Perspectival ontology: between situated knowledge and multiculturalism

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1. *Ts'iits'ilche'* honey and Hebridean kelp

Ts'iits'ilche' is the Mayan name for a plant known in Western botany as *Gymnopodium floribundum*. It is a common melliferous plant in the Yucatán peninsula, belonging to the family of Polygonaceae. Its flowering season peaks between February and April and its nectar is a resource for the local bee species, such as *Melipona beecheii*. Archaeological evidence of beekeeping goes back to the late Pre-Classical Maya period (see Crane 1999, p. 295) and honey production continues to be an integral part of the local economy of the communities of Xmabén, Hopelchen, and Campeche in Mexico (see Coh-Martínez et al. 2019; see also Bratman 2020). Beekeeping and honey production are an example of local or situated knowledge in being knowledge pertaining to historically and culturally situated epistemic communities.

What can situated knowledge tell us about scientific ontology? I think it tells us a lot. Suppose you want to know about a certain flowering plant by asking "What is *that* plant?" The question is an invitation to identify a particular natural kind. In philosophy of science, various approaches have been proposed and defended in relation to natural kinds. They go under the names of microstructural essentialism (Putnam 1975), promiscuous realism (Dupré 1981), and nominalism (Hacking 1991), to mention just a few. The approach I sketch below goes under the name of *perspectival realism*—a view I articulate in detail in my monograph (Massimi 2022). In its abridged version, it runs roughly as follows: that *kind* of plant (or mineral, etc.) is a historically identified and open-ended grouping of modally robust *phenomena* that a plurality of culturally and historically situated epistemic communities have *reliably* identified over time.

To unpack this definition, I see natural kinds as being identified (1) not by sets of properties, but by groupings of *phenomena*. I further take those phenomena (2) to be *reliably* inferred from relevant data. Moreover, I deem those reliable data-to-phenomena inferences (3) to be *perspectival*: inferences drawn by a plurality of historically and culturally situated epistemic communities. In what follows, I spell out this three-step recipe to 'perspectival ontology' and clarify its connection to situated knowledge and multiculturalism.

Consider again the example of *Gymnopodium floribundum* or *Ts'ïits'ilche'*. In asking "What is *that* plant?", one is inviting different possible answers typically elicited by different epistemic communities, depending on which particular phenomena are highlighted. Plant morphologists would answer the question by considering anatomical features of the plant. Cytogeneticists would appeal to DNA and chromosomes. Ecologists would consider pollination and environmental interactions. Melissopalynologists would focus on the presence of pollen in honey samples to study the geographical distribution of the plant. Beekeepers and honey producers would answer the question by delivering information on pollination peak times and the api-botanical cycle.

Each community, I contend, has the epistemic upper hand on a few clearly identifiable types of *phenomena*—be they morphological, genetic, or ecological phenomena, among others. Each phenomenon is indexed to a particular *epistemic domain*. For example, pollination involves api-botanical cycles and a wider understanding of complex interactions between the plant and its pollinators in the ecological domain. Perianth concerns the flower structure in the morphological domain. Being indexed to a particular domain is key to identifying 'events' that are candidates for 'phenomena' and sieving them apart from those that are not. I will say more about this point, the nature of phenomena and the difference between events and phenomena in the next section. But for now, what is to be said about this plurality of epistemic domains and associated phenomena?

This contextual pluralism might be reminiscent of Dupré's promiscuous realism (1981), where the vernacular kind term 'lily' maps differently onto the botanist's taxon *Liliaceae* and the chef's gastronomical grouping for garlic and onions. Yet the underlying philosophical concerns of my perspectivalist approach to natural kinds are somewhat different from those of promiscuous realism. A semantic concern with vernacular kind terms vs botanical taxa originally motivated promiscuous realism: namely, the need to acknowledge that the two classification schemes do not necessarily overlap. Promiscuous realism was intended to show that the Putnam–Kripke view—whereby natural kinds are demarcated by real essences which in turn provide the extension of many terms in ordinary language—is simply untenable when it comes to biological classifications.

An epistemic (rather than semantic) concern primarily prompts my perspectival realism: namely, the need to understand how a particular (*perspectival*) type of pluralism functions as the driving engine in delivering *reliable scientific knowledge* about natural kinds. That there is a plurality of historically and culturally situated epistemic communities, each of whom might deliver reliable knowledge in its own domain, is a fact about science. What this perspectival pluralism can teach us about scientific ontology is the ongoing concern of perspectival realism.

