Opened, November 27, 2025
First draft, February 23, 2026
Edits, March 23, May 19, June 23, 2026

Chapter 18

Small-r realism[1]

1. Introduction

The debate between scientific realism and antirealism has held a central position in the philosophy of science since the middle of the twentieth century. It is driven by two competing intuitions. Realists are guided by a triumphalist sentiment that our best science has enjoyed extraordinary success in discerning contingent truths of the world, where those truths extend from the prosaic to the profound. Antirealists regard such triumphalism as overreaching and counsel a more skeptical attitude to science's putative successes.

Something like the scientific realist intuition is correct, in my view. The long-standing problem has been to find a precise and sustainable formulation of it. This chapter seeks to establish that small-e empiricism solves the problem. It is already the strongest formulation of scientific realism that is admissible within the bounds of the fallibility of inductive inference. Since it concedes this fallibility to antirealists, it amounts to a view that successfully mediates between the extremes of an excessively optimistic realism and excessively pessimistic antirealism.

What will sustain this mediating view, I shall argue in Section 2 below, is that there are two parts to the scientific realists' intuition. The first is that we have the epistemic means to learn core, contingent propositions in a science. The second is that individual sciences have successfully employed these means. This first part only is amenable to a formulation as a general doctrine of scientific realism. Determining the truth of the second part lies beyond what a general doctrine can achieve. It must be determined in a case-by-case analysis. The enduring failure of formulations of scientific realism lies in unsuccessful attempts to find a general formulation that implements this second part.

[1] My thanks for Howard Sankey for helpful comments on this chapter and the two following.

Section 3 reports that small-e empiricism already embodies a formulation of scientific realism that conforms with this first part. The formulation, here called "small-r realism," identifies inductive inference as the uniquely available epistemic means. Crucially, small-r realism makes no assertion that any particular science has attained a final truth. Rather it asserts that sciences have the means to do this through inductive inferences from experience. The extent to which any particular science has succeeded in applying the means is left to the individual science. The complications of the fallibility of inductive inference are thereby relocated to where they belong: in the case-by-case analysis of the inductive support of the individual sciences. This particularism extends to how strongly supported propositions are to be interpreted. Whether such a proposition should be interpreted literally, as some versions of scientific realism require, should also be left to a case-by-case analysis. The dangers of assuming otherwise are illustrated by the notorious complications of interpreting the meaning of entropy.

The resulting small-r realism is essentially coincident with small-e empiricism. It adds only a reminder of the fallibility of inductive inference. Thus, as Section 4 reviews, small-e empiricism/small-r realism moderates the extremes of empiricism and realism into a single, mediating position that preserves the best of both views.

Section 5 contains a short, summary conclusion.

2. How to Formulate Scientific Realism: Escaping Fallibilism

2.1 A Division of Labor

How can we take the triumphalist intuition that science has successfully discerned deep truths of nature and give it a precise formulation? A primary concern is that the formulation should accommodate the fallibility of inductive inference. My sense is that the literature in scientific realism has met only with limited success in this task. Common formulations tend to skirt around a successful formulation without getting it precisely right.

The key to a successful formulation is to recognize that the intuition underlying scientific realism has two parts:

Core Intuition of Scientific Realism

• Our epistemic resources are powerful enough to inform us of deeper truths of science.

• Our present sciences have used these resources effectively to learn these truths.

The first part only is amenable to a formulation of scientific realism as a general philosophical doctrine. For it has to express something general and robust through time that will apply across all the sciences. The second part depends on the specific state of individual sciences at specific times. Whether a particular science at a specific time meets the conditions of this second part must be determined on a case-by-case basis. It is not within the scope of a general philosophical doctrine. The case-by-case analyses must be carried out in the individual sciences themselves or in the history of science.

2.2 Inductive Support of Experience as the Means

Small-e empiricism supplies a single, unique means as the epistemic resource of the first part. It is inductive inference; and small-e empiricism affirms that this resource does have the capacity to inform us of these deeper truths. That inductive inference is fallible does not undo this capacity. Rather, it just means that the support might err, but that the chance of an error can be made very small, when the inductive support is very strong.

