# Reviews

*Perspectival Realism* by Michela Massimi (Oxford University Press, 2022).
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Michela Massimi has written a book broad in scope and ambition but full of wonderful details. It moves from technical philosophical discussions of conditionals to detailed case studies of work in child literacy. From perspectival art to dark matter. From Borges to blown glass – and much else in between. It is impossible not to be impressed.

Massimi's book is a detailed elaboration and defence of a position, perspectival realism, she has been developing over several years. Perspectival realism offers a new twist on realism debates in science. Standard scientific realist views focus on the *products* of science. They are concerned with questions like whether our current scientific theories are approximately true or our best models accurate. Massimi's perspectival realism, in contrast, focuses on the *process* of scientific investigation. She is interested in the question of how scientific communities come to produce reliable knowledge. Massimi addresses that question by offering the reader several detailed case studies. The centrepiece of the book is a long and multi-part discussion in Chapter 4 in which she describes the development of models in nuclear physics, climate science, and developmental psychology. The central message of each case study is the same: scientific knowledge emerges through the interaction of diverse scientific communities. For example, crucial to the development of models explaining nuclear stability was prior work done by petrologists, vulcanologists, meteorologists, and others in establishing a consistent pattern of isotopic abundances through a variety of environments. It was this knowledge which in conjunction with other accepted physical constraints, like Pauli's exclusion principle, that led to the development of a series of nuclear models, culminating in Goeppert Mayer and Jensen's Nobel Prize-winning shell model.

  

Successful science then often (maybe always) involves the work of different communities of investigators in collaboration. Perspectival realism is an attempt to offer a theoretical description of how this is possible. First, we are to consider different epistemic communities, different groups of scientific researchers, as occupying different perspectives. A perspective, according to Massimi, is a:

> 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 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. (pp. 5–6)

The brief sketch given above of work in nuclear physics can be elaborated in terms of perspectives. For example, the community of early twentieth-century meteorologists represents one perspective. They were interested in better understanding the composition of the atmosphere. Using balloon flights in a variety of locales, data about the relative abundance of different chemicals in the atmosphere were collected, eventually leading to the discovery that the percentage of each gas in the troposphere was independent of altitude. This involves all three elements of scientific practice that Massimi describes. A claim about relative abundance is justified using balloon collection methods which are taken to be reliable in part because they are robust over variations in the locations at which the samples are collected.

Another perspective is occupied by scientists studying the chemical composition of rocks and meteorites. Using methods like X-ray crystallography, they were able to establish that some nuclides with particular neutron numbers were abundant in both meteorites and rocks from the earth's crust. Combining insights from both perspectives leads to compelling evidence that there is a stable pattern in isotopic abundances found throughout the universe.

As I understand Massimi, the work done by mineralogists, meteorologists, chemists, and others described above provides what she would call robust *data*. To go from these data about the distribution of isoptopes to knowledge about nuclear stability, a further step is required: a model of the nucleus which *explains* why some nuclei and not others are stable.

Models according to Massimi are to be thought of as 'inferential blueprints'. One part of the blueprint metaphor is familiar from many discussions of modelling in the philosophy of science.



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Scientific models are representations which are partial and perspectival, often involving simplifications and distortions. But the idea of a blueprint is also meant to jibe more generally with Massimi's perspectival and collaborative understanding of the scientific process. Models, like blueprints, are not just representations, they are a common resource amongst diverse communities, allowing them to draw relevant inferences and plan for future actions. Moreover, again like blueprints, these models can and will be revised and updated as scientific investigation unfolds. The same climate model, for example, might provide urban planners with information about what needs to be done to mitigate flood risks and climate scientists with incentives to develop better models of cloud cover.

The inferential part of the blueprint metaphor is explained through a complicated story involving epistemic modals and conditionals. Models allow us to 'physically conceive' of various possibilities concerning the target. This in turn licenses indicative conditionals with suppositional antecedents (p. 143). For example, thinking of the nucleus through the shell model might lead one to assert the following conditional:

> If the nucleus is conceived as per the shell model, particular nuclides with magic numbers will show stability. (p. 177)

Massimi suggests that the consequents of these conditionals contain hidden or suppressed modals. So what they tell the scientists is that, at least from a certain perspective, things might be thus and so. What eventually elevates this to knowledge of a non-perspectival kind is the possibility of cross-perspectival assessment. The claims of the shell model, for example, are consistent with the isotopic abundance data collected by other epistemic communities; and the general mechanism which explains the structure of stability, the spin-orbit coupling of the nucleons, is retained in later models.

