in what I call a 'historical lineage'.[9]

For example, I briefly tell the story[10] of how the Chinese geomancers of the Han and Sung dynasties produced tools (dry and wet compasses) that were originally for divination before they became the mariner's compass used in navigation in the Mediterranean and in Scandinavia during the Middle Ages. It is through the historical interlacing of these different perspectives (the Han–Sung astronomical–geomantic one and the nautical one of the Mediterranean and Norse sailors, among others) that the Earth's magnetic field was encountered as a modally robust phenomenon. Scientific knowledge is multicultural through and through. Historians and sociologists of science have long stressed and emphasized this aspect, while philosophers of

[8] Chapter 5, *Perspectival Realism*.
[9] *Perspectival Realism*, p. 340.
[10] Chapter 11, *Perspectival Realism*.

science have not yet entirely caught up with it, trapped (as many still are) within the myth of Science.

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But not only has Science never existed historically, the perpetuation of its myth—or, equivalently, the identification of Science with European 'modern science' from the so-called Scientific Revolution four centuries ago—does harm to the myriad of historically and culturally situated epistemic communities that over millennia have produced and continue to produce reliable scientific knowledge. Those communities, especially those who are under-represented on various (class, ethnicity, or gender) reasons, tend to be severed from narratives about scientific knowledge production, as if the latter were the exclusive prerogative of the dominant, ruling, scientific canon writing community.

This is what I call the injustices of *epistemic severing* and *epistemic trademarking*[11]that tear apart the historical interlacing of situated scientific perspectives at the junctures were under-represented communities typically feature and present scientific outcomes as the trademarked products of one particular community. These epistemic injustices prevent us from understanding the very conditions under which scientific knowledge grows and evolves over time.

It is through this ever-evolving dynamical collective process of intersecting and interlacing scientific perspectives that reality is encountered. Or better, it is through this plurality of scientific perspectives that "windows on reality" open in front of us, to return one more time to the metaphor of perspective, and to use an apt expression from the art historian Erwin Panofsky.[12] In perspectival drawing, intersecting planes at the vanishing points transform a two-dimensional canvas into a three-dimensional window on reality, where one can see large objects in the foreground and smaller objects in the background. Similarly, the interplay of scientific perspectives is what opens windows on reality through which appropriate and relevant inferences can be made on what there is. This is the kind of realism that is within our grasp, a *perspectival* kind of realism.

[11] Chapter 11, *Perspectival Realism.*
[12] Panofsky, E. (1937/1991) *Perspective as Symbolic Form.* Cambridge, MA: MIT Press.

Modally robust phenomena and natural kinds with a human face

What can one see through these windows on reality that a plurality of intersecting and interlacing scientific perspectives open up? What is the world really like? The pressing question of realism brings us back to the opening question, "why trust model-based inferences and projections?". I think one should be careful not to slip back unwittingly into the myth of Science.

For one natural option would be to claim that what we see through this plurality of scientific perspectives and their embedded modelling techniques (what I call *perspectival modelling*) are the "hidden goings on"—to use an expression of philosopher Gilbert Ryle—to indicate the metaphysical foundations of Reality. Such presumed Reality (with capital R to go with capital S of Science) goes under a number of names in the metaphysics of science—essential properties, dispositions, categorical properties, powers, just to name a few.

For example, one could say that J.J. Thomson discovered the essential property of electric charge whose bearer is the electron as a natural kind of particle. Couched in this idiom, the aim of Science is to discover one and the same *natural kinds* (kinds of particles, kind of plants, kind of virus, kinds of stars….) that are said to mark natural boundaries where a group of entities (e.g. half-integral spin particles) can be labelled as being of the same kind (e.g. the electron) if they share some essential property (e.g. the negative electric charge), or disposition (e.g. the disposition of the electric charge to be repelled by another electric charge), or similar.

This familiar way of describing Reality falls back onto the myth of Science. For it assumes that there is a way of transcending scientific perspectives, of bypassing their historical situatedness, and of elevating scientific knowledge to the status of an eternal and fixed once and for all certainty about what there is. At best as a response, philosophers of science with leanings for scientific pluralism have insisted on the importance of cross-cutting classifications in areas of science (e.g., biology) with often incompatible, overlapping kind membership.