Perspectival realism is therefore an invitation to rethink scientific ontology altogether. It does not take ontology as a given, either in the form of essentialist kinds 'carving nature at its joints' or in the form of individuals—*this* plant *here, that* mineral *there*—whose classifications might be overlapping and promiscuous. Nor does perspectival realism handle taxonomic classifications (overlapping and pluralist as they might be) as simply labels attached to clusters of properties, or superimposed on a world of individuals. Rather, it treats natural kinds as historically identified and open-ended groupings of domain-indexed phenomena. A plurality of scientific perspectives is therefore not just a reflection of different (possibly disjoint and often incompatible) epistemic needs of various communities. It is instead—first and foremost—the very engine of reliable knowledge production, according to perspectival realism. And to see why, let us return one more time to the *Gymnopodium floribundum.*

Melissopalynological studies in the region of the Yucatán have found that *Ts'íits'ilche'* is under-represented at *ca* 3% among the single-flower honeys of the region, despite the plant being common. This finding has in turn suggested that the pollen production of this plant must be lower than that of other varieties of melliferous flora in the region (see Alfaro-Bates et al. 2010, p. 60). Local communities and their situated knowledge play an integral role in trying to understand and explain this finding. Beekeepers know best how to protect their apiaries across season; how to control insecticides that have devastating effects on bees; and the timing for the nectar peak, which is key to sustaining honey production.

It is by virtue of their being historically, geographically, and culturally situated that local epistemic communities know best about the phenomenon 'pollination peak': they know how to identify this modally robust phenomenon among a swarm of stable events. This example of situated knowledge about a phenomenon (let us call it P_k) enables in turn other epistemic communities (e.g. plant morphologists) to investigate related phenomena P_j (e.g. about the reproductive organs of the plants and the possible causes for the low pollen production in some of them).

In my philosophical idiolect, the *Gymnopodium* taxon is *all these phenomena.* The situated knowledge of different epistemic communities—melissopalynologists, beekeepers, plant morphologists, etc.—makes it possible to fine-grain or coarse-grain the description of the taxon by focusing on one phenomenon rather than another. For example, plant morphologists know how to describe the reproductive organs of the plant and the surrounding flower structure known as perianth. However, to gain insight into the reproductive performance of the plant, one needs to fine-grain the description at the level of the pollination peak. It is here that the local knowledge of beekeepers and honey producers about the api-botanical cycle has the epistemic upper hand in better understanding what might be causing the under-representation of *Ts'ïits'ilche'* pollen in the honey of the region as spotted by melissopalynologists.

This is just one example of how perspectival pluralism matters to scientific ontology. It re-aligns questions about 'what there is' with questions about reliable scientific knowledge production. The outcome is a radical shift in ontology: from properties to phenomena; and from natural kinds as clusters of properties to natural kinds as open-ended groupings of domain-indexed phenomena. But there is more. Perspectival ontology so understood serves two additional important functions:

(a) From an *epistemic* standpoint, it reinstates epistemic communities that have been (culturally, socially, historically) 'severed' from epistemological narratives about scientific knowledge production.
(b) From a *normative* standpoint, it makes the case as to why scientific knowledge is multicultural and cosmopolitan at the same time: why it ought to be regarded as *pertaining to* a variety of historically and culturally situated epistemic communities.

Before I expand on these two points, a critic might be envisaged who could reply along the following lines: "Perspectival pluralism and situated knowledge may well befit botanical taxa and similar examples. But what about other examples that might seem impermeable to perspectival pluralism? What about supernovae, atoms, and electrons? Where is the perspectival pluralism, situated knowledge, and perspectival ontology *there*?"

Consider, for example, the natural kind 'electron'. J.J. Thomson's experiments with cathode rays (back in 1897) eventually earned him the Nobel Prize for Physics in 1906 for the discovery of the electron—or what he at the time referred to as a 'corpuscle' carrying a minimal unit of electric charge (see for the history of this episode Massimi 2019b and 2022 Ch. 10, on which I draw here). The history of the electric charge itself was at the turn of the last century entangled with ether theories in Victorian Cambridge and a long history of experiments in electrochemistry going back to the early 1800s. A plurality of historically and culturally situated scientific perspectives underwrites the ontological commitment to the 'electric charge': from Grotthuss' chain model for electrolysis to Thomson's 'Faraday tubes' marking the boundaries of lines of forces, to Planck's research programme of quantizing electricity alongside radiation.