Whether the inductive support for some contingent proposition in science has failed is not something that can be determined by general principles. In the case of very strong inductive support, such failure is very unlikely, but can happen. If we have very many contingent propositions, all enjoying strong support, then we can still expect that one among the very many will fail. As Chapter 15 noted, that is as much as can be said at the level of general principles and as much as can be incorporated into a general formulation of scientific realism. Anything further must be handled on a case-by-case basis by an examination of the particular circumstances of the contingent proposition at issue. Commonly, we find in history of science that such unlikely failures are revealed by the discovery of new evidence. As much as centuries of time may pass before this new evidence emerges.

Where existing formulations of scientific realism err is that they try to find some way of incorporating both parts of the initial intuition into their formulations. They are, in effect, engaged in a futile attempt to evade the fallibility of inductive inference. We shall review some of them below. Briefly, these formulations may attribute not truth but a nebulous “approximate truth” to well-supported contingent propositions. Or they may try to select out that part of a present theory that will endure, while being unable unambiguously to identify precisely which those parts may be. Or they may speculate on future successes. If a science has not secured the truth today, we are assured that it is on the way to the truth and that scientific progress will take us there eventually.

2.3 Early forms of Scientific Realism

Writing in philosophy of science in the mid-twentieth century started to turn away from antirealist philosophies, such as we saw in Chapter 3, Section 2.5, had been pressed by the Vienna Circle. Reichenbach's logical empiricism was an early phase of this rise. We saw in Chapter 3, Section 3.4, that it included a sharp repudiation of the logical positivists' rejection of both realism and antirealism, as then conceived. It derived from Reichenbach's assigning of probabilistic weights to propositions. They included propositions expressing sense impressions, as well as those expressing facts remote from experience, such as the temperature of the interior of the sun. These last propositions allowed Reichenbach to formulate his "realistic conception of the world," which asserts that the external world has an existence independent from our impressions. This is a version of the division of labor urged here. For Reichenbach's claim is that his probability theory of meaning gives us the means to affirm probabilistic facts in the external world, without specifying further which those facts are.

Other versions of this division of labor appear in formulations of scientific realism from the mid twentieth century, at the outset of the present debate. For example, Boyd (1973, pp.1, 3) gave a formulation marred only by its inclusion of an appeal to approximate truth:

> By scientific realism I mean the doctrine that the sort of evidence which ordinarily counts in favor of the acceptance of a scientific law or theory is, ordinarily, evidence for the (at least approximate) truth of the law or theory as an account of the causal relations obtaining between the entities quantified over in the law or theory in question.

and

> … experimental evidence for a theory is evidence for the truth of even its non-observational laws and, hence, for the truth of observational predictions deduced from them, since deductive inference preserves truth.

The idea of a division of labor between philosophers and scientists is clearly articulated in J. J. C. Smart's (1963, p.27, his emphasis) monograph on scientific realism. He defends what we would now call an "entity realism" and notes:

> I shall try to uphold a realistic view of these theoretical entities, and will try to establish that the elementary particles of physics are just as respectable entities as tables and galvanometers. By 'just as respectable' here I mean '*philosophically* just as respectable'. Unicorns are philosophically just as respectable as cows: it is for the zoologist, not the philosopher, to decide that there are no unicorns. Similarly, the physicist may come to replace his present theory of elementary particles with some other theory of what goes on at the sub-atomic level. Nevertheless, he will presumably postulate some new set of theoretical entities to replace the old ones. It is not for the philosopher to decide between one physical theory and another any more than it is up to him to become a zoologist and decide for or against the existence of unicorns. My problem is concerned with the ontological status of the physicist's theoretical entities, whatever they are.

3. small-r realism

3.1 The Formulation

These last reflections delineate a version of scientific realism that lies within the existing commitments of small-e empiricism. In more compact form, it is:[2]

> *small-r realism*: the propositions of experience can provide inductive support for the truth of the contingent propositions of the sciences. This inductive support can be very strong, but can never rise to absolute certainty; and no other means can provide that certainty.

