Perspectival ontology: between situated knowledge and multiculturalism

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

Ts'íits'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 (300 BCE to 300 CE—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, situated, or—as I'd like to call it interchangeably—*perspectival* 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 in press). 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 do not happen in a vacuum; they are 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'îits'ilche'*. In asking "What is *that* plant?", one is inviting different possible answers typically elicited by different epistemic communities. Plant morphologists would answer the question by considering anatomical features of the plant. Cytogenetists 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 some clearly identifiable types of *phenomena*—be they morphological, genetic, or ecological phenomena, among others. Each phenomenon, in turn, is indexed to a particular *epistemic domain*: for example, the achene-type germination occurs in the cellular domain; pollination involves api-botanical cycles 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.

For example, a child flying a kite in the proximity of the plant at peak season is an event that is not a candidate for the phenomenon of pollination. By contrast, a bee buzzing in the proximity of the plant is an event that is a candidate for such a phenomenon. Domains give epistemic communities a sieve for identifying events that are *bona fide* candidates for the title of 'phenomena'. I will say more about the nature of these phenomena and their modal robustness in the next section. But for now, what is to be said about this plurality of 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 this 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 (more than semantic) concern 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 which 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 *Gymnopodium floribundum.*

Melissopalynological studies in the region of the Yucatán have found that *Ts'iits'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 in the dry and rainy 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 in the ever-changing tropical conditions.

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 or perspectival knowledge about a phenomenon (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 can describe the reproductive organs of the plant, but to gain insight into its reproductive performance, 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'íits'ilche'* pollen in the honey of the region as spotted by melissopalynologists.

This is just one example of how situated knowledge and 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: 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 in press 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 included (in a non-exhaustive and open-ended 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 drawn about each of them but also the connection to be made 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: it was the first sub-atomic particle to be identified (a 'corpuscle', as Thomson called it at the time).

"But where is perspectival ontology in this example?", a 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 metaphysical 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 may be a corpuscle with a certain charge-to-mass ratio" depends crucially on the ability to elicit its 'manifestations' across various phenomena. And these 'manifestations' in turn require and presuppose perspectival pluralism. Indeed, they presuppose a particular kind of pluralism about situated knowledge 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 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 originally made using kelp (i.e. ashes of seaweed) as an alkali source to reduce the melting temperature.

An industry of kelp-making boomed in the late eighteenth and early nineteenth century 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 pluralism behind 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, for example, modelling the electrostatic field via 'Faraday tubes' to manipulating electromagnetic interactions with cathode rays, making exhausted glass tubes with lead-free glass, and producing seaweed ashes (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. 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' that can only be appeased by converging on it.

2. **What is perspectival ontology?**

It is time to zoom into the notion of phenomena at play in perspectival realism and associated perspectival ontology. Phenomena have long been considered no match for a realist ontology in science. A stronghold of the empiricist tradition, phenomena have often been taken to be synonymous with appearances. Scientific realists, for their part, have treated them at best as manifestations of an underlying reality of causal properties, causal powers, essences, 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 in press, 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 (yet the event kite-flying-in-a-thunderstorm might well qualify as a *bona fide* candidate phenomenon in other domains 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 pollen deposited on plants 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).[1] Lawlikeness plays the realist tether in perspectival

[1] Flower coverage denotes how many pollinators of a given species are present on flowers and the number of flowers they visit in a certain interval of time. Pollen deposited refers to the number of pollen grains deposited on the stigma for each pollinator's visit (for a discussion, see Pérez-Balam et al. 2012).

realism. It is a primitive property of stable events in nature and 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 the electric charge *would* be repelled *if* an electric 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, in a certain interval of time, etc.). 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. It is typically the job of different epistemic communities—pollination ecologists, conservationists, ornithologists, entomologists, and so forth—to tease out the network of perspectival inferences from a range of data to the stable event in question (i.e. pollen being deposited on the reproductive organ of a particular plant).