Again, in my philosophical idiolect, the natural kind 'electron'—as the bearer of negative electric charge—is an open-ended grouping of historically identified phenomena, which in this case includes (in a non-exhaustive list) the electrolysis of water, the bending of cathode rays, and blackbody radiation, among many more phenomena to be discovered after Thomson. Different epistemic communities at the turn of the nineteenth century inferred these perspectival phenomena from wide-ranging data (bubbles in water, bent fluorescent beams in exhausted glass tubes, etc.) within the experimental, theoretical, and technological resources available at the time to *reliably* make those scientific knowledge claims.

Lawlike relations among features of these phenomena enabled not only inferences to be made about each of them but also the connection to be discovered between, say, the type of phenomenon 'water electrolysis' and the type of phenomenon 'bending of cathode rays'. For example, the lawlike relation in the charge-to-mass ratio that obtained in these phenomena was key to establishing that the minimal unit at play in electrolysis was also the minimal unit at play in cathode rays; and, even more importantly, that such a unit had a mass much smaller than that of the hydrogen ion. Thomson's 'corpuscle' (as he called it at the time) was the first sub-atomic particle to be identified.

"But where is perspectival ontology in this example?", my critic might insist. "Is not this a typical example of scientists converging on an entity-with-property—the electron with negative electric charge—that manifests itself across various phenomena?" Ultimately, I think, how one answers this question is a matter of philosophical stances. Philosophers, who are metaphysically more hard-nosed than I have ever been, will remain unmoved. But even they will have to concede that the ability to formulate scientific knowledge claims such as "there is an *electric charge*" or "there is a corpuscle with a certain charge-to-mass ratio" depends crucially on the ability to elicit its 'manifestations' across various phenomena. And these 'manifestations' (as one might want to call them) in turn require and presuppose perspectival pluralism. Indeed, they presuppose a particular kind of pluralism that extends well beyond the variety of scientific theories, models, and explanations available at the turn of the nineteenth century.

For example, some of these phenomena—e.g. the bending of cathode rays in the presence of an electric or magnetic field—could only manifest themselves thanks to the production of specially manufactured exhausted glass tubes. The latter were made possible by sophisticated experimental practices of glass-blowing, which flourished in Britain in the nineteenth century. J.J. Thomson himself had a professionally trained glass-blower, Ebenezer Everett, as his assistant at the Cavendish Laboratory. Exhausted glass tubes for research on electrical conductivity required lead-free glass, namely glass which was made using kelp (i.e. ashes of burnt seaweed) as an alkali source to reduce the melting temperature.

In the late eighteenth and early nineteenth century, kelp-making was commong in Scotland, especially around the Hebrides, before the production of synthetic soda and the Highland Clearances squashed the local economy and dispersed the local communities of kelp-makers. This is yet another example of situated knowledge and perspectival ontology. The natural kind 'electron' is an open-ended grouping of historically identified phenomena. Each phenomenon was reliably inferred from data by a number of epistemic communities, whose *situated knowledge* ranged from, modelling the electrostatic field via 'Faraday tubes' to manipulating electromagnetic interactions with cathode rays, making exhausted glass tubes with alkali flux, and producing the ashes of seaweed (and later synthetic soda) necessary for glass manufacture.

Situated knowledge matters not just from a cultural point of view (as with the contemporary Yucatán beekeepers), but also from a historical point of view (as with the Hebridean kelp-makers of the eighteenth and early nineteenth century). Attention paid to the range and variety of 'situated knowledges' behind scientific ontology is a way of 'reinstating' epistemic communities that historically have been (and continue to be) 'severed' from the epistemological canon of scientific knowledge production: be they kelp-makers, glass-blowers, or beekeepers (I develop this point in Massimi 2022, Ch 11). Perspectival ontology does just that: it reinstates those epistemic communities to their rightful roles in scientific narratives. It replaces the 'view from nowhere' with a view that is always and inevitably 'from somewhere'. It takes scientific knowledge as *always* local, situated, and ultimately perspectival knowledge. In a word, perspectival realism re-orients ontology as downstream from perspectival knowledge rather than upstream from it—as if ontology were a 'given'.

2. **What is perspectival ontology?**

It is time to zoom into the notion of phenomena at play in perspectival realism and associated perspectival ontology. It might look *prima facie* strange to appeal to phenomena in trying to develop a realist ontology for science. According to a well-established empiricist tradition, phenomena have often been regarded as mere appearances. Scientific realists, in turn, have often downgraded phenomena to mere manifestations of an underlying reality of causal properties, causal powers, and so forth. Building on earlier work (Massimi 2007, 2008, 2011), I have put forward an alternative way of thinking about phenomena that takes them in their own right (see Massimi 2022, Ch. 6, on which I draw here). My view places phenomena centre-stage when it comes to ontological commitments for the perspectival realist. What are phenomena, then, under the view I am proposing? Here is a definition:

> 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.

