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2nd Prize: Jean Paul Aulet (Puerto Rico)

Formulating Scientific Realism: Aims, Commitments, and Challenges

Introduction

Scientific realism is a position in the philosophy of science that asserts that scientific theories aim to accurately describe both observable and unobservable aspects of a mind-independent world. Its appeal lies in its explanatory power, its alignment with scientific practice, and its continuity with common-sense realism. At its core, it maintains that scientific statements are literal, truth-apt, and often approximately true, even when referring to entities beyond direct observation. Yet this position faces persistent philosophical challenges, especially concerning how we can justify belief in theoretical entities such as electrons, black holes, and quarks, which are inaccessible to direct sensory experience. These challenges raise questions about the nature of truth, reference, and epistemic justification in science, and are most vividly expressed in the pessimistic meta-induction argument and in debates over the distinction between the observable and the unobservable.

This essay explains how to best formulate scientific realism. It begins by clarifying its core metaphysical, semantic, and epistemic commitments. It then considers major challenges from anti-realism, especially the historical argument that theory change undermines the realist's claims to truth and reference. Finally, it defends a more modest and resilient formulation of realism grounded in the reasonable aim of science and the methodological progress that underpins it.

Core Commitments of Scientific Realism

The traditional formulation of scientific realism is threefold. First, it holds a metaphysical commitment: that there exists a reality independent of human minds, which science seeks to describe. This view extends the intuitions of common-sense realism, developed in early empiricist philosophy by Locke (1690), who argued that material objects exist independently of perception. Scientific realism generalizes this commitment to include the unobservable entities posited by scientific theories.

Second, it involves a semantic commitment: that theoretical statements, including those about unobservables, are literal and truth-apt; they are capable of being true or false depending on how the world is. Psillos (1999) formulates this aspect of realism as a rejection of instrumentalist or fictionalist views of theory: scientific claims are assertoric, not merely convenient.

Third, there is an epistemic commitment: that many of our best scientific theories are approximately true, and their theoretical terms successfully refer to real entities and structures in the world (Devitt, 1997; Musgrave, 1981). This commitment builds upon a correspondence theory of truth and implies that science, though fallible, offers knowledge, not merely predictive efficacy.

Theory Change and the Pessimistic Meta-Induction

A key historical challenge to scientific realism is the pessimistic meta-induction (PMI) argument, advanced by Laudan (1981). Laudan notes that many past scientific theories, such as the caloric theory of heat, the phlogiston theory of combustion, and the theory of the luminiferous ether, were once empirically successful but are now considered false. He infers that our current theories will likely suffer the same fate. The implication is that theoretical terms do not reliably refer, undermining realism's epistemic commitments.

Stanford (2006) builds on this argument through the "Problem of Unconceived Alternatives." He argues that there are likely many potential scientific theories we have yet to develop, just as there were better theories historically that succeeded past ones. Given the continual evolution of science, we have reason to be skeptical that any current theory represents the final word on reality. Realists counter that theory change does not necessarily imply total discontinuity. Psillos (1999) argues that theories are often abandoned not because they are entirely false, but because they are limited or incomplete. Many theoretical terms, such as "gene" or "atom", retain continuity in reference across theoretical frameworks.

Furthermore, Devitt (1997) contends that the pessimistic meta-induction relies on a flawed historical analogy; it assumes that we are no better today at discovering truths about unobservables than in the past. Yet methodological advances, such as improvements in experimental design, instrumentation, and statistical modeling, make this pessimism less credible.

Formulating a More Resilient Realism

Godfrey-Smith (2003) offers a powerful alternative to naïve realism: scientific realism should be formulated not in terms of the literal truth of current theories, but in terms of science's aims. He argues that "the actual and reasonable aim of science is to produce true or approximately true descriptions of the world," including its unobservable features. This formulation avoids tying realism to the fate of specific theories and instead interprets realism as a philosophical outlook on scientific practice.