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, or with different gases filling the tubes. And here too, different epistemic communities—from kelp-makers to professional glass-blowers like Ebenezer Everett; from chemists working on electrolysis to physicists studying electromagnetism—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. Trying to detach and insulate the stable event from the inferential space of *modal knowledge claims* in which it is located would leave unscathed its primitive lawlikeness but would deprive it of its modal robustness.

Thus, to say (as I do) that modal robustness is a secondary quality of phenomena 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 from one or more datasets through often diverse and long inferential routes and advance claims of a modal nature about it. Primitive lawlikeness of events is the underpinning foundation for 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 one regards 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 in press, 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*[2] 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.

Metaphysical, philosophical, or religious beliefs may also have been influential in making the community endorse some claims of knowledge. But they do not count as part of a 'scientific perspective' as I am going to use the term. They are intended to explain how communities come

[2] 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.

to accept some knowledge claims but not how the communities come to *reliably* make them, or *justify* 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 a 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 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 in press). 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 theoretical 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, who in my view has charted a fertile middle ground beyond foundationalism and coherentism.[3] 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 and depends on having *reliable* procedures for arriving at these claims.

In other words, the reliability and ultimately the truth of those 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

[3] See in particular the essays 'The raft and the pyramid: coherence versus foundations in the theory of knowledge', 'The coherence of virtue and the virtue of coherence', and 'Intellectual virtue in perspective' (all in Sosa 1991). My remarks here build on Massimi (2012).

as indexed to a perspective or relative to a perspective (see Massimi 2018b and again in press Ch. 5). I see scientific perspectives as offering instead both justificatory principles and assertability conditions for specific claims of knowledge.

As new scientific perspectives come to the fore, existing claims of knowledge can be cross-perspectivally assessed and retained or withdrawn accordingly. While truth as correspondence with the way the world is (loosely speaking) is a cross-perspectival affair, scientific perspectives offer a second-order set of epistemic-methodological principles that can shed light on whether or not someone has *justifiably* come to *reliably form* claims of knowledge.

By separating issues about reliability from those of justification, the aforementioned working definition of scientific perspective does not fall prey to classical problems affecting, for example, Kuhn's view about scientific paradigms. For instance, there is no equivalent to 'living in a new scientific world' under my definition of 'scientific perspective'. Scientific perspectives do not mould ontology. They do not produce perspectival facts.

There is more. A scientific perspective may reliably identify modally robust phenomena but have sometimes the wrong justificatory principles, or 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 establish the *reliability* of knowledge claims advanced about 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 inferences from data about transition of states to the putative phenomenon of caloric. Individual perspectives neither sanction their own facts nor license the reliability of their own knowledge claims about phenomena. 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 ultimately secure reliable knowledge production. This is what one would expect from the social and collaborative nature of scientific inquiry. And it is also what makes phenomena modally robust across a variety of perspectival data-to-phenomena inferences.

Crucially, then, 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 sometimes 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 scientific knowledge claims. 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 scientific knowledge claims is key to deliver reliable scientific knowledge and, ultimately, its 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 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). 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 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 (despite appeal to historical case studies to support various global arguments pro and con). There are of course some obvious methodological reasons for this. 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 intended to be 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 in press) 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 in press) I discuss the local knowledge about the melliferous flora among the beekeepers of the Yucatán peninsula; knowledge about 'kelp-making' by the Scottish communities of the eighteenth and early nineteenth century, which was important for enabling the instrumentation behind the trend of electrical researches to follow, among several other examples.

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 and epistemic injustices in science. The *situated knowledge* captured by any scientific perspective should not be equated with 'enrolling' in a particular epistemic community to the exclusion of other relevant ones. Scientific knowledge by its very nature is cosmopolitan. It does not grow in silos, via historically and culturally *insulated* scientific perspectives, but instead through exchanges, trades, and cultural encounters—through what I call *intersecting scientific perspectives*.

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.