Phenomena are 'stable events' that can be recognized in a swarm of data and across different data-to-phenomena inferences. The process of identification and re-identification of stable events that are genuine candidates for phenomena requires a *distinctive domain*. Going back to my earlier example, although it might be indexed to a particular spatio-temporal location (say, a particular local area of the Yucatán yesterday), the event of a child flying a kite nearby a blossoming plant does not have a proper domain of inquiry for it to qualify as a candidate phenomenon. (Caveat: the event kite-flying-in-a-thunderstorm might well qualify as a *bona fide* candidate phenomenon in some other domain of inquiry—think of Benjamin Franklin and the phenomenon of electric discharge). By contrast, the event of a bee buzzing nearby the same plant has a proper domain of inquiry (pollination ecology) and as such it is an eligible candidate for a phenomenon: that is, pollination.

Second, the events have to be *stable* to count as candidates for phenomena. I see stability as related to lawlikeness: an event is stable if there is a lawlike dependency among relevant features of it. Lawlike dependencies are at play in the pollination of flowers no less than in the charge-to-mass ratio of the electron. For example, pollinator performance is defined as the product of flower coverage (FC) and pollen deposited (PD). Perspectival realism treats lawlikeness as a primitive property of stable events in nature. Lawlikeness grounds a first-tier modality at play in, for example, whether a flower *would* be pollinated *if* a pollinator were to visit it; or whether cathode rays *would* bend *if* an electric or magnetic field were applied to it. How to go from stable events so defined to phenomena?

A phenomenon, as I see it, is a stable (qua lawlike) event whose occurrence *can be inferred* in *many different possible ways*. Stability goes hand-in-hand with modal robustness: indeed, the two come together in a two-tier modal view. In addition to lawlikeness as a primitive property of stable events, there is a second-tier modality at play in perspectival ontology: what I call the *modal robustness* of phenomena understood as an *epistemic* form of modality. Modal robustness expresses the many ways in which epistemic communities *infer* the relevant phenomenon by connecting often diverse datasets to the occurrence of the stable event in question. This is where the *inferential and perspectival* aspects in my definition of phenomena become salient.

To return to my opening examples, one of the domain-indexed stable events for the plant *Gymnopodium floribundum* consists in pollen grains being deposited on the reproductive organ of the plant (in certain numbers, at a certain interval of time, frequency, and so on). The associated phenomenon is 'pollination'. Pollination is a modally robust phenomenon in that the occurrence of the aforementioned stable event *can be inferred* in many different ways in different plants by different epistemic communities. Think of hummingbirds hovering, honeybees dancing, bumblebees sensing static electricity, midges pollinating cacao tree flowers while laying eggs in rotting cocoa husks. The phenomenon 'pollination' involves inferences from a range of data to the stable event in question (pollen being deposited on the reproductive organ of a particular plant). And these inferences are drawn by different epistemic communities—pollination ecologists, conservationists, bee-keepers, ornithologists, entomologists, and so forth—who rely on their respective situated knowledges.

Likewise, an electric charge being attracted or repelled by an external field is a lawlike event in nature. The bending of cathode rays is the modally robust phenomenon in that the occurrence of the aforementioned stable (qua lawlike) event *can be inferred* in different ways: for example, using both electric and magnetic fields of different strengths, or by deploying cathode ray tubes made of different metals for the cathode and anode, and with different gases filling the tubes. And here too, different epistemic communities—from kelp-makers to professional glass-blowers like Ebenezer Everett; from physicists studying electromagnetism to quantum theorists exploring the quantised nature of electricity—were ultimately responsible for enabling and teasing out the network of inferences from the relevant data to the stable event in question.

The modal robustness of phenomena can be regarded as a secondary quality: it depends on how epistemic communities occupying particular scientific perspectives relate a variety of datasets to the stable event in question *within the inferential boundaries* of their situated knowledge—including (perspectival) experimental techniques, technological tools, and modelling practices. The latter *are* subject to change over time—that is what makes knowledge situated and perspectival. By contrast, the occurrence of stable-qua-lawlike events is irrespective of the particular perspectival pluralism human beings have historically developed. *This* is realism—or, better, the realist tether in perspectival ontology.

