Emergence, Causal Powers, and Aristotelianism in Metaphysics

Introduction

Some recent trends in metaphysics have a noticeable Aristotelian cast, as even philosophers who are not specialists in the history of philosophy have noticed; but, to a historian of philosophy, what is distinctive about this contemporary resurgence of Aristotelianism in metaphysics is its subtle difference from standard versions of Aristotelianism, such as that which can be found in the high middle ages, in the work of Aquinas, for example. In this paper, from among the many accounts that could be selected, I will present one representative contemporary account (that given by Timothy O'Connor and John Ross Churchill) and one representative medieval account (that given by Aquinas) of emergence and causal powers. Then I will explore the difference between these two positions and the implications of that difference for accounts of emergence. Finally, I will consider briefly one account of emergence weaker than that defended by O'Connor and Churchill, namely, that argued for by Mark Bedau; and I will show that, contrary to what one might initially suppose, it differs in substantial ways from Aquinas's account as well.

I am not so much interested in evaluating these differing accounts as I am in comparing them, in order to bring out what is distinctive about the medieval account. In her own recent attempt to explain the nature of emergence, Sandra Mitchell says, "there are both faulty assumptions and an impoverished conceptual framework that prevents the character of emergent properties referenced by science to be adequately represented in some forms of philosophical analysis."[1] My hope is that the medieval account will help with the problem Mitchell wants to call attention to.[2] In my view, the medieval account illuminates a position that has not yet been sufficiently explored in the contemporary discussion but that is worth taking seriously as regards emergence.

O'Connor and Churchill: Non-reductive physicalism and causal powers ontology

For their purposes, O'Connor and Churchill (O&C, for short) understand causal powers this way:

"[The causal] powers [of an object] are either identical to, or figure into the identity conditions of, certain of the object's properties…. Causally efficacious properties have the power to make the world unfold in ways it otherwise would not, and this is a fundamental feature about these properties upon which all else (counterfactuals true of them, regularities and patterns that encompass them, explanations that cite them) is derivative."[3]

On this way of thinking about causal powers,

"a single property may contribute to a very wide array of effects, depending on the context in which it is instanced…. The key is to understand a basic power or disposition not in terms of this or that salient manifestation, but rather in terms of a unitary causal

influence, something that is constant across circumstances while its manifestations will vary."[4]

O&C go on to ask whether it is possible to "make out a non-reductive physicalist view on which mental states are causally efficacious in this sense…"[5]

Roughly summarized, their careful argument in support of the claim that it is *not* begins this way.

For non-reductive physicalists, mental properties supervene on physical properties and are realized by them. The event of a person's having a mental property is somehow constituted by "various physical particulars having certain physical properties and standing in certain physical relations."[6] In addition, there is causal closure of the physical: "nothing non-physical is *required* in order to causally account for the occurrence of any physical event."[7] This position, O&C argue, cannot be made compatible with the claim that "there is a causally efficacious mental event… that is the instancing of a particular mental property," that "impinges the realm of physical event".[8]

So, for example, let the mental event in question be Max's having a glimpse of his daughter across a crowded room. In this event, Max has the mental property of seeing his daughter. For non-reductive physicalists, this mental property of Max's is realized by physical properties of Max's, presumably, neural states of his brain; and the event of Max's having this mental property is constituted by the activity of various neurons in his brain having certain physical properties and certain physical interactions with each other. The general claim that there is causal closure at the level of the physical holds here also; nothing non-physical – no mental stuff or soul stuff – is required to causally account for the physical event in Max's brain correlated with his having sight of his daughter.

On the position of O&C, a non-reductive physicalist who accepts these claims about Max's seeing his daughter cannot also hold that Max's mental property of seeing his daughter is itself causally efficacious in a way that "impinges the physical realm". For example, on O&C's view, it is not compatible with non-reductive physicalism to hold that seeing his daughter causes Max to smile at his daughter, that something about the mental property of Max's seeing causes the physical action of smiling. The causal history of anything in the physical realm, such as Max's smiling at his daughter, cannot include in its history Max's having the mental property of seeing his daughter. Rather, the non-reductive physicalist is stuck with supposing that Max's smiling at his daughter is caused only by the physical properties and the causal activity of the neurons in his brain (and the subsequent events caused by the causal activity of those neurons). For O&C, the non-reductive physicalist has to accept the conclusion that Max's mental property of seeing his daughter is causally inert.

In taking this stand, O&C are of course siding with Jaegwon Kim's negative evaluation of non-reductive physicalism, although, unlike Kim, they support this evaluation by focusing on the implications of a causal powers metaphysics.

Put in terms of Max's seeing his daughter, the short version of their form of Kim's argument goes this way. If the mental event of Max's having the mental property of seeing his daughter is causally efficacious, in the sense of causation at issue in a causal powers metaphysics, then it either (a) directly produces the subsequent mental event expressed in his smiling at his daughter, or (b) it directly produces the wholly physical

event of the facial movement that is a smile. But bringing about a mental event involves bringing about the neural correlate which realizes that mental event. And so not (a). On the other hand, since, for the non-reductive physicalist, there is causal closure of the physical, (b) would require that Max's smiling be overdetermined, by the causal activity of the mental event as well as by the causal activity of the neural correlate of the mental event. But systematic causal overdetermination seems bizarre if we accept a causal powers account of causation. Therefore, not (b). And so it follows that the mental event of Max's having the mental property of seeing his daughter is not causally efficacious.

O&C characterize this argument this way:

"The argument.., like its earlier relatives, seeks a reductionist or eliminativist conclusion by way of arguing for the *exclusion* of irreducibly mental causation. Yet it does this by explicitly involving the thesis of causal powers realistically construed. … The commitments that drive [this argument] … are tenets of the causal powers metaphysics, on the one hand, and non-reductive physicalism, on the other. If we wish to preserve a realist and non-reductive view of the mind and its causal influence, we must reject one or another tenet of these two packages."[9]

O&C themselves want to reject two theses of non-reductive physicalism:

(1) Mental properties are realized by physical properties [*realization thesis]*
and
(2) For every physical event, its objective chance of occurring is fully fixed by physical events. [*causal completeness of physics thesis]*[10]

On their understanding of ontologically emergent properties, emergent properties are not realized in any structural property of the whole and so are basic, and they constitute causal powers of the whole which are different from the causal powers determined by the microphysical parts of the whole. In consequence, although the laws of particle physics apply to the whole, those laws need to be supplemented "to account for the interaction of large-scale properties with the properties of small-scale systems."[11]

There is a great deal more to the version of Kim's argument as formulated by O&C and their characterization of ontological emergence, but this is enough for my purposes. O&C remark that concepts of emergence have a long history, tracing all the way back to "Aristotle's notion of irreducible substantial forms".[12] In what follows, I will briefly summarize Aquinas's Aristotelian account of substantial forms, for the sake of considering the way in which it is and is not like the account of emergent properties O&C give.

Aquinas: matter-form composites and systems-level properties

Aquinas thinks that a macro-level material thing is matter organized or configured in some way, where the organization or configuration is dynamic rather than static. That is, the organization of the matter includes dynamic causal relations among the material components of the thing as well as such static features as shape and spatial location. This dynamic configuration or organization is what Aquinas calls 'form'.[13] For Aquinas,

function follows form. The causal power of a thing is given by its form, where Aquinas's notion of causal power is at least in the same family as that of O&C.

Form counts in Aquinas's metaphysics; and, from his point of view, the metaphysical parts of a material thing include form as well as matter. Aquinas's account is thus anti-reductionistic.[14] It is not true on his account that a material whole is nothing but its material parts or is identical to its material components.[15]

So, for example, expounding a view of Aristotle's, Aquinas says,

"sometimes a composite has its species from something one, which is either a form… or a composition.. or an organization…. In such cases, it must be the case that a composite is not those things out of which it is composed, as a syllable is not [its] letters. Just as this syllable 'BA' is not identical to these two letters 'B' and 'A', so neither is flesh identical to fire and earth [the elements of which it is composed]. And [Aristotle] proves this in the following way. If those things out of which the composition is formed are dissociated or separated from one another, …the whole does not remain after the dissolution, just as flesh does not remain once [its] elements are separated [from each other], and the syllable does not remain once its letters are separated [from each other]. But … the letters remain after the dissolution of the syllable, and fire and earth remain after the dissolution of the flesh. Therefore, a syllable is something more than [its] letters … and in this way, similarly, flesh also is not only fire and earth (or heat and cold, by virtue of which the elements are commingled) but rather there is something else by means of which flesh is flesh."[16]

Aquinas takes it that the forms of material objects can be divided into two sorts, substantial forms and accidental forms. One way of distinguishing the two is by what they configure. A substantial form of a material thing configures prime matter. Prime matter is matter without any form at all, "materiality" (as it were) apart from configuration. When it is a component in a matter-form composite,[17] prime matter is the component of the configured composite which makes it the case that the configured thing is extended in three dimensions and occupies a particular place at a particular time.[18] By contrast, an accidental form configures something which is an actually existing complete thing, a matter-form composite.[19] For my purposes here, we can leave accidental forms to one side and consider just substantial forms.

No material thing has more than one substantial form, on Aquinas's account.[20] A composite that consists of prime matter configured by a substantial form could not itself be one component among others of a larger whole configured by yet another substantial form. That is because if a substantial form were to configure what is already configured by a substantial form, then it would be configuring a matter-form composite, not prime matter.

Elements -- earth, air, fire, and water -- are substances, and so is a material made of one element.[21] Furthermore, different elements can combine to form a compound which is itself a substance.[22] But the constituent things that existed earlier cease to exist as the things that they were when they are woven together by a substantial form.[23] Instead, a new substance is generated. So, for example, earth and fire can combine to form flesh. But they can do so only in case the substantial form of each combining element is lost in the composite[24] and is replaced by the one substantial form of the whole

compound.[25] On Aquinas's view, the parts of a whole are actual (rather than potential) things existing in their own right, as independent substances, only when the composite of which they are parts is decomposed and the substantial form of the whole is lost.[26]

On Aquinas's view, the substantial form of a whole confers causal powers on the whole. The operations and functions of a substance derive from the substantial form configuring the whole.[27] Furthermore, as we increase complexity in systems, even systems of inanimate things, properties arise that are properties of the whole system but not properties of the material parts of the system. For example, he says,

"the nobler a form is, the more it dominates corporeal matter and the less it is submerged in it and the more it exceeds it in its operation or power. And so we see that the form of a mixed body has a certain operation which is not caused from the qualities of the elements [of which that body is composed]."[28]

And elsewhere he says,

"to the extent to which a form is more perfect, to that extent it surpasses [its] corporeal matter…. For the form of an element does not have any operation except that which arises by means of the active and passive qualities which are the dispositions of the corporeal matter [it informs]. But the form of a mineral body has an operation that exceeds the active and passive qualities… as, for example, that a magnet attracts iron…."[29]

Aquinas's systems-level properties and the emergent properties of O&C

This, then, is Aquinas's metaphysics of material objects, roughly put. On Aquinas's account of form, even inanimate material objects can have systems-level properties, and these systems-level properties bring with them causal powers that belong to the whole but not to its parts. Are these systems-level properties emergent properties in the sense of 'emergent property' O&C employ?

On the face of it, it seems at first glance as if the answer ought to be 'yes'.

Top-down causation has typically been taken as one hallmark of emergent properties.[30] As O&C explain, non-reductive physicalists share with physicalists the views that higher-level properties are realized in lower-level properties and that there is causal closure of the physical. And, as O&C argue, these views combined with a causal powers metaphysics rule out top-down causation. If there is genuine top-down causation, on the view of O&C, then the properties involved are emergent properties.

But Aquinas is clearly committed to the existence of top-down causation, even for inanimate objects. From his point of view, a mineral such as a magnet has a property and a causal power (to attract iron) conferred on it only by the form of the whole. None of the components of the magnet taken singillatim and apart from the configuration of the whole have this property or the causal power of this whole. On Aquinas's metaphysics, where the microphysical bits of iron move is determined by a causal power vested in the magnet as a whole. This does seem to be a case of top-down causation.

On the other hand, however, it is not at all clear that the systems-level features Aquinas accepts meet the conditions O&C give for emergent properties. Are the systems-

level properties Aquinas accepts even for inanimate objects realized in lower-level properties? Or are they ontologically basic, as O&C claim emergent properties are? Is there causal closure at the level of the physical on Aquinas's metaphysics of material objects? Or are the causal powers of the whole not determined at the micro-level by the activity of the micro-level components of the whole?

It will help in dealing with these questions to have a concrete and detailed example in front of us, one which is much less contentious than the case O&C consider, of mental properties.

So consider water, which has been an example in discussions of emergence for a long time. In 19th-century treatments of emergence, the readily observable properties of water were sometimes taken as emergent "because there were no explanations of them in terms of the constituent molecules of oxygen and hydrogen…."[31] The view of the properties of water as emergent was dismissed by twentieth-century philosophers and scientists, because it seemed to them that

"twentieth-century science succeeded in providing … successful reductive explanations [of such putative emergent properties.] … [T]he properties of chemical compounds, like water,… have arguably been explained in terms of the properties of their constituent parts."[32]

But, most recently, water has again come to be of interest to scientists studying complexity in systems. In this new work, the systems-level features of the whole such as a water molecule are indeed realized in the properties of the parts.[33] Nonetheless, the dynamic, complex interaction among the micro-level components "generates properties that none of the individual micro-level components possess, and these higher-order properties in turn can have causal efficacy…."[34] Autonomous, irreducible top-down causation is therefore possible.

As I will try to show in what follows, reflection on the chemistry of water in fact illuminates Aquinas's metaphysics of substantial forms, and it in turn provides a helpful philosophical foil for thinking about the general characterization of emergence. So, for my purposes, it is profitable to return to the example of water, although it is instructive to think in terms of just one water molecule and its properties.

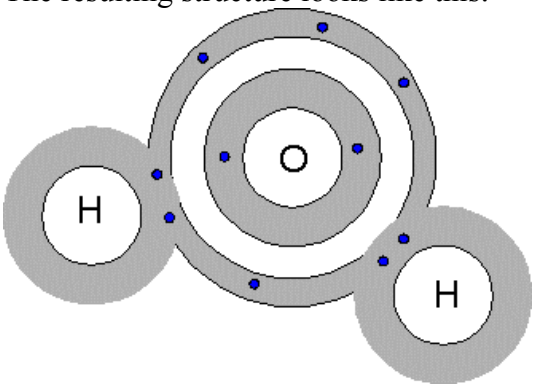
The case of water

It is hard to overestimate the importance of water for life, and much of the role it plays can be explained by what chemists call its 'anomalous properties'. These include its strong surface tension, its hydrophobic effect (that is, its ability to exclude non-polar compounds), and its ability to act as a solvent for other substances. Hydrogen bonds are responsible for these anomalous properties of water. And the structure of a water molecule makes hydrogen bonds possible.

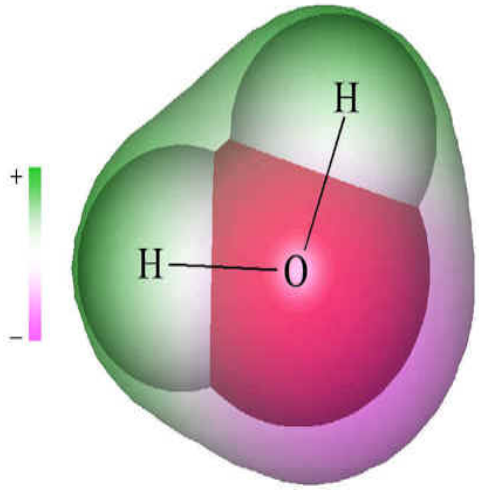
An individual molecule of water consists of one oxygen atom and two hydrogen atoms. Each hydrogen nucleus is bound to the oxygen atom by a sharing of electrons that alters the dynamic structure of all three atoms. In isolation, a hydrogen atom has one electron; and a oxygen atom has eight electrons, two in the innermost shell and six in the outer shell. When two hydrogen atoms combine with one oxygen atom to form a water

molecule, the organization each atom had before their bonding together is replaced by the new organization of the water molecule. In a water molecule, the electron of each hydrogen atom pairs with one electron of the oxygen atom to form a shared electron pair. Each shared pair of electrons constitutes a covalent chemical bond.

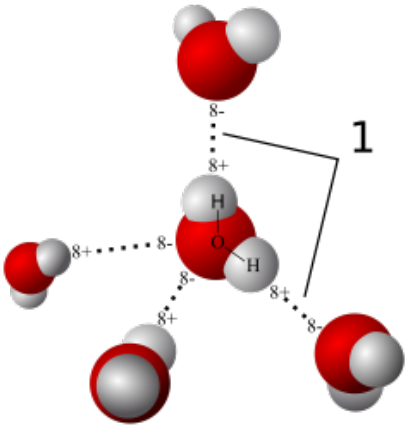
The resulting structure looks like this:



The two covalent bonds in a water molecule are polar and give the molecule its geometry. That is, the non-bonding electrons of oxygen remain closer to the oxygen atom than the shared electrons do, and they exert a stronger repulsive force against the shared electrons. As a result, the two hydrogen atoms are pushed closer together. Consequently, the molecule has a peculiar characteristic: the charge of the electrically neutral water molecule is not distributed uniformly though the molecule. Unlike either a hydrogen or an oxygen atom taken in isolation, the water molecule, which is composed of hydrogen and oxygen, is unevenly charged. The polar covalent bonds shared between each of the hydrogen atoms and the oxygen atom effect a charge separation in the molecule. One end of the water molecule (the oxygen side) has a partial negative charge, and the other end (the hydrogen side) has a partial positive side, as in the figure below:[35]



Because of this charge separation in the molecule, the partial positive charge near the hydrogen atoms in the molecule can attract the partial negative charge in the oxygen atom of another water molecule to form a weak bond, the hydrogen bond, as in the figure below, which shows hydrogen bonding among different water molecules. [36]



So the systems-level property of the water molecule of being unevenly charged confers on the molecule as a whole the causal power that enables it to form hydrogen bonds. And the power to form hydrogen bonds is responsible for the anomalous properties of water, which result in water's playing the part it does in life on earth.

The role Aquinas assigns to substantial forms in his metaphysics of material objects is well illustrated by this brief and rudimentary sketch of the chemistry of the water molecule.

As Aquinas sees the metaphysics of a material object, the substantial form of the water molecule informs prime matter; it doesn't configure an oxygen atom and two hydrogen atoms. That is, the configuration of a water molecule isn't just a combination of the configurations of the hydrogen atoms added to the configuration of an oxygen atom. In order to get a water molecule, the configuration that the oxygen atom had in isolation and the configuration that each hydrogen atom had in isolation, before they were conjoined into a water molecule, have to be replaced by a new configuration that configures all the matter of the molecule. In the whole that is the water molecule, neither the oxygen nor the hydrogen atoms retain the configurations they had earlier.

By contrast, if one inserts a metal axe head into a wooden axe handle, in the new whole that is the axe the metal remains the metal it was before it was put into the axe, and the wood remains the wood it was before as well. The difference between a substance and an artifact[37] for Aquinas is precisely that in an artifact the components retain the configuration they had in isolation. Bread is a substance for Aquinas, rather than an artifact, because the configuration of the components of bread do not remain, as the things they were, when they are mixed together and baked into bread.

Furthermore, for a water molecule as for other substances, on Aquinas's view function follows form. The whole has systems-level properties that confer causal powers on the whole. And the causal power is a result of the configuration or organization of the whole, rather than a sum of the properties and causal powers of the components. The causal power of an axe to depress one plate of a balancing scale to a certain degree is a simple sum of the causal powers of the components of the axe to do the same. The weight

of the whole is nothing more than the sum of the weights of the parts. The causal power of a water molecule to form a hydrogen bond is different. It is not a simple sum of the causal powers of the atoms that are the components of the molecule. By themselves, even with their causal powers added together, those atoms could not form hydrogen bonds.

The distinction among kinds of systems-level properties at issue here was recognized by the early British proponents of emergentism, including John Stuart Mill. In fact, George Henry Lewes seems to have coined the term 'emergent' for the sake of making this distinction. These philosophers recognized that some causal "effects are the sum of what would have been the effects of each of their causes had those causes acted alone."[38] Lewes calls such effects 'resultant effects'. Mill's example of a cause producing only a resultant effect has to do with motion. He says,

"If a body is propelled in two directions by two forces, one tending to drive it to the north and the other to the east, it is caused to move in a given time exactly as far in both directions as the two forces would separately have carried it."[39]

By contrast, for the early British emergentists, emergent causes are those that are not resultant.

The favored examples of emergent causes among these philosophers come from chemistry. Describing Mill's examples of emergent causes and effects, Brian McLaughlin picks out the chemical interaction in which methane and oxygen combine to form carbon dioxide and water. He says, "The product of this chemical process is not, in any sense, the sum of the effects of each reactant."[40] The effects of the causal power of the water molecule to form hydrogen bonds are also not resultant but emergent, in this sense. The separate causal actions of hydrogen and oxygen could not form hydrogen bonds.

For the British emergentists as for Aquinas, the difference between mechanics and chemistry marks a critical boundary. For Aquinas, it marks the difference between artifacts and substances as well. Composite things formed through chemistry or higher level processes are substances and have substantial forms. Consequently, some of the systems-level properties of these things are emergent rather than resultant, in the sense the British emergentists were trying to capture.

Emergent properties

With the help of the illustration of the water molecule, we can profitably return to the question I raised above: on Aquinas's metaphysics of material objects, are the systems-level properties of a whole such as a water molecule emergent properties in the sense at issue for O&C? On Aquinas's account of substantial form, is the molecule's causal power to form hydrogen bonds emergent in this sense?

Suppose that we separate this question into three subsidiary questions, to reflect the understanding of 'emergent property' O&C are using:

(1) is the water molecule's causal power to form hydrogen bonds realized in lower-level properties?

(2) given the water molecule's causal power to form hydrogen bonds, is there causal closure at the level of the physical?

(3) when the water molecule exercises its causal power to form hydrogen bonds, is the causation top-down?

Because in the case of the water molecule, we are not dealing with anything as complicated or controverted as consciousness, it seems that these questions would be easy to answer. And yet the answers to the questions above are nonetheless remarkably hard to come by.

Consider the first question. The water molecule's causal power to form hydrogen bonds is a power vested in the molecule as a whole, in consequence of the configuration the molecule as a whole has, as Aquinas sees things. The lower-level properties of the atoms of the molecule do not have this causal power on their own, taken in isolation, outside the molecule. So, it seems that the answer to the first question ought to be 'no'. On the other hand, of course, that causal power is in some sense a function of the properties of the electrons and nuclei of the component atoms of the molecule. The systems-level property is in some sense a function of the lower-level properties, as I explained just above. Does this fact alone mean that the first question ought to be answered 'yes'? What exactly is it for a systems-level property to be realized in lower-level properties?

The confusion arises, in my view, because there are two ways of thinking of the lower-level components and their properties. We can think of the lower-level properties of the components of a whole either as (i) the properties of the components when those components are taken singillatim or individually, *or* (ii) the properties the components have when they are configured by the substantial form into the higher-level whole.

In sense (i), it is true to say, as biochemists do, that a protein's higher-level property of having a certain folded shape is not simply a function of the lower-level biochemical properties of the components of the protein, including their causal interactions, because these might be insufficient to give the protein its folded shape; it might be the case that the protein achieves that folded shape only with the help of enzymes, for example.

It would not be true to say this in sense (ii), however. If we understand lower-level properties in sense (ii), then we smuggle the configuration, or the form, of the whole, into the description of the lower-level properties. In sense (ii), it would be surprising, not to say highly mysterious (as some opponents of emergence suppose), if there were systems-level properties of a whole such as a molecule that were not realized in the lower-level properties of the components of the system. Certainly, in sense (ii), a systems-level property is a function of the lower-level properties of the components of the whole, since the systems-level properties of the whole result from the configuration of the whole together with the configured components.

On the Thomistic way of thinking about the issue, then, the causal power of the water molecule to form hydrogen bonds is not realized in the lower-level properties of the components of the molecule taken in isolation; but, add in the substantial form configuring the whole, and then it is certainly true that the systems-level property is realized in those lower-level properties *as they are organized into the whole.* It is the organization of the whole, as Aquinas's metaphysics has it, that gives the whole the systems-level property it has. But what is organized in the whole are the micro-level components of that whole.

The second question about causal closure is equally confusing but admits of the same solution. On Aquinas's metaphysics of material objects, with respect to a water molecule, is there causal closure of the physical? Here too the appropriate answer is "It depends." We can think of the physical in two ways. With respect to a water molecule, we can think of the physical as (i) just the fundamental bits postulated by particle physics and the causal interactions among those bits, when the bits are taken in isolation. Or we can think of the physical as encompassing (ii) the whole molecule, which is certainly and entirely a material object, with its configuration included.

As regards a water molecule, there is undoubtedly causal closure of the physical in sense (ii). That is, there is no mental stuff or panentheistic stuff or anything else non-physical which is responsible for the causal power of a water molecule to form a hydrogen bond. But there is not causal closure in sense (i), at the level of the *micro-physical.* Taken in isolation, outside the configuration of the whole, the causal powers and activities of the elementary particles cannot by themselves account for the effect of the molecule's forming a hydrogen bond. The congiguration of the whole is what gives the molecule its causal power to form hydrogen bonds. Insofar as this causal power is a systems-level feature, causation involving the water molecule is not closed at the level of the elementary particles composing the molecule.

Clearly, this result gives us the answer to the third question. On Aquinas's metaphysics of material objects, even though there is causal closure of the physical in sense (ii), there is nonetheless top-down causation, of a kind that is not resultant. Where an elementary particle in the nucleus of a hydrogen atom moves might be an effect of causal interactions among it and other elementary particles. But it is also true that it might not be. Instead, it might be an emergent effect of the exercise of the causal power of the molecule as a whole. In that case, the particle will be caused to move where it does because of the motion of the whole molecule, which is brought about by the molecule's emergent causal power to form hydrogen bonds, and not by the causal power of the particles composing the molecule.

So the systems-level property of the water molecule that is or confers the causal power to form hydrogen bonds fits the O&C conditions for an emergent property in one sense and not in another. The molecule's systems-level property is realized in the lower-level properties of its components in one sense, but not in another. For the molecule, there is causal closure at the level of the physical, in the sense that everything about the molecule is physical, although there is not causal closure at the level of the elementary particles of the molecule. As regards material objects, then, Aquinas's account is a physicalism, but a non-reductive physicalism. There is top-down causation, and yet this systems-level feature is not ontologically basic. It is a function of the organization or substantial form of the molecule as a whole, together with the matter configured by the substantial form.

The analysis of a whole material object such as a water molecule which is given by Aquinas's metaphysics of material objects is part of a causal powers metaphysics. But there is a sense in which Aquinas's account also counts as a non-reductive physicalism. At least, there is a sense of the conditions for non-reductive physicalism on which Aquinas's account satisfies those conditions. In addition, there is also a sense of the conditions for emergent properties O&C give which is satisfied by the systems-level properties of something such as a water molecule.

What explains the combination of similarities and differences between Aquinas's account and that of O&C is the fact that, in Aquinas's metaphysics of material objects, a material object such as a water molecule is materiality configured by a substantial form. For Aquinas, the ontology of a chemical or biological system includes a form or configuration as well as the lower-level material components of the whole. Some of the properties of the system are a consequence of the form of the system as a whole, and that form also confers causal powers on the whole. Nonetheless, it is still not true that a systems-level causal power is basic, in the sense O&C have in mind. In the water molecule, the causal power to form hydrogen bonds is realized in lower-level properties of the components of the molecule. And yet there is top-down causation; it can be the case that the particles of the water molecule are caused to do what they do by the causal action of the molecule as a whole.

Weak emergence

There are, of course, other accounts of emergence besides that offered by O&C, and some of them are weaker than that argued for by O&C. Someone might suppose that Aquinas's account is like these, just a weaker notion of the strong sort of emergence at issue for O&C. In a recent paper on emergence,[41] Mark Bedau explicates such a weaker notion of emergence. Weak emergence, as Bedau characterizes it, might be thought to capture the Aristotelian-Thomistic relation as I have presented it here. But, in fact, Bedau's weak emergence differs from the Thomistic relation in significant ways, too. Sketching the difference between the two relations is the last part of my attempt to highlight the distinctive character of the Thomistic notion of emergence.

Bedau describes weak emergence this way:

"Weak emergence refers to the aggregate global behavior of certain systems. The system's global behavior derives just from the operation of micro-level processes, but the micro-level interactions are interwoven in such a complicated network that the global behavior has no simple explanation. The central idea behind weak emergence is that emergent causal powers can be derived from the micro-level information but only in a certain complex way…. In contrast with strong emergence, weak emergent causal powers can be explained from the causal powers of micro-level components… The strengths and the weaknesses of weak emergence are both due to the fact that weak emergent phenomena can be derived from full knowledge of the micro facts."[42]

And he goes on to say,

"weak emergent phenomena are *ontologically* dependent on and reducible to micro phenomena; their existence consists in nothing more than the coordinated existence of certain micro phenomena. Furthermore, weakly emergent causal powers can be explained by means of the composition of context-dependent micro causal powers. … [But] they have *explanatory* autonomy and irreducibility, due to the complex way in which the iteration and aggregation of context-dependent micro interactions generate the macro phenomena. … The scope of weak emergence is limited to what has a micro-level derivation (of a certain complex sort). So those who hope that emergence will account for

irreducible phenomena will find weak emergence unsatisfying. … [On weak emergence,] macro entities are ontologically dependent on and reducible to micro entities. … [The state of a macro entity] consists simply in the aggregation of the states of all its component micro entities and their spatial relations…. [M]acro causal powers are wholly constituted and determined by micro causal powers."[43]

So, on this understanding of weak emergence, a macro-level property is ontologically dependent on and reducible to micro-level properties; *but* it is independent and irreducible as regards explanation because of the complexity of the micro-level phenomena. On this view, the causal power of a water molecule is dependent on and reducible to the properties of the elementary particles that make up the molecule, but it is nonetheless explanatorily independent and explanatorily irreducible because of the complexity of the micro-level facts. Because the irreducibility is limited to the explanatory, because there is reducibility as regards ontology, any top-down causation is only the aggregate of the micro-level causal activity of the components of the whole.

In fact, Bedau sees this implication as a strength of his notion of weak emergence, because, on his account, there is still causal closure at the level of the microphysical even in the case of downwards causation. The ocean wave causes the movement of molecules of water, but the causal activity of the wave is itself just the aggregate of the causal behavior of the molecules of water composing the wave. And so Bedau says, "weak emergence avoids the problems of downward causation."[44]

Weak emergence is therefore like Aquinas's account in making the systems-level property a function of the micro-level properties of the thing. Unlike the emergent properties in the account of O&C, for Bedau as for Aquinas, emergent properties are not ontologically basic. But, unlike the systems-level properties in Aquinas's account, Bedau's account locates the autonomy and the irreducibility of emergent properties only in the explanatory realm. Because of the complexity of the micro-level phenomena, the macro-level emergent property is explanatorily irreducible to the micro-level facts. The macro-level properties can be derived from the micro-level properties only by means of a step-wise simulation that recapitulates the construction of the macro-level from the micro-level. For Bedau but not for Aquinas, there is causal