Dynamics of Reason Revisited

6 October 2021

Work in ‘progress’

An 18-year project to develop Michael Friedman’s *Dynamics of Reason* to make sense of an ongoing revolution.

Much of the improvement comes from the case study maturing.

Michael Friedman

Selected writings

- Foundations of Space-Time Theories: Relativistic Physics and Philosophy of Science (1986)
- Kant and the Exact Sciences (1992)
- Reconsidering Logical Positivism (1999)
- A Parting of the Ways: Carnap, Cassirer, and Heidegger (2000)
- **Dynamics of Reason (2001)**
- Synthetic History Reconsidered (2010) (240 page chapter in Mary Domski and Michael Dickson (eds.), *Discourse on a New Method: Reinvigorating the Marriage of History and Philosophy of Science*)
- Kant's Construction of Nature (2013)

Today's talk

1. Explain Friedman's account.
2. Offer a third exemplar.
3. Discuss some consequences for philosophy

Friedman's scheme

What I call the dynamics of reason is an approach to the history and philosophy of science developed in response to Thomas Kuhn's theory of scientific revolutions. Unlike many philosophical responses to Kuhn, however, my approach, like Kuhn's, is essentially historical. Yet Kuhn's historiography, from my point of view, is much too narrow. Whereas Kuhn focusses primarily on the development of the modern physical sciences from the Copernican revolution to Einsteinian relativity theory, I construct an historical narrative depicting the interplay between the development of the modern exact sciences from Newton to Einstein, on the one side, and the parallel development of modern scientific philosophy from Kant through logical empiricism, on the other. I use this narrative to support a neo-Kantian philosophical conception of the nature of the sciences in question—which, in particular, aims to give an account of the distinctive intersubjective rationality these sciences can justly claim. By contrast, Kuhn's picture led to philosophical challenges to this claim, I argue, precisely because he left out the parallel history of scientific philosophy.

(Extending the Dynamics of Reason, 2011: 431)

Friedman's account

I want to make clear how the neo-Kantian conception in question presents us with a fundamentally historicized version of scientific intersubjective rationality, so that the standards of objectivity in question are always local and contextual. Nevertheless, in spite of, and even because of, this necessary historicization, the way in which such standards change over time still preserves the trans-historical rationality of the entire process.
(Extending the Dynamics of Reason, 2011: 432)

Three-step cycle

... – Metascience – Revolution – Philosophical grounding –...

1. **Metascience**: Philosophically-informed work on foundations of science.
2. **Revolution**: Revision of the constitutive order, where new mathematics allows the expression of new physical principles.
3. **Philosophy**: Making sense of the revolution.

Kuhn

He agrees with Kuhn that while it is possible to reconstruct Newtonian physics as an empirical possibility in Einstein's system, allowing us to reject it through observation, this reconstruction is a radical reworking.

This reworking allows for a **retrospective** rationality, but it gives no clue as to how the new framework emerged out of the old. The converted are convinced, but not the unconverted.

Friedman wants a **prospective** rationality too. Radical incommensurability is wrong. This is provided by the work of 'metascience'.

Einsteinian revolution

In a post-Kantian world,

- **Metascience**: The likes of Helmholtz, Hertz, Mach and Poincaré rethink the foundations of science, and along with changes to geometry by Riemann, Lie, Klein and Hilbert,
- **Revolution**: Einstein formulates the general theory of relativity,
- **Philosophy**: which then Schlick, Carnap and Reichenbach look to make philosophical sense of.

Quine

Contra Quine, we have a **historicized** *a priori*, theories play **constitutive** roles.

What occurs is not of the form of the falsification involved in the *Duhem-Quine thesis*:

- A & B & C implies D

D is found to be false, so at least one of A, B, C is false, but we don't know which.

For Friedman, B will typically be such that it can't even be expressed without A, nor C without A and B.

Einsteinian revolution

The revolution sees a shift in the ordering of its concepts, where one system

- **Mathematical language**: Infinite 3D Euclidean space + calculus
- **Coordinating principles**: Newton's Laws of motion
- **Empirical laws and regularities**: Law of Gravitation, inertial mass = gravitational mass

is replaced by another

- **Mathematical language**: Pseudo-Riemannian manifold + tensor calculus
- **Coordinating principles**: Invariance of speed of light, Einstein's equivalence principle, freefall as geodesic motion.
- **Empirical laws and regularities**: Field equations, approximately flat time slices.

Promotion/Demotion

During a revolution, propositions may change their status:

- **Promotion**: A contingent fact of the Newtonian universe, that the inertial mass and the gravitational mass are the same, becomes a constitutive principle in the Einsteinian picture.
- **Demotion**: On the other hand, the constitutive lack of curvature of the Newtonian universe becomes an approximately true, but in places false, description of this universe.