However, what makes a stable event a 'phenomenon' *does* depend on a range of epistemic communities and their inferential tools. That the negative electric charge is repelled by an electric field is a stable event in nature, whose lawlike occurrence is independent of J.J. Thomson and the situated knowledge of Victorian Cambridge and associated ether theories and 'Faraday tubes'. However, that the occurrence of such an event—and associated ones such as electrical ions in water—*could be robustly inferred* in many different ways (as described above) is dependent on the situated knowledge of particular communities at particular historical times.

In this example, it is dependent on knowledge about kelp-making, glass-blowing, and how to produce exhausted glass tubes with different metallic anodes and cathodes, how to manipulate them, and how to model what could be seen. This is what makes the phenomenon of the 'bending of cathode rays' *modally robust* across a variety of perspectival data-to-phenomena inferences. Teasing out the space of inferences for any given phenomenon is what historically and culturally situated epistemic communities do.

Thus, to say (as I do) that modal robustness is a secondary quality is to stress how the modal features that are so crucial to *scientific discourse about phenomena* depend both on the *stability of the event* (which is in nature, grounded in its lawlikeness) and on *epistemic communities occupying one or more scientific perspectives* that are able to observe, detect, and identify the stable event through often diverse and long inferential routes and advance claims of a modal nature about it. There is no ultimate metaphysical foundation to modal robustness in perspectival ontology: no need for categorical properties, dispositional essences, causal powers, and so forth. That does not make phenomena any less real, though. If anything, it transforms the old ontological category of phenomena from Platonic 'shadows on the walls' into 'empowered' phenomena in their own right.

One might raise two concerns at this point. A first concern relates to the *reliability* of the inference from data to phenomena. Is not there a risk of delegating to epistemic communities, whose knowledge is inevitably limited and perspectival, the exacting task of discerning what phenomena are in existence? And how can they possibly get this right given the situatedness of their knowledge? In other words, what guarantees that the perspectival data-to-phenomena inferences are in fact *reliable*? The second and related concern pulls in the opposite direction. Let us take for granted that such inferences are after all reliable. What makes them *perspectival*? Are not they reliable precisely because they reliably infer the relevant phenomenon, no matter what kind of perspectival tools, modelling assumptions, and techniques are available to any given epistemic community and their situated knowledge?

In reply to both concerns, situated knowledge at work behind perspectival data-to-phenomena inferences is not an epistemic limitation that must be overcome. Neither is it a stumbling-block on the road to reliable scientific knowledge production. If anything, it is the very driving engine of reliable scientific knowledge production. A data-to-phenomena inference is reliable *because* it is perspectival (not *in spite of* being perspectival). To appreciate this point, which is core to my view, I need to introduce my working definition of a 'scientific perspective' (see Massimi 2022 Ch. 1, expanding on Massimi 2018a and 2019a):

> *Scientific perspective* (*sp*): A scientific perspective *sp* is the actual—historically and culturally situated—scientific practice of a real scientific community at a given historical time. Scientific practice should here be understood to include: (i) the body of *scientific knowledge claims*[1] advanced; (ii) the experimental, theoretical, and technological resources available to *reliably* make those scientific knowledge claims; and (iii) second-order (methodological-epistemic) principles that can *justify* the *reliability* of the scientific knowledge claims so advanced.

My definition stresses the role of situated experimental, theoretical, and technological resources in producing *reliable* claims of knowledge. As a result, a 'scientific perspective', as I use the term, does not include a number of (metaphysical, philosophical, or religious) beliefs, which might be influential in making a community endorse some claims of knowledge but do not explain how the community came to *reliably* make them, or how the community *justified* the *reliable* procedures for advancing them. For example, the philosophical view of Neoplatonism was very influential in the Renaissance period and a contributing factor for the epistemic community of the time (including Kepler) to *accept and endorse* Copernicanism as an attractive scientific view.

However, reasons for accepting and endorsing Copernicanism are not the same as reasons for reliably and justifiably coming to *know* Copernicanism. Neoplatonism did not play a direct role in establishing either the *truth* of or the *justification* for the *reliability* of Copernican knowledge claims (e.g. the claim that the Earth orbits the Sun). This is what makes a scientific perspective—in my use of the term—different from, say, Kuhn's scientific paradigm (for a different take on this issue, see Giere 2006).