This formulation is largely a restatement of the core doctrine of small-e empiricism, as formulated in Chapter 12. The addition is an explicit acknowledgment of the fallibility of inductive inference, as explored in Chapter 15. It is merely a reminder of what is part of the definition of inductive inference, its fallibility.

Small-r realism simply affirms that inductive inferences are a sufficient means for securing, fallibly, contingent propositions of a science. The doctrine cannot and should not assert that any of our latest science has actually secured such propositions. For there are many sciences and some are in active evolution.

[2] These contingent propositions include what are commonly called scientific laws, for, within small-e empiricism, they are just contingent propositions of very broad scope.

A case-by-case analysis of individual sciences is encouraging. Many have secured very strong evidential support for their core, contingent propositions. If we add this fact to small-r realism we arrive at the optimistic result amenable to scientific realists: the world is most likely truly as these sciences say. We have strong inductive support for the contingent proposition in cosmology of the expansion of the universe from a big bang. We infer that it is very likely that this expansion truly is the case. This optimistic result can be recovered for central propositions drawn from across the sciences. It cannot be recovered universally. Evidential support in some sciences is weak. No theory of quantum gravity enjoys evidential support comparable in strength to that of, say, ordinary chemistry. All such theories must be treated as speculative.

3.2 Interpretive Autonomy of Science

An important consequence of small-r realism/small-e empiricism is the interpretive autonomy of science. The autonomy requires the failure or superfluity of any general principles of interpretation, such as a realist's blanket injunction to read the propositions of mature sciences literally or an antirealist's blanket injunction that these propositions cannot be read literally. For how such propositions are to be interpreted is itself a factual matter for the science. Small-r realism/small-e empiricism asserts that our only means of assessing all such factual matters is by the inductive support of experience.

We may conceive a general principle of interpretation that goes beyond what the inductive support of experience supplies. Since the inductive support of experience gives us all the support we can have, the principle will fail, in so far as it goes beyond what inductive inference can support. If it does not go beyond what inductive inference can support, then it is superfluous. Anything it can contribute has already been contributed by the inductive support of the propositions from experience.

Nothing fancy is intended by the term "interpretation" in the interpretive autonomy of science. It is just what we take the propositions of a science to mean in a quite ordinary sense. For mature science, it is generally unproblematic to take the interpretation simply to be what the propositions assert literally. When astronomy tells us that our planetary system is heliocentric, it tells us just what is says, that the orbits of the planets are centered on the sun.

Although this is true generally, it is not universally true. We must always allow for the possibility that the literal interpretation is incorrect. A straightforward case arises with effective theories. An example is the theory that gases and liquids are continuous fluids whose behavior is governed by the Navier-Stokes equation. It is very well supported inductively by experience. However further experience tells us that the theory is only true of averaged behaviors, after the molecular granularity of gases and liquids has been smoothed out. The theory's assertion of continuity is not a literal truth, since a literal truth requires the infinite divisibility of the fluid. The inductively well-supported atomic theory of matter denies this infinite divisibility.

3.3 The Interpretation of Entropy

One presently intractable example is enough to illustrate the delicacy of problem. When water boils to steam at 100C and 1 atmosphere pressure (101.42 kPa), its internal energy per unit mass u changes by[3]

$$\Delta u = 2{,}087 \text{ kJ/kg};$$

and its entropy per unit mass s changes by

$$\Delta s = 6.0471 \text{ kJ/(kg.K)}.$$

Both of these quantities, u and s, are core theoretical terms in thermodynamics. The propositions asserting both changes are very strongly supported by experimental measurements on the more directly measurable properties of water and steam, such as their temperatures, pressures and densities, and by the measurable quantities of heat supplied to them. The entropy change Δs is computed[4] as the heat supplied in (reversibly) vaporizing the water to steam Δh divided by the absolute temperature T, $\Delta s = \Delta h / T$, where $T = 373.15$K.