"By embedding the old constitutive framework within a new expanded space of possibilities it has, at the same time, entirely lost its constitutive (possibly defining) role." (Dynamics of Reason, p. 99)

Newtonian revolution

Here we have Kant making sense of Newtonian physics and Leibnizian metaphysics, after prior work by Galileo, Descartes, Spinoza, More,...

If 600 pages are devoted by Friedman to Kant's reading of Newton, we're going to need large canvases to portray exemplars fully.

What's at stake is the vitality of philosophy. Good things happen to philosophy via this engagement. Without Newton, Kant isn't Kant; without Einstein, Logical Positivism is different.

Mark Wilson

Michael Friedman's The Dynamics of Reason (DofR) and my own Wandering Significance (WS) recommend that analytic philosophy revisit the themes of its "scientific philosophy" roots, maintaining that philosophical progress remains most secure when it has anchored itself firmly in real life dilemmas. Through neglect of such ties, we feel that our discipline has slipped into a conceptual complacency from which it should be reawakened. One route to doing so is simply to think again about the methodological worries that troubled the pioneers of scientific philosophy, considered afresh in light of the gallons of discovery that have subsequently washed beneath knowledge's bridge. (p. 545)

What Can Contemporary Philosophy Learn from Our "Scientific Philosophy" Heritage?, 2010

What next?

Wilson works on smaller-scale struggles (such as hardness in materials science).

Any likely third candidate of monumental Friedmannian scope?

There seems to be a curious lack of interest shown in such a thing. Surely a great deal of meta-scientific work must be going on.

Fortunately, I have one to offer. (For which I owe a great debt to many people, but especially Urs Schreiber.)

The Third Exemplar

1. An instance of an A has been used to formulate (Hypothesis H) a long-sought fundamental physical theory.
2. In physics, mathematical concept A is fundamental to modern formulations.
3. Mathematically, the ubiquitous A is best treated as functions in Bs.
4. Logically, Bs may be reasoned about in the language C.
5. Philosophically, language C makes sense of many currents of thought in metaphysics, philosophy of language, etc.
6. Metaphilosophically, we need to situate Friedman within the story of philosophy.

Key

- A = cohomology theory
- B = ∞-topos
- C = homotopy type theory

More precise key

- $A =$ differential cohomology theory
- $B =$ cohesive ∞-topos
- $C =$ modal homotopy type theory

Key

- $A =$ cohomology theory
- $B = \infty$-topos
- $C =$ homotopy type theory

To fill in the details of these 6 strands and their relations would be a Herculean task. Here I'll touch on a few points. I imagine people here will be more interested in those at the end of the list, and yet there is much to be gained by integrating them.

Ideally, this form of tight integration will persist, but even if some of the component strands end up looking somewhat different, that something along these lines is even thinkable is important.

Physics meets mathematics...

1. An instance of a **cohomology theory** has been used to formulate (Hypothesis H) a long-sought fundamental physical theory.
2. In physics, the mathematical concept of **cohomology** is fundamental to modern formulations.

Physics meets mathematics...

- Cohomology plays a fundamental role in modern physics. (Zeidler)
- Is there much in fundamental physics that does *not* originate in natural constructions in nonabelian differential cohomology? (Schreiber)

Philosophers of physics have paid good attention to core physical theories, but have overlooked the formulation in cohomological terms.

We need here to tell of attempts to find the deepest mathematical understanding of modern quantum gauge field theory and relativity theory to reconcile them. (See Interview with Schreiber.)

More broadly we need to portray the shifting relationship between physics and mathematics over the past century.

...meets mathematics...

- "The origins of cohomology theory are found in topology and algebra at the beginning of the last century but since then it has become a tool of nearly every branch of mathematics. It's a way of life!" Ulrike Tillmann, Cohomology Theories

Cohomology for patching local-global relations

Also for extensions, classification, ... in all branches, including arithmetic.

Cohomology everywhere

Carrying in arithmetic: Dan Isaksen, A cohomological viewpoint on elementary school arithmetic, The American Mathematical Monthly, Vol. 109, No. 9. (Nov., 2002), pp. 796-805.

Voting theory

> *The Condorcet paradox that individually consistent comparative rankings can lead to global inconsistencies is a favorite topic in voting theory. Its best explanation cohomology is less popular. (Ghrist, Elementary applied topology)*

Mass in physics

> *Mass "has a cohomological significance, it parametrizes the extensions of the Galileo group." (Santiago Garcıa, hep-th/9306040)*

...mathematics...

The philosophy of mathematics has been very weak here, has barely shown any interest in such commonalities within mainstream mathematics.

All one had to do was extend Lakatos's *Proofs and Refutations* (see my 2003, also Colin McLarty's work).

...mathematics meets logic and computer science...

3. Mathematically, **cohomology theories** are best treated as functions in ∞-**toposes**.
4. Logically, ∞-**toposes** may be reasoned about in the language **homotopy type theory**.

We find that something occurs in mathematics very similar to Friedman on physics: constitutive language, promotion/demotion, etc. (See my Vienna slides.)