But the familiar phenomenon of cross-cutting kind classifications is a red herring. For it is a semantic, not a metaphysical phenomenon. It concerns particular classification practices in some scientific disciplines, but it does not go anywhere near to the heart of the metaphysical question about Reality. Most importantly, it does not address the question that a defender of Science considers the most pressing: namely, what is Reality? Should not one say that it is only Science that is perfectly equipped to legitimately answer that question?

It is this implicit metaphysical attitude in traditional debates about realism in science that is unwittingly responsible for the "following the science" mantra as a way of discarding one's own political (or civic) responsibility and passing the epistemic buck on to the scientists. And, inevitably, if the gap between the model-based inferences and what comes to pass becomes glaring on occasions, it is this same metaphysical attitude that indirectly explains another kind of epistemic passing the buck: Why follow the science at all? Why trust experts if the certitude promised has not materialized?

The problem very often has nothing to do with the experts or their modelling techniques and its inherent limitations due, for example, to parameter uncertainty or scenario uncertainty or similar—all familiar problems that modelers deal with in their daily job. The problem lies in how the public at large including politicians and policymakers expects Science to convey definitive truths and certitude about Reality.

Perspectival realism offers a different metaphysical narrative where the pressing question about realism is not offloaded to hidden goings on, namely to a Reality allegedly mirrored by Science. The reality that opens up through the windows produced by intersecting and interlaced scientific perspectives consists of *modally robust phenomena*. The bending of cathode rays studied by J.J. Thomson, the decay of the Higgs boson detected at CERN, the electrolysis of water, germline APC mutations, the pollination of melliferous flora, the growth of a mycelium, the eco-location of belugas are all examples of modally robust phenomena, among countless other examples.

For long time in the history of philosophy, phenomena have been regarded as no match for realism: at best pale images of Reality, or transient appearances of what is real. Plato's myth of the cave[13] did much to establish this tradition, which was further strengthened by centuries of ancient Greek astronomy where to "save the phenomena", or the appearances of what one sees in the sky, became a deeply rooted epistemic stance, as the physicist and philosopher Pierre Duhem beautifully reconstructed in his 1908 book *Saving the Phenomena*.[14] To these days, saving the phenomena remains the aim of science, according to the influential antirealist view of Bas van Fraassen.[15]

Against this philosophical backdrop, the modally robust phenomena that populate nature according to perspectival realism are not Platonic shadows on the wall, or faint appearances. Phenomena are stable events indexed to a particular domain (depending on the context of inquiry) and modally robust across a variety of perspectival data-to-phenomena inferences. They are, first of all, stable events, where stability is understood as synonymous with lawlikeness: stable events are those that display lawlike dependencies among relevant features.

13 Plato, *Republic*. In Cooper, John M. (ed.), 1997, *Plato: Complete Works*, Indianapolis: Hackett.
14 P. Duhem (1908/1969). English translation by E. Dolan and C. Maschler. *To Save the Phenomena. An essay on the idea of physical theory from Plato to Galileo.* Chicago: The University of Chicago Press.
15 B. van Fraassen (1980). *The Scientific Image.* Oxford: Clarendon Press.

Phenomena are stable events that can be identified and re-identified through different perspectival data-to-phenomena inferences. For example, the phenomenon that we call colloquially "bending of cathode rays", observed by Thomson in an exhausted glass tube at the end of the 19th century, is nothing but the stable (qua lawlike) event of the negative electric charge interacting with the external (electric or magnetic) field that has been identified and re-identified through a number of perspectival data-to-phenomena inferences, using different metals as anode and cathode and different gases inside the glass tubes. What makes this inference perspectival—like any other data-to-phenomena inference—are the varieties of epistemic communities and their situated practices that made the inference possible.

The inference from the data about fluorescence in a cathode ray to the stable event of a charge-to-mass ratio of a "corpuscle" (what we now call an "electron") was made possible not just by the theoretical resources available to Thomson in the Victorian Cambridge at the time (following on the footsteps of the then Faraday–Maxwell perspective). It was also made possible by the expertise and situated knowledge of his professionally trained glass-blower Ebenezer Everett, who produced high-quality exhausted glass tubes for electrical researches. And in no less measure the inference was enabled by a century-long tradition of producing high-quality glass not contaminated with lead, which was originally obtained using as alkali flux ashes of seaweed [kelp] produced by Scottish crofters in the Hebrides, among other places (until synthetic soda was invented and took over the market).