If approached at a more general level, the similar propositions asserting the values of Δu and Δs would naturally both be interpreted literally. A literal interpretation of the value of Δu is strongly supported by all the evidence that has repeatedly affirmed that energy is a conserved quantity passed between materials undergoing changes. It is a commonplace of thermodynamics

---

[3] Data from Parry *et al.* (2014) Table S-1. It gives the value of Δs directly and the enthalpy change per unit mass $\Delta h = 2{,}256.5$ kJ/kg. The internal energy change per unit mass Δu is calculated from $\Delta h = \Delta u + p\Delta v$, using the pressure $p = 101.42$ kPa and the volume change per unit mass $\Delta v = 1.6708$ m^3/kg.

[4] The heat of vaporization is given by the enthalpy change $\Delta h = \Delta u + p\Delta v$, where Δu is the internal energy increase of the steam and $p\Delta v$ is the energy lost to work in expanding the steam by a volume Δv against the resisting pressure p.

that the energy content of the water increases as indicated, whether the change is considered phenomenologically or statistically in light of the molecular constitution of water.

Tempting as it is, no similar literal interpretation of the value of the entropy change Δs is sustainable. The question of just how we are to think of entropy has remained troublesome since its introduction by Clausius in 1865. Is it a real physical quantity like internal energy? Is it a measure of accessible energy? Is it a merely instrumental tool for gauging the temporal direction of processes? Is it a purely effective magnitude resulting from our limited control of molecular-scale processes? Is it a parameter of the probability distribution for energy over the system's components? Is it a measure of the probability of a state or of the randomness of a state? Is it a measure of information in the spirit of Shannon's information theory? Or is it a quantity best understood by conceiving thermodynamic processes as computations? These are open issues over which debate endures.[5]

The proposition Δs = 6.0471 kJ/(kg.K) is as strongly supported by the evidence and as good a candidate for truth as any in thermodynamics. It has been an unchallengeable result since the nineteenth century. However, there is no agreement on what is its literal construal.

4. A Single Mediating Position

Small-r realism provides a view that mediates as successfully as possible between the strictest versions of scientific realism and antirealism. It preserves as much of the original intuitions behind scientific realism, while discarding those parts incompatible with the fallibility of inductive inference. In not endorsing the blanket truth of our mature sciences, it concedes to some of reservations of antirealism, while not succumbing to a pessimistic overreaction to inductive fallibilism. That the commitments of small-r realism coincide with those of small-e empiricism is a welcome result. For it tells us that together that they provide a single view that preserves what is valuable in all of the existing doctrines of empiricism, scientific realism and antirealism.

Here is how small-r realism relates to Big-R Realism and to antirealism.

[5] I have written extensively in the debate. See Norton (2025) for a recent contribution.

4.1 Not Big-R Realism

By a Big-R Realism, I mean a version of scientific realism that proposes, as a general result, that our best science has in some way discovered the final truths of the science. It may be a proposal of structural realism that asserts an enduring truth in the identification of structure; or it may be a version that asserts an equally enduring "approximate truth" of some contingent proposition.

Small-r realism is close in spirit to Big-R Realism in its epistemic optimism. The methods of science are fully capable of providing strong support for the truth of the core propositions of a science. Small-r realism differs from a Big-R Realism in affirming only the capacity of inductive inference from experience to secure the truth of contingent propositions central to a scientific theory. Whether a science has succeeded in securing such strong support must be determined on a case-by-case basis. Even ardent Big-R Realists must accept that some sciences are in a rudimentary state and have not secured this strong support. To sustain itself, Big-R Realism must provide a way to separate out those sciences or those parts of the sciences that have secured the final truth from those that have not. This amounts to the need for some generally applicable principle that tells us when the truth of a contingent proposition has been determined with finality.