At the same time, the above definition is broad enough to encompass under the name of 'scientific perspective' claims of knowledge generated via modelling practices, particular

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[1] By 'scientific knowledge claims', I mean *claims of* scientific knowledge—the kind of claims that communities of epistemic agents advance at a particular historical time and using specific theoretical, experimental, and technological resources. Not all of them amount to genuine scientific knowledge (some may prove wrong over time). Still, we would not want to deny the title of 'scientific perspective' to Ptolemaic astronomy, and so forth, just because some claims of knowledge proved false over time.

experimental-technological resources, and, more broadly, historically and culturally situated practices—be they about beekeeping and honey production or kelp-making and glass-blowing (among many other examples I discuss in Massimi 2022). Situated knowledge runs deep in scientific perspectives. For it is impossible to detach the body of scientific knowledge claims from the varieties of experimental, technological, and modelling procedures employed in advancing them *reliably*; *and* from the methodological and epistemic principles that can in turn *justify* those *reliable procedures*.

My definition of 'scientific perspective' owes a great deal to perspectival knowledge in epistemology as described by Ernest Sosa (1991), who in my view has charted a fertile middle ground beyond foundationalism and coherentism.[2] One of the attractive aspects of this definition is that a clear distinction between the *truth* and the *justification* for claims of knowledge becomes immediately available. The truth of knowledge claims endorsed by particular epistemic communities is ultimately a matter of correspondence with the way the world is (i.e. correspondence with modally robust phenomena as described above) and it requires having *reliable* procedures for arriving at these claims.

The truth of knowledge claims is not fixed by the scientific perspective in which they might have originated. Scientific perspectives do not offer perspectival facts. Nor should truth be understood in terms of perspectival truthmakers, or as indexed to a perspective or relative to a perspective (see Massimi 2018b and again 2022 Ch. 5). I see scientific perspectives as offering instead justificatory principles for the reliability of specific claims of knowledge and also playing the role of contexts of assessment for claims of knowledge originating from other scientific perspectives. As new scientific perspectives come to the fore, existing claims of knowledge can be cross-perspectivally assessed and retained or withdrawn over time accordingly. Thus, while truth as correspondence is a cross-perspectival affair in that different epistemic communities with different scientific perspectives have to be able to identify and re-identify modally robust phenomena over time, scientific perspectives offer a second-order set of epistemic-methodological justificatory principles that can shed light on whether or not someone has *justifiably* come to *reliably form* claims of knowledge about those phenomena (and groupings thereof).

By separating truth from justification, the aforementioned working definition of scientific perspective does not fall prey to classical problems affecting Kuhn's view about scientific paradigms. For instance, there is no equivalent to 'living in a new scientific world' under my

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[2] See Massimi (2012). I return on this point in Massimi (2022), Ch 1.

definition of 'scientific perspective'. Scientific perspectives do not mould ontology. They neither produce perspectival facts nor deliver truths relative to a perspective.

There is more. A scientific perspective may lack access to well-defined truth conditions, despite clearly defined assertability conditions in a certain historical and cultural context. Think of Lavoisier advancing claims of knowledge about caloric, whose assertability conditions were well defined given the experimental methods and historical-cultural context he was working with. Yet the truth conditions of those claims were not well defined at the time in the absence of the relevant evidence against caloric that became available only later, after a long tradition of geophysical studies on thermal conductivity in rocks and Joule's experiments with paddle-wheels.

Thus, when I say that truth as correspondence is a cross-perspectival affair, what I mean is that ultimately a *plurality of intersecting perspectives* is needed to transform claims of knowledge into knowledge concerning particular phenomena. Again, think of Lavoisier's claims about thermal phenomena in terms of caloric and how geothermal physics had to be brought to bear on chemistry to establish the unreliability of Lavoisier's inferences from data about transition of states to the existence of the putative caloric. The modal robustness of phenomena as a secondary quality marks, then, an important point in this discussion: namely, that a plurality of perspectival inferences is required to secure *reliable scientific knowledge* production. This is my reply to the first aforementioned concern. There is no risk of delegating to epistemic communities, whose knowledge is inevitably limited and perspectival, the exacting task of discerning what phenomena are in existence because reliable scientific knowledge production is the product of a plurality of intersecting scientific perspectives, rather than the prerogative of any one epistemic community in particular.

Relatedly, and in reply to the second concern, I see the plurality of scientific perspectives not as a disjoint set of necessarily (and by default) dissonant and incompatible vantage points, as scientific pluralism is often presented in the literature. Scientific perspectives *intersect with one another* to fulfil a key epistemic role for scientific knowledge: namely, to cross-check the *justification* and/or the *reliability* of claims of scientific knowledge. It could be, for example, that the data-to-phenomena inference, while justifiably drawn, is nonetheless unreliable (as with Lavoisier's example above). Or it could be that, while reliably formed, some claims are suffering from justificatory principles that might be defective, or that might be insufficient by themselves to ground the reliability of the procedure behind those claims.