In *DoR*, Friedman falls into the common error, the systematic downplaying of the conceptual originality of mathematics, but redeems himself later (final slides below).

...meets logic and computer science...

- Category theory meets type theory: Mac Lane, Grothendieck, Lawvere, Lurie,...; Prawitz, Martin-Löf,...; Voevodsky, ...

Further vast stories: the shifts from set theory to category theory to ∞-category theory, and from first-order logic to dependent type theory. The role of constructive logic...

Analytic philosophy has been obsessed with first-order logic and set theory. Logicians in alternative traditions and computer scientists have been much more innovative.

...meets philosophy

5. Philosophically, language **homotopy type theory** makes sense of many currents of thought in metaphysics, philosophy of language, etc. (my 2020 book)
6. Metaphilosophically, we need to situate Friedman within the story of philosophy.

Topics to be included

- Brentano, Frege, Lotze, Husserl
- Cassirer
- Collingwood (logic of Q & A), Ryle (type-trespassing), Strawson
- Brandom, Thomasson,...
- Computer science/Applied category theory as applied metaphysics – types, modalities, etc.

Developing Friedman

So we modify Friedman's *Dynamics of Reason* to allow a more dynamic mathematical reasoning, and admit computer science into the mix.

We can have something along the lines of Friedman's dynamic neo-Kantianism.

Michael Friedman

> *In my reconceived version of transcendental philosophy, therefore, integrated intellectual history of both the exact sciences and scientific philosophy (a kind of "synthetic history") takes over the role of Kant's original synthetic method; and, in particular, constructive historical investigation of precisely this kind replaces Kant's original transcendental faculty psychology. (2010, p. 702)*

In fact, my exemplar, if it works out, would be better in many ways than Friedman's two with its closer integration of logic, mathematics and physics. Contrast with the Newtonian, and Kant claiming logic hasn't moved on since Aristotle and treating Euclidean geometry, and with the Einsteinian, and the Vienna Circle's taking up largely just the new logic.

Where are we now?

Where to situate this work? Friedman as someone synthesizing Logical Postivism, Cassirer, Kuhn, ... into his own form of Neo-Kantianism is presumably to be taken as a continuation of the philosophical response to Einstein.

Can it be that only meta-science is to be involved in the run up to the next revolution? That my 'Modal HoTT' book is then metascience?

Seems an odd picture.

Why not Hegel rather than Kant?

Alan Richardson, *Ernst Cassirer and Michael Friedman: Kantian or Hegelian Dynamics of Reason?*, in Domski and Dixon (eds.) pp. 279

Hegel in Cassirer, Brandom, Lakatos, Lawvere, ..., nLab

> *The truth is the whole — yet this whole cannot be presented all at once but must be unfolded progressively by thought in its own autonomous movement and rhythm. It is this unfolding which constitutes the being and essence of science. The element of thought, in which science is and lives, is consequently fulfilled and made intelligible only through the movement of its becoming. (Cassirer 1957, p. xiv)*

Introduction to his third volume of *The Philosophy of Symbolic Forms*, Cassirer explains his debt to Hegel as shown by the subtitle of the book – *The Phenomenology of Knowledge*.

Friedman errs on mathematics

In pure mathematics, however, there is a very clear sense in which an earlier conceptual framework (such as classical Euclidean geometry) is always translatable into a later one (such as the Riemannian theory of manifolds). In the case of coordinating principles in mathematical physics, however, the situation is quite different. To move to a new set of coordinating principles in a new constitutive framework (given by the principle of equivalence, for example): what counted as coordinating principles in the old framework now hold only (and approximately) as empirical laws, and the old constitutive framework, for precisely this reason, cannot be recovered as such. By embedding the old constitutive framework within a new expanded space of possibilities it has, at the same time, entirely lost its constitutive (possibly defining) role. (2001, Dynamics of Reason, p. 99)

Friedman recovers

The difficulty arises when one accepts the sharp distinction, emphasized by Schlick, between an uninterpreted axiomatic system and intuitive perceptible experience, and one then views the constitutive principles in question (which, following Reichenbach, I called "coordinating principles" or "axioms of coordination") as characterizing an abstract function or mapping associating the former with the latter. This picture is deeply problematic, I now believe, in at least two important respects: it assumes an overly simplified "formalistic" account of modern abstract mathematics, and, even worse, it portrays such abstract mathematics as being directly attached to intuitive perceptible experience at one fell swoop. (2010, pp. 697-8)

Friedman recovers

> *Our problem, therefore, is not to characterize a purely abstract mapping between an uninterpreted formalism and sensory perceptions, but to understand the concrete historical process by which mathematical structures, physical theories of space, time, and motion, and mechanical constitutive principles organically evolve together so as to issue, successively, in increasingly sophisticated mathematical representations of experience. (2010, p. 698)*

Yes!

Work to do

After 18 years I have at least a sketch now. Now to fill in the details.

Thanks for listening.