The assumption of insulated scientific perspectives, which I resist, is a remnant of 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'. Kuhn advocated a strongly communitarian view, whereby scientific knowledge is produced in fairly well-insulated scientific paradigms, competing with one another, pitted against one another, and with a successor 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. This is how, according to Kuhnian communitarianism, 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.

But a historically *insulated* and culturally *homogeneous* scientific paradigm is very hard to find. Moreover, scientific progress quickly becomes mysterious under Kuhnian communitarianism. Hence, the debates about the incommensurability thesis and so-called Kuhn-loss (see Bird 2000; Wray 2011), the baffling succession of one paradigm after another with no commensurable methodologies or taxonomic concepts; and the even more perplexing analogy with Gestalt-switch to explain consensus-gathering around a new paradigm whose language—as Kuhn reminded us—required bilingualism instead of translation.

The mystery, of course, is only apparent. Indeed, it is an artefact of Kuhnian communitarianism and its view of how one paradigm is replaced by another, like a piece on a chessboard being taken by an opponent's piece. This hardly ever happens in practice. To start with, at any given historical point there is typically a pluralism of epistemological practices. 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).

Normal science inscribed in canonical textbooks and shared lexicons risks unwittingly buying into a kind of 'scientific homogenizing'. Those who oppose a scientific paradigm are epistemically disenfranchised and institutionally disempowered. Minority views are excluded from the dominant paradigm. And the condition for gaining 'scientific citizenship' is to adopt the main scientific paradigm, its language, its laws, and its conceptual taxonomy.

Perspectival realism rejects the philosophical assumption that science evolves via epistemic *membership of any particular 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 claims—the pluralistic and fluid nature of scientific perspectives becomes evident. *Pace* Kuhnian communitarianism, scientific knowledge travels across cultures and times and is inherently cosmopolitan. The notion of scientific perspective and the view of perspectival realism open the door to what I'd like to call 'scientific cosmopolitanism', which, in my idiolect, has nothing to do with scientific 'globalization',[4] or the 'integrating' of scientific perspectives in the sense of 'melting', 'merging', 'overlapping' historically and culturally situated perspectives, with all the troublesome consequences implicit in such expressions.

Neither does scientific cosmopolitanism imply a lingua franca,[5] a vestige of the Western colonial-imperialistic past (see, e.g., Gordin 2015, Ch. 11). Historically and culturally situated

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

[5] As Gobbo and Russo (2020, pp. 196–197) write: "The expression 'lingua franca' comes from Latin. … It was proposed originally by Hugo Schuchardt, … for him, the *lingua franca* was a *Vermittlungssprache*, a "mediation language", that emerged because of the trading in the Mediterranean Sea during the Middle Ages between speakers of Romance languages such as Castilian, Catalan, Provençal, Ligurian, Venetian, once in contact with Arabs and Turks. It was a

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, intersecting scientific perspectives make of scientific knowledge a kind of cosmopolitan knowledge over long periods of time.

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 a well-defined set of 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. The material here presented is copyrighted and reproduced in suitably abridged and edited form from Michela Massimi (in press) *Perspectival Realism* (Oxford University Press), extracts from Chapters 1, 6, 8, 10, and 11. Many thanks to the OUP Editor Peter Ohlin for kindly giving permission to reproduce the material in this article. Special thanks to Helen Beebee, Julia Bursten, Ana-Maria Creţu, Adrian Currie, Joe Dewhurst, Catherine Elgin, Steven French, Franklin Jacoby, Katherine Kendig, Craig J. Kennedy, Sabina Leonelli, Sandra Mitchell, Paul Teller, Jon Turney for helpful discussions and comments on various points here covered.
This article 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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sort of unstable pidgin for the domain-specific purpose of trading. … Clearly, the original *lingua franca*, and pidgins in general, do not respect this requisite. In fact, the club of the languages of science is very exclusive: according to *Ethnologue*, there are currently more than 7000 living languages in the world; however, if we check all the original scientific production—even in a large sense, including Western and Eastern antiquity—the languages of science in all the history of humankind are less than 20."

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