It is the historical interlacing of several situated practices, including oral and artisanal ones (from kelp-making to glass blowing), that enabled the perspectival inference concerning the modally robust phenomenon of the bending of cathode rays. And it was the methodological intersecting of the Faraday–Maxwell perspective (within which Thomson was working) with the electrochemical perspective dating back to Grotthuss and Helmholtz concerning the modally robust phenomenon of electrolysis that ultimately led to the grouping of these two phenomena (among others) under the natural kind concept of *electron*.

Natural kinds are nothing over and above historically identified and open-ended groupings of modally robust phenomena. No need to postulate essential properties, dispositions, or powers to delineate what counts or does not count as a natural kind. True to the historically and culturally situated nature of scientific knowledge and to the myriad scientific perspectives through which modally robust phenomena get inferred and re-identified, natural kinds themselves are not carving nature *sub specie aeternitatis*. They are instead what I call Natural Kinds with a Human Face (NKHF).

Born as in-the-making, some kinds prove over time to be *empty kinds* (e.g., caloric, ether, phlogiston…); others become *evolving kinds* across intersecting and interlacing scientific perspectives (e.g., the electron). What makes some groupings evolve while others wither away over time is the presence (or absence) of lawlike dependencies among relevant features of the phenomena. Such lawlike dependencies are what guides epistemic communities over time to make truth-conducive inferences from one phenomenon to the next that get identified as being part of the same natural kind concept.

The anti-essentialist, anti-foundationalist, and ultimately inferentialist view of NKHF does not make natural kinds any less real than the kinds envisaged by Science. If anything, it gives epistemic communities their due for the reliable identification of modally robust phenomena over time. The reality that perspectival modelling—understood in terms of intersecting and interlacing scientific perspectives—opens up in front of us does not consist of fixed-once-and-for-all eternal hidden goings on and monolithic natural kinds.

It is instead a reality where the unreasonable projectibility of now discarded empty kinds and the effective naturalness of engineered kinds can be easily explained and does not pose a hurdle to realism. Most importantly, it is a reality that glassblowers, kelp-makers, beekeepers, chemists, synthetic biologists, pollination ecologists, and cosmologists, among many others, can all epistemically reclaim as their own.

The right to enjoy the benefits of scientific progress

To conclude, let me return one more time to the delicate triangulation among scientific knowledge, the public, and policymaking where often Science gets weaponized and scientists' expertise comes under fire by those who avowedly confess not to trust the experts. Narratives about scientific knowledge are an important tool in this complex dynamic. A well-entrenched narrative that puts Science on a pedestal as the source of certitude not only flies in the face of the historically and culturally situated nature of scientific knowledge. It also tacitly conveys the idea that Science is the product of elites of experts reinforcing skepticism and mistrust among portions of the public.

The best antidote against such anti-science mistrust consists in changing narratives and presenting scientific knowledge for what it has historically been: situated knowledge produced by myriad epistemic communities over millennia. The social, collective, non-elitist narrative of scientific knowledge that perspectival realism delivers is also meant to achieve a further and no less important role—that of fighting two pervasive kinds of epistemic injustices, the aforementioned *epistemic severing* and *epistemic trademarking*:

> Epistemic severing is the almost surgical excision of the contribution of particular communities (either within the same scientific perspective or across culturally diverse perspectives) from narratives about scientific knowledge production. Epistemic trademarking is the subsequent fencing and ultimately often merchandising of portions of scientific knowledge as a 'trademark' of one epistemic community at the expense of others who have historically contributed to such production. I see perspectival realism as an antidote to these epistemic injustices and a prelude to what at the very end of the book I call *non-classist scientific cosmopolitanism*, taking my cue from a large literature in cultural studies, sociology, and anthropology: scientific knowledge at the genuine service of a diverse and multi-cultural 'world citizenship'.[16]

Epistemic severing is not just the failure to recognize the contribution of myriads of situated epistemic communities in the scientific knowledge production. It is the process of cutting off some of these under-represented communities from narratives about scientific knowledge production, tearing apart the historical interlacing of perspectives that is key to the reliable identification of modally robust phenomena over time. Epistemic trademarking is the further step of trademarking the severed historical lineages and presenting scientific outputs and outcomes as the exclusive prerogative of one epistemic community. Very often these mechanisms are implicit and structural rather than intentional and willful: they are part of how Western societies come to conceive of scientific knowledge as mostly written rather than oral, theoretical rather than experimental or even artisanal, codified in scientific canons rather than orally transmitted.

