## **Review of Carl Gillett's** *Reduction and Emergence in Science and Philosophy*

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Primarily an original work of metaphysics, Carl Gillett's *Reduction and Emergence in Science and Philosophy* proposes and develops a new philosophical framework for understanding the ideas of scientific reductionism and emergentism. The exposition aims to be refreshing, and its findings are claimed to be shocking. The book's bilateral goals, of reviving a stagnant philosophical dialectic while also assisting a resolution of the stalemate in the scientific debates, are to be achieved by bringing the philosophical understanding of scientific reductionism and emergentism in line with the ideas espoused by scientists. Indeed a welcome surprise is the book's focus on the mundane: it is not concerned with the peculiarities of quantum mechanics, nor those of phenomenal consciousness. The stated methodology of the work also offers relief from previous philosophical discussions---which, Gillett argues, have either suffered from their fixation upon purely semantic accounts, or from their taking the wrong approach to the relationship between science and metaphysics. The shocking conclusions reveal how "dead wrong" the previous philosophical understandings of reductionism and emergentism are, compared with the actual "live views" identified by Gillett.

The book opens with some grand quotes from Robert B. Laughlin and Alfred North Whitehead, which Gillett uses to colourfully paint the scientific debate over reductionism and emergentism as a "Battle of the Ages": a perspective that shades the work throughout. Gillett points out that scientists (including the condensed-matter physicist, and Nobel laureate, Laughlin) have been having exciting debates about Big Questions concerning such things as the nature of composition and aggregation, varieties of determination, and the character of fundamental laws---and they have been doing so very publicly, and with great significance. Meanwhile, Gillett laments, philosophers have shown comparatively little interest in these discussions, to their own detriment (and that of the discipline itself, given the jaundiced views of philosophy that many prominent scientists publicly express). The admirable motivation driving the work is thus to rectify this situation.

Gillett's three-step methodology in the book is to firstly describe the scientific concept or position of interest (these are, i. composition, ii. reductionism, and iii. emergentism), secondly, to construct a philosophical framework that facilitates an assessment of the arguments for the concept/position, and, thirdly, to engage in the prescriptive project of assessing these arguments. The intention is to do "metaphysics *of* science", rather than "metaphysics *for* science", where the latter involves unwittingly shoehorning scientific concepts into unsuitable philosophical frameworks developed for other purposes. Gillett argues that even the best previous philosophical accounts of reduction and emergence have suffered from being metaphysics *for* science---particularly those accounts, like Jaegwon Kim's, that mistakenly utilise "functionalist" machinery developed for other purposes (Gillett uses the scare quotes on "functionalism" purposefully, to avoid implying that the term is univocal).

The book is divided into four sections. Part 1 is Groundwork, where Gillett serves a swift overview of the state of the art of both the scientific and philosophical debates, before diving into metaphysics and detailing his novel account of scientific composition: the *joint role-filling* framework. The main negative conclusions here are reiterated from the introduction: that philosophical accounts are profoundly mistaken compared to the scientific ones, and that even the

scientific accounts have misjudged the debate, by failing to appreciate the strongest arguments for their opposing position, whether reductionism or emergentism. The main positive conclusion----which is also important and striking---is that scientific reductionists and emergentists both endorse "everyday reductionism", meaning that they are both engaged in the pursuit and use of *compositional explanations*: the explanation of higher-level, *composed* powers, properties, individuals and processes in terms of lower-level, *component* ones.

Part 2 of the book explores reductionism. It includes a demonstration of the problems with current philosophical accounts, and how these have caused philosophers to miss the real issues. The bulk of this section, though, develops Gillett's account of reductionism (and its key arguments), which is largely inspired by the writings of high-energy physicist, Steven Weinberg (another Nobel laureate). The crux of the position is that the only entities, or at least the only *determinative* entities, are components. The startling revelation here for philosophers is that scientific reductionists accept many things that, according to the philosophical accounts, they should not. These include, for instance, the claims that the higher-level sciences provide true explanations, that these can, in some cases, be the best explanations, and that many of these higher-level true explanations cannot be deduced from true explanations of the lower-level sciences, even in principle. (The full list is in Section 4.4.1, which should really be titled, "Reductionism: The Shocking Truth"). This discussion naturally prompts the thought that, "Well then, maybe we are all reductionists?", which Gillett handles in an exemplary fashion. Another highlight of this section is Gillett's outline of the reductionists' arguments for the justification of research-funding priority, which is likely not only to reinvigorate the debate, but to start some new ones.