Cross-perspectival assessment of claims of knowledge is key to deliver reliable scientific knowledge and, ultimately, truth conditions. The epistemic heavy lifting is done by the pluralistic, diverse, and fluid interplay of historically and culturally situated scientific perspectives. Perspectival pluralism is what makes *us wonderfully diverse human beings capable of reliable scientific knowledge over time.*

3. **Situated knowledge and multicultural science**

In a book provocatively entitled *Is Science Multicultural?*, Sandra Harding (1998) has made an unflinching assessment of science and especially scientific narratives that have failed to engage with postcolonial histories of science. She opens the book by asking Kuhn's question: "How could history of science fail to be a source of phenomena to which theories about knowledge may legitimately be asked to apply?" (Kuhn 1962/70, p. 9), and she takes aims at what she describes as "older theory of scientific knowledge" and "conventional epistemology of modern science", whereby

> The success of modern science is insured by its general features—experimental method or scientific method more generally, science's standards for maximizing objectivity and rationality, the use of mathematics to express nature's laws, the distinction between primary and secondary qualities in nature, or some other. Science is singular—there is one and only one science—and its components are harmoniously integrated by such internal features. (Harding 1998, p. 2)

To this view of "one 'nature,' one truth about it, and one science" as a remnant of internalist epistemology, Harding counterposes post-Kuhnian and postcolonial science studies which have emphasized how "cultures have been interacting with each other from the beginning of recorded human history. Cultures have exchanged shells, beads, seeds, cattle, manufactured goods, women and scientific and technological ideas" (ibid., p. 8). She then asks, following up on Kuhn's question: "how could the recent interactionist accounts of sciences and technologies in multicultural and global (and gendered) history fail to be a source of phenomena to which theories about knowledge may legitimately be asked to apply?" (ibid., p. 9).

Harding's pressing question has a bite for the epistemology of science. Why is it so hard to engage with what she refers to as the "interactionist accounts of sciences and technologies"? This is particularly evident in the debate on scientific realism and anti-realism in science, which has had a tendency to proceed in some weirdly engineered historical and cultural vacuum. There are some obvious methodological reasons. The questions that philosophers of science tend to ask are often questions about methods, rationality, and the nature of evidence in science. Inevitably, the tools and approaches adopted to answer these questions tend to be general and possibly impermeable to the vagaries of any particular historical or cultural context.

Yet there is a problem arising from the uncritical use of such philosophical tools, which I take is what Harding's question is getting at. These tools often hide a presumption that scientific knowledge production proceeds on some kind of idealized frictionless plane rather than in well-defined historical and cultural contexts, which in turn affect the nature of the claims of knowledge advanced. One of the main motivations for perspectival realism is to counteract this presumption. The realism I articulate in my monograph (Massimi 2022) is realism within the bounds of a plurality of intersecting scientific perspectives, where I understand the notion of scientific perspective rather broadly to include any scientific practice that has resulted in reliable knowledge claims retained across scientific perspectives.

One outcome of this re-orientation of the debate on realism is a greater emphasis placed on historically and culturally situated epistemic communities, including communities that are often severed by epistemological narratives and frictionless accounts of scientific knowledge production. Going back to the examples in section 1, in my monograph (Massimi 2022) I discuss the local knowledge about the melliferous flora among the beekeepers of the Yucatán peninsula; ethnobotanical knowledge of the rosy periwinkle in the communities of Madagascar; and engineering knowledge about ground-water motion behind fountains, such as those of Alhambra and Villa d'Este, among many others.

It is, then, worth stressing the important multicultural dimension inherent in the notion of 'scientific perspective' and its implications for how to think of scientific knowledge production and epistemic injustices in science (a theme I attend to in Massimi 2022, Ch 11). I urge to understand *situated knowledge* not in terms of 'enrolling' in a particular epistemic community with its modelling assumption, technological tools and so forth. Scientific knowledge by its very nature is cosmopolitan in that it grows through exchanges, trades, and cultural encounters. For example, it would be wrong to identify what one might call the 'Faraday–Maxwell perspective' with 'shared membership' of some field-theoretical assumptions and modelling practices as the exclusive intellectual repository of the Cavendish Lab in Victorian Cambridge. Doing so would lose sight of the broader historical and cultural context in which the perspective became possible in the first instance, and eventually thrived. It would, for example, unjustly cut out Scottish kelp-makers, local glassware artisans, and glass-blowers, among others, whose practices were important enabling factors behind the Faraday–Maxwell perspective in which J.J. Thomson's research on cathode rays thrived.