But these epistemic injustices do not remain confined to narratives about science. They have wider and more pervasive implications. For they enter into the very images of science upon which international institutions, policymakers, and governments around the world operate. They can go some way toward explaining for example why the Right to Enjoy the Benefits of Scientific Progress (REBSP), established by Article 15(1)(b) of the International Covenant on Economic, Social, and Cultural Rights (ICESCR) in 1966, remains to this day not very well implemented. In 2009 the UNESCO (Venice Statement) launched an expert meeting to look into ways of improving the implementation of the REBSP. And in 2020 a General Comment N. 25

[16] *Perspectival Realism*, p. 11.

by the UN Economic and Social Council on Article 15 of the ICESCR was published to a similar effect.

I have briefly discussed the implications of perspectival realism for REBSP elsewhere.[17] It suffices to say that the right for everyone to enjoy the benefits of scientific progress can be regarded as a cosmopolitan right, namely a right that pertains to everyone in virtue of being part of a world citizenship. Until and unless one sees REBSP as a cosmopolitan right, I have maintained, the lingering risk remains that the implementation of the right is left at the mercy of individual nation States some of which might not even ratify the ICESCR to these days (e.g., the U.S.).

But to see the REBSP as a cosmopolitan right that transcends national boundaries and applies to *everyone*, one would need first to transcend epistemic boundaries that continue to sever and trademark scientific knowledge production as the elitist product of particular communities at the expenses of others. The vaccine nationalism that we witnessed during the COVID pandemic, in addition to widespread phenomena of biopiracy when it comes to the exploitation of traditional knowledge of the flora and fauna of local indigenous communities, are just two glaring examples of socioeconomic injustices operative along the divide between Global North and Global South. Often enough behind these socioeconomic injustices lie structural epistemic injustices, such as epistemic severing and epistemic trademarking deeply embedded in our very narratives about who produces scientific knowledge and who accordingly gets to benefit from its progress and advancements.

Until and unless States and governments around the world, as well as international institutions such as the UN and UNESCO, come to terms with these epistemic injustices and realize the complex historical and multicultural dynamics underpinning scientific knowledge, the REBSP will continue to be paid only lip service. Where there are rights, there are obligations. Obligations to implement the REBSP to the service of a world citizenship starts with simple obligations such as not to deny vaccines to States in the Global South; or not to appropriate traditional knowledge of flora and fauna; or not to exploit deep sea mining and damage marine biodiversity at the expense of local coastal communities, among countless other examples.

[17] See Massimi, M. (2022b) "Perspectives on scientific progress", *Nature Physics* 18, 604-606 (https://rdcu.be/cO4qv) see, and Massimi, M. (2022c) "A human rights approach to scientific progress. The deontic framework", in Y. Shan (ed.) *New Philosophical Perspectives on Scientific Progress,* London: Routledge (preprint in http://philsci-archive.pitt.edu/20485/)

Those obligations too will continue to be given only lip service until a sustained conversation about the nature of scientific knowledge, who produces it, and who should benefit from it has taken place. Philosophers of science have a role to play. Indeed, they have a duty to inform such conversations with the tools and insights coming from the epistemology of science suitably informed by scientific practice and the history of science. This is what in some of my past work, and building on J. D. Bernal, I have called the *social function* of philosophy of science.[18]

To conclude, to "follow the science" in a way that neither weaponizes scientific knowledge nor opens the door to passing-the-buck to the scientists, more is required than Science and Reality. What is needed is the epistemic humility of rediscovering the truly collective nature of scientific knowledge production and the diverse multicultural epistemic communities that with their situated practices have made and continue to make it possible.

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[18] Massimi, M. (2018) "Why philosophy of science matters to science", *Notes and Records: The Royal Society Journal for the History of Science.* doi:10.1098/rsnr.2018.0054