Part 3 is on emergentism, which considers Weak emergence, Ontological emergence, and Strong emergence. Gillett argues that the only viable position is Strong emergence, and that this has been overlooked by philosophers, thanks to the work of an "Unholy Alliance" between philosophical reductionists and Anti-Physicalist philosophers. The key feature of Strong emergence is *machreatic determination*: a relation between composed and component entities through which composed entities determine the powers contributed by their components (by, e.g., constraining them). Composed entities are also, according to Strong emergence, productive at their own level. Gillett's account of Strong emergence is supposed to reflect and illuminate the emergentist views of scientists such as Laughlin.

Crucially, and most interestingly, is the difference between the views of Gillett's reductionists and emergentists regarding the nature of aggregation and collective behaviour. According to *Simple aggregation*, favoured by scientific reductionists, the laws describing a collection of (component) entities are the same whether there are only a few of these entities, forming a simple collective, or a large number of them, forming a complex collective. On the other hand, emergentists believe in *Conditioned aggregation*, according to which the laws describing a complex collective of component entities are not the same as those that describe a simple collective of the same entities.

Part 4 of the book is to bring it all together, and provide a road map for the Battle of the Ages (i.e., indicate the tasks of future research). Here, Gillett ascertains the live positions (spoiler alert: there are in fact *three* live positions, out of 2<sup>3</sup> possibilities), contrasts these with the false dichotomy offered by current philosophical debates, and articulates the kind of empirical evidence that would be necessary for establishing which of the actual live positions is correct. Gillett finally looks at several existing arguments in philosophy and accessible scientific literature, to see what has been established so far from the empirical evidence, and whether this supports any of his live views. But, he finds these all wanting---and thus, the Battle of the Ages rages on (although Gillett admits there is plausibly a victor in sight).

One of the reasons the extant arguments in the literature fail to establish any of the live views,

Gillett shows, is that these arguments do not engage the views of their strongest rivals. The main reason for their failure, though, according to Gillett, is that in most of these cases, it remains to be demonstrated that the empirical evidence satisfies a minimal Threshold necessary for evaluating whether any of the live views obtain. And yet Gillett says---strangely and frustratingly---that on the positive side, his work shows that in some cases we have, or are close to getting, the kind of empirical evidence that satisfies Threshold.

This brings me to my main criticism of the work: an almost complete lack of engagement with actual scientific examples. In spite of Gillett's repeated claim that *quantitative evidence* is required to *empirically* break the deadlock, there is not a single plot or table of data to be found in the book, nor even any detailed qualitative exploration of scientific case-studies. Gillett seems extremely reluctant to examine the empirical evidence himself, instead relying on the accounts of other philosophers, as well as popular- and other non-specialised writings of scientists. These non-scientific works are not reliable guides---though they express the opinions of scientists (obviously informed by their engagement with the relevant science), they do not necessarily demonstrate how the concepts of emergence and reduction are actually used in science, nor which concepts are appropriate for understanding emergence and reduction in science. Many of these expositions are (to avoid using another "p"-word) *publicity* designed to persuade the audience (and funding institutions) of the merits of the proponents' research in the face of competitors---thus, for instance, it is not so surprising to find that such accounts fail to properly engage the strongest arguments of their rivals.

This is not to say that the resulting framework built on these accounts is necessarily inaccurate, nor that it cannot be useful---far from it (although I suspect, as the quote of Weinberg on p. 159 hints, that engagement with actual scientific examples, especially physical ones, will reveal that inter-theory accounts of reduction and emergence involving, e.g., derivations, are not as useless as Gillett makes out). However, there is no justification for a book supposedly presenting the correct accounts of scientific reductionism and emergentism to keep arms-length from any real science. The net-effect of this distancing---both in the formulation, as well as the evaluation, of the framework---is that we are left without means of appraising its applicability. Thus, when Gillett finds no evidence for any of his "live positions" in the final section of the book, this comes across less like a call-to-arms, and more like a devastating blow for his account.

In spite of this, and my reservations about a project intended to formulate a single account of emergence and reduction applicable across all the sciences, I found the book very useful in providing new ways to think about these issues---for this, I wholeheartedly recommend it. In particular, the illumination of the common ground between the reductionists and emergentists is an especially commendable service to the metaphysics, and general philosophy of science literature. Gillett's work certainly prepares us to advance in the Battle of the Ages: it clears the field of misconceptions, draws up the battle lines, fashions the tools to be used, equips both sides with strong positions and defences, and shows what is required of each side if it is to be declared the winner. Given all this work, Gillett is justified in closing the book by saying that he does not want to be a hero by attempting to resolve the debate here himself---instead, Gillett calls for patience and a division of labour. I thus hope this work will be successful in refreshing the debates, and prompting collaboration between metaphysicians and philosophers of specific sciences, in evaluating the empirical evidence for the articulated positions.

(I must also mention my appreciation for the enormously useful Glossary at the end of the book).