NEW MECHANISM, REDUCTION AND EMERGENCE

in Physics, Chemistry and Biology

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ABSTRACTS

William Bechtel UC San Diego

Organisms need mechanisms; Mechanisms need organisms

As systems far from equilibrium with their environments, organisms must continually perform work to build, repair, and reproduce themselves. This work is performed by production mechanisms whose parts serve to constrain flows of free energy. But production mechanisms on their own won't suffice to maintain the organism. They require the other mechanisms of the organism to provide the resources they need for their activities as well as remove the waste products they produce. Moreover, production mechanisms must be controlled so that they perform their activities when and in the manner needed by the organism. Control depends upon a distinct type of mechanism, one that makes measurements of relevant variables inside and outside the organism and alters flexible constraints in other mechanisms, changing the work they perform. Control mechanisms provide a bridge between the work performed by individual production mechanisms and the ability of organisms to build, repair, and reproduce themselves.

Nancy Cartwright Durham University, UC San Diego, **John Pemberton** Durham University

Mechanistic v covering-law explanation: a false conflict

New mechanists often claim that the new form of explanation they offer - mechanistic explanation - is different from covering-law (CL) explanation. We argue to the contrary, that much mechanistic explanation is in fact CL. The explanatory work in mechanistic explanations is supposed to be done by providing a description of the structure and operation of the mechanism (i.e. its part, arrangement, interactions, activities, etc.). But unless this description includes an account of what the parts of the mechanism can be expected to do (together) in their salient context and why, then in general (except perhaps for cases of genuine emergence) there is no

explanation of why the mechanism behaves as it does. Typically in mechanistic explanations, the account of what the parts are expected to do in context uses already established principles, typically ceteris paribus laws. Once we identify these principles, these explanations can be seen as CL after all.

Brigitte Falkenburg Technische Universität Dortmund

Mechanistic explanations in physics: history, scope, and limitations

There is a striking methodological continuity of mechanistic explanations from early modern science to current scientific practice in physics and beyond. Mechanistic explanations in early modern science draw on the analogy between processes in nature and the ways in which machines work. Their common background is the traditional method of analysis and synthesis. This method has remained effective up to the present day: Analysis aims at tracking back from the phenomena to the principles; in particular, from wholes to parts, and from effects to causes. Vice versa, synthesis aims at explaining the phenomena from lower-level components and their interactions. Mechanistic explanations in the advanced sciences are atomistic in a generalized sense, having in common to explain higher-level phenomena in terms of lower-level components and causes or activities. In quantum physics, the lower-level components are subatomic particles and the causes are their quantum interactions. After the quantum revolution, the approach continues to work in terms of the sum rules which hold for conserved properties of the parts and the whole. My talk will focus on the successes and limitations of this approach, with a side glance at the recent generalization of mechanistic explanations in cognitive neuroscience.

Falkenburg, Brigitte: Mechanistic Explanations Generalized: How Far Can We Go? In: B. Falkenburg & G. Schiemann (eds.): Mechanistic Explanations in Physics and Beyond. Springer Nature Switzerland AG 2019, 65-90.

--- How Do Quasi-Particles Exist? In: B. Falkenburg & M. Morrison (eds.), Why More is Different. Philosophical Issues in Condensed Matter Physics and Complex Systems. Heidelberg: Springer 2015, 227-250.

--- Mythos Determinismus. Wieviel erklärt uns die Hirnforschung? Heidelberg: Springer 2012.
--- Particle Metaphysics. A Critical Account of Subatomic Reality. Heidelberg: Springer 2007.

Stuart Glennan Butler University

The many mechanisms of emergence

Emergence is often imagined to be opposed to mechanism. If some phenomenon admits of mechanistic explanation, it is thought to be ipso facto not emergent. But nothing is further from the case. When a system has emergent features, those features arise from and depend upon the activities of the system's parts, but are at the same time something more than the "sum of the parts." These emergent

phenomena are generated by the mechanisms, and mechanistic explanations show how such phenomena emerge. The last twenty five years of philosophical work on emergence have made it clear that there are a number of varieties of emergence — different ways of being dependent upon but more than the sum of the parts. If I am right that emergent phenomena are generated by mechanisms, then we can make use of an analysis of types of mechanisms and mechanistic organization, to bring some order to diversity of phenomena that we call emergent.

Robin Hendry Durham University

Mechanisms in chemistry

Mechanisms are the how of chemical reactions. Substances are individuated by their structures at the molecular scale, so a chemical reaction is just the transformation of reagent structures into product structures. Explaining a chemical reaction must therefore involve different hypotheses about how this might happen: proposing, investigating and sometimes eliminating different possible pathways. One distinctive aspect of mechanisms in chemistry is that they are broken down into a few basic kinds of step involving the breaking and making of bonds between atoms. This is necessary for chemical kinetics, the study of how fast reactions happen, and what affects it. It draws on G.N. Lewis' identification of the chemical bond as involving shared electrons, which from the 1920s allowed for the partial commensuration of physical and chemical entities, properties and relations. The breaking or making of a bond just is the transfer of electrons, so a chemical bond on one side of an equation might be balanced on the other side by the appearance of some excess charge. Understood as a process, a bond is understood to have become a pair of electrons. Since reaction mechanisms rely on identities, doesn't the establishment of a reaction mechanism essentially involve explaining away chemical phenomena, showing that they are no more than the movement of charges and masses? In one sense yes: these mechanisms seem to involve a conserved-quantity conception of causation. But in another sense no: the 'lower-level' entities can do what they do only when understood as part of larger or 'higher-level' entities, though in some cases this is hidden.

Alvaro Moreno IAS-Research

The ontology of research strategies in the life sciences

In this talk I will analyze how and why present-day research in the life sciences is based on two main strategies: mechanistic modelling and network modelling. Although the latter is really a new research strategy, the former has been widely used in biology since the origins of this science. And yet, surprisingly, philosophers of science have begun to study the epistemological and methodological aspects of the mechanistic

research strategy only in the last two decades, almost at the same time as its relations with the network-like strategies were beginning to be studied. Even worse is the fact that practically all these studies are focused on the epistemological and methodological dimensions of these research strategies, neglecting the ontological reasons that underlie their use. Here I will analyze this question, trying to grasp the ontological reasons that explain the use of these different research strategies, connecting this diversity of methodologies with the appearance of new, emergent levels of reality and causation.