According to small-e empiricism, such a principle is unattainable. The best we can have is very strong, but fallible inductive support for contingent propositions. The failure of attempts to work around this limit is assured. It is just a matter of examining these attempts to discern how they fail. Claims of approximate truth founder on the ambiguity of the adjective "approximate" when applied to "truth." Claims of enduring structure require something that has yet to be found: a precise definition of structure such that this structure of a present scientific theory can be affirmed to survive through all future discoveries.

These last remarks should not be understood as a form of skepticism. They are entirely compatible with the possibility of the contingent propositions of a science enjoying such strong inductive support that the falsity of their central propositions is well-nigh inconceivable. Such is the case, I believe, with many of our best sciences. Slender as it may be, the possibility of falsity remains as a matter of principle, even if not one of any practical import.

4.2 Not Antirealism

By antirealism I mean those positions that assert that science can secure truth only for contingent propositions that express experience directly or, commonly, possible experiences, but not for propositions that go beyond experience. These latter propositions may be portrayed as merely of instrumental or pragmatic utility. The view is not just that science happens to have failed to secure the truth of the latter. Rather, it asserts that to secure it lies beyond the methods available to science as a matter of foundational principle.

Small-r realism conforms with antirealism in not automatically declaring the truth of core propositions of mature sciences. It differs from antirealism in treating alike the import of inductive support for the contingent propositions of a science. Small-r realism has to treat them alike since it has no means to distinguish them. small-r realism/small-e empiricism has abandoned the long dubious bifurcation of experience and theory, as reported in Chapter 10.

Antirealism asserts a one-size-fits-all blanket view of skepticism towards any propositions beyond experience. In small-r realism, all that matters is the extent of the inductive support for a contingent proposition. It does not even have a general principle that accords specific observational propositions greater support than the propositions of the deeper theory to which the observations pertain. Decisions concerning comparative strengths of support must be made on a case-by-case basis.

Commonly, individual observation reports are better supported than their theoretical generalizations. Examples are easy to find. In the 1990s, Schilling and collaborators (1993) had observed superconductivity at the highest temperature (under normal pressures) yet found, 133K, in their sample of Hg-Ba-Ca-Cu-O. Given the continuing progress in finding higher temperature superconducting material, this observational report is better supported inductively than the generalization that all superconduction arises at normal pressures below 135K.

Inversions are equally easy to find, in which the strengths of support for particular experiential claims are weaker that those of the theoretical claims that govern them. For example, the evidential support for the truth of the conservation of energy is far stronger than for the veracity of any particular report of a perpetual motion machine. The evidential support for the standard chronology of species evolution is far stronger than for the veracity of a report of coincident fossilized human and dinosaur footprints.

5. Conclusion

The present literature in philosophy of science depicts empiricism and scientific realism as irreconcilable opposites, largely I believe through the influence of van Fraassen's *Scientific Image*. It is an unfortunate conceptualization since empiricism and realism each have something of value. Each, however, also harbors elements that should be discarded. Big-E Empiricism endorses an indefensible inductive skepticism. Big-R Realism underestimates the intractability of the inductive fallibility.

My goal in this chapter has been to show that, if we discard these troublesome elements in each, we arrive at a welcome consonance between the two views. Small-e empiricism discards inductive skepticism. Small-r realism accepts that inductive fallibilism is inescapable. What results in small-e empiricism and small-r realism is a single, optimal, mediating position that preserves the best of both extremes and discards the worst.

References

Boyd, Richard N. (1973) "Realism, Underdetermination, and a Causal Theory of Evidence," *Noûs*, **7**, pp. 1-12.

Norton, John D. (2025) "The Simply Uninformed Thermodynamics of Erasure," *Philosophy of Physics*, 3(1): 3, 1–21.

Parry, William T. *et al.* (2014) *ASME International Steam Tables for Industrial Use*. New York: The American Society of Mechanical Engineers.

Schilling, A.; Cantoni, M.; Guo, J. D.; and Ott, H. R. (1993). "Superconductivity above 130K in the Hg–Ba–Ca–Cu–O system," *Nature*. **363**, pp. 56–58.

Smart, J. J. C. (1963) *Philosophy and Scientific Realism*. London: Routledge and Kegan Paul.