Scientific perspectives, as I use the term, are therefore not akin to Kuhn's scientific paradigms, which are in turn associated with what I am going to call 'Kuhnian communitarianism': that is, the idea that scientific knowledge is *defined by* the specific historical-geographical-cultural *membership* of particular epistemic communities sharing what the early Kuhn called a 'paradigm'. Think again of the image of scientific knowledge production emerging from *The Structure of Scientific Revolutions*, whereby a succession of incommensurable scientific paradigms, competing with one another, result in a new paradigm eventually supplanting the previous one. Kuhnian 'normal science' is defined by canonical texts (be it the *Almagest* of Ptolemaic astronomy or the *Principia* of Newtonian mechanics). Scientific terms and associated nomic generalizations are learned from such canonical texts. For Kuhn, scientific knowledge gets passed on from one generation to the next *belonging to the same scientific paradigm* in periods of normal science—until the time comes when anomalies accumulate, trigger a crisis, and a new paradigm comes to the fore.

The problem with this image of scientific knowledge production is that historically it is hard to find genuine examples of *insulated* and culturally *homogeneous* scientific paradigms. Indeed some of the well-known difficulties emerging from Kuhn's image of science—for example, how to explain the paradigm shift, how it is possible for communities engrained into a paradigm to abandon it and move on to a new one (see Bird 2000; Wray 2011)—are the side effect of what I have called Kuhnian communitarianism'. The historical reality is quite different.

At any given historical point, there is typically a plurality of historically and culturally situated scientific practices or what I call 'scientific perspectives'. Going back to the 'Faraday–Maxwell perspective', just in Europe at the turn of the nineteenth century there were, for example, at least three different perspectives on the nature of the electric charge (see Massimi 2019b). Perspectival realism rejects therefore the philosophical assumption that science evolves via epistemic *membership of one historically-culturally sufficiently well-insulated scientific perspective*. This is something that historians of science have long rediscovered with their kaleidoscopic approach to science and increasing emphasis on material cultures, rather than canonical textbooks, systems of beliefs, or scientific theories.

As soon as attention shifts to material cultures—or, in my language, to the modelling techniques, experimental tools, and technological resources available to any epistemic community to *reliably* advance scientific knowledge claims—the pluralistic, diverse, and fluid nature of scientific perspectives becomes immediately evident. *Pace* Kuhnian communitarianism, scientific knowledge travels across cultures and times and is inherently cosmopolitan. In this way, the notion of scientific perspective and the view of perspectival realism open the door to what I'd like to call 'scientific cosmopolitanism'. Scientific cosmopolitanism, in my idiolect, has nothing to do with scientific 'globalization'.[3] It does not imply the integration of historically and culturally situated perspectives, with all the troublesome attributes implicit in such expressions. It simply signals how historically and culturally situated scientific perspectives have been able to travel, trade, and thrive, not only in the absence of but in fact *thanks to the absence* of a lingua franca. Without ever losing their historical and cultural situatedness, scientific perspectives nevertheless *collectively* feed into cosmopolitan knowledge. The broad normative contours within which these cosmopolitan exchanges take place, and associated risk of epistemic injustices (what I call 'epistemic severing' and 'epistemic trademarking') is something that deserves closer attention and whose treatment goes beyond the scope and remit of this paper (I refer the reader to my discussion in Massimi 2022, Ch 11).

To conclude, when seen through the lenses of perspectival realism, scientific knowledge is never the prerogative of one single epistemic community at one historical moment. It is social and collective in a distinctively multicultural and cosmopolitan way where the emphasis is on the plurality of phenomena (rather than properties or pre-carved natural kinds). In reply to Harding's invitation, perspectival ontology, as I'd like to think of it, is one possible multicultural source of phenomena to which theories about knowledge may legitimately be asked to apply.

Acknowledgements

I am very grateful to Meir Hemmo and Orly Shenker for inviting me to contribute to this special issue. This article builds upon and develops ideas present in Michela Massimi (2022) *Perspectival Realism* (Oxford University Press). This research is part of a project that has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement European Consolidator Grant H2020-ERC-2014-CoG 647272 *Perspectival Realism. Science, Knowledge, and Truth from a Human Vantage Point*).

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[3] See Harding (2015, Ch. 4) for a discussion of the problems she sees in well-intentioned calls for 'integrating', for example, indigenous cultures with modern Western ones.

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