The No Miracles Argument, initially formulated by Putnam (1975), supports this pragmatic realism. It states that the success of science, especially its ability to make novel predictions, is best explained by the "approximate" truth of its theories. If false theories routinely made accurate predictions, that would be a miraculous coincidence. Thus, the success of science is evidence for its truth-tracking capacity. Psillos (1999) reinforces this view by distinguishing between essential and idle theoretical components. Many abandoned theories had success-generating components that survive in successor theories, suggesting that scientific progress is cumulative. Rather than being wholly discarded, past theories often contribute approximations or conceptual tools that evolve over time.

Formulating realism around science's aims and long-term progress allows us to retain realist commitments without requiring confidence in the literal truth of any particular theory. It emphasizes epistemic humility while preserving the ontological and semantic core of realism.

Observables, Unobservables, and the Anti-Realist Challenge

Anti-realists, such as van Fraassen (1980), argue that we are only justified in believing in observables: entities accessible through unaided perception. Claims about unobservables, they contend, should be treated as agnostic or instrumental. Logical empiricists, notably Carnap, reinforced this stance by insisting that only empirically verifiable statements are meaningful, thereby denying ontological commitment to theoretical entities.

However, realists argue that the observable/unobservable distinction is unstable. Maxwell (1962) argues that observation is a continuum, ranging from unaided vision to technologically mediated detection. For example, we observe bacteria via microscopes and subatomic particles via detectors. Drawing a sharp epistemic line between what is "observed" and what is "inferred" is difficult.

Godfrey-Smith (2003) likewise observes that scientific practice does not support a strict observability criterion. Scientists often treat instrumentally detected entities, such as electrons, as observable in practice. The epistemic standards used for observable and unobservable claims are often the same: explanatory coherence, predictive success, and consistency with background theory.

This view is further reinforced by the theory of the extended phenotype, particularly in the human case, where technological instruments, ranging from microscopes to particle detectors, can be understood as cognitive and perceptual extensions of our biological apparatus. These tools, themselves products of our evolved capacities, function as externalized sensory systems, enabling us to empirically engage with phenomena far beyond the reach of unaided perception. As such, they support a broader, embodied conception of observability that challenges strict empiricist limitations and strengthens the realist claim that unobservables can be known through technologically mediated observation (Dawkins, 1982).

If the distinction between observables and unobservables cannot be precisely maintained, then the anti-realist's restriction collapses. As Psillos (1999) argues, realists are justified in believing in unobservables because they play essential explanatory roles and are embedded in successful theory.

Conclusion

Scientific realism is best formulated not as a dogmatic belief in the truth of current scientific theories, but as a commitment to the rational aims of scientific inquiry. It asserts that science aims to produce true or approximately true representations of a mind-independent world and that theoretical terms, including those referring to unobservable entities, are capable of referring and conveying knowledge. In this formulation, realism becomes not a naïve optimism about science's current achievements, but a philosophical posture that recognizes both the fallibility and the cumulative nature of scientific understanding.

Importantly, this formulation distinguishes realism from simple theory endorsement. It allows the realist to acknowledge that theories are subject to revision, while still maintaining that scientific practice, its methods, predictive success, and explanatory coherence, provides compelling reason to believe that we are getting things at least roughly right. As Godfrey-Smith (2003) emphasizes, the aim of science is not just to model or organize data but to reach toward a truth-tracking description of reality, even when that reality is not fully observable.

Challenges such as the pessimistic meta-induction and the observability criterion urge caution. They remind us that science has a history of error, and that theoretical posits often extend beyond direct experience. Yet these challenges do not undermine realism when it is properly formulated. Advances in methodology, continuity in theoretical terms, and the enduring success of science in explaining and predicting phenomena all support a modest yet resilient version of realism. The anti-realist's demand for observable verification, while rooted in a laudable empiricism, ultimately falters under the weight of modern scientific practice, where unobservables are indispensable and deeply integrated into empirical workflows.

In this light, scientific realism should be seen as a philosophical commitment grounded in both humility and hope: humility about the limitations of current theories, and hope in the capacity of human inquiry to uncover the deep structure of reality. Rather than collapsing under historical scepticism, the practice of scientific realism adapts by refining its formulation, aligning with the actual aims of science, and preserving its fundamental insight that science is not merely useful, but truth-seeking. It remains, historically, one of the most coherent and philosophically robust interpretations of scientific knowledge.

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