The kind of knowledge this cross-perspectival assessment provides is knowledge of what Massimi calls lawlike dependencies. These dependencies are robust worldly relations which come in a variety of flavours. They include the *causal* relations, for example between greenhouse gas emissions and global warming; *explanatory* relations like those between certain atomic numbers and nuclear stability; and the statistically *objective* relations, like those between difficulties with balance and difficulties with reading in children. We often express our knowledge of these lawlike dependencies through subjunctive conditionals. For example, we can truly say that if a nucleus were to have an atomic number of 82, it would be stable or, perhaps more interestingly, if we were to limit carbon emissions



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over the next 30 years that would lower the probability of 1.5°C global temperature rise.

In the second half of the book, Massimi builds on her story of how we come to know lawlike dependencies to give an account of phenomena and natural kinds. Unlike lawlike dependencies, both phenomena and kinds are to be understood, at least in part, in perspectival terms. Phenomena 'are stable events indexed to a particular domain of inquiry, and modally robust across a variety of perspectival data-to-phenomena inferences' (p. 207).

The account of phenomena is central to Massimi's picture. She even describes her view as a 'phenomena-first ontology' (p. 217). But I found this part of the book one of the most difficult to understand. Consider a concrete example, the bending of cathode rays. This is a modally robust phenomenon according to Massimi, since epistemic communities are in a position to access it in many different ways. Massimi says the modality here is a 'secondary property' to be understood by reference to the kinds of inferences different epistemic communities can make. I'm a little puzzled about what exactly this means but even more perplexed as to why Massimi wants an epistemic or perspectival characterization of the modal aspect of phenomena, given that she is already committed to there being real, aperspectival lawlike dependencies. If we have already admitted such modally-loaded features into our world picture, it seems more natural to say that what epistemic communities discover are just aspects of these dependencies and so let the modal aspects of phenomena be worldly rather than perspective-dependent.

Kinds, what Massimi calls 'natural kinds with a human face', are defined as groupings of phenomena. A detailed and subtle account is developed over several chapters (Chs. 7–10). To simplify greatly, kinds are in a sense made by grouping phenomena under a common sortal but this making is not arbitrary. Successful kind terms relate phenomena which are genuinely connected. We might think, for example, of the way the term 'atom' as used in the late nineteenth century gradually begins to connect work in thermodynamics, chemistry, Brownian motion, colloid concentrations, and Rayleigh scattering. An unsuccessful kind term like 'ether' is introduced with the same goal, to connect phenomena, but is judged to be empty because it turns out the phenomena it attempts to group together lack any real connection, any real lawlike dependencies. As before, there is a perspectival aspect to this account of kinds. Scientific communities have to do the hard work of discovering and connecting phenomena. But there is a realist part too. The success



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of this sort of kind-making depends on the independent existence of worldly lawlike dependencies.

There is a certain elasticity to the grouping of phenomena together. Varying interests and explanatory goals might lead us to think different phenomena sometimes belong to the same kind and sometimes not. So, Massimi can take a relaxed attitude to questions like whether $D_2O$ (deuterium oxide) is really water. If our interest is in phenomena connected to atomic structure or isotopic abundance, there may be good reasons to say 'yes'. If our interest is in the role water plays in biological systems ($D_2O$ is poisonous) or thermodynamic properties like boiling points ($D_2O$ has a higher boiling point than $H_2O$), the answer might be 'no'.

This is just to skim the surface of a rich and original text. I have sketched the bare bones of perspectival realism in the most abstract way. In my view, what is most appealing about the book is its well-researched and detailed analysis of multiple cases from the history of science. These include many surprising details, like the role Hebridean kelp-making communities played in high-quality glass production; something which was needed for many experiments being conducted at British universities in the nineteenth century. It becomes clear in the final chapter of the book that these details are not just incidental colour. Massimi's perspectival realism recognises these communities as one more perspective, essential to the growth of scientific knowledge. Perspectival realism is a step towards what Massimi calls a 'scientific cosmopolitanism' in which in recognising the role diverse epistemic communities can and do play in science, we should turn the conversation towards: '*who* scientific knowledge is really *for*, *who produces* scientific knowledge over time and *who* should be benefitting from it' (p. 367). Massimi suggests these are topics for future work. If that work approaches these questions with the same subtlety and originality with which Massimi has presented her view on models, perspectives, and kinds, I for one very much look forward to reading it.[1]

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[1] Many thanks to Michela Massimi for reading a draft of this review and correcting mistakes both large and small. Any remaining errors are, of course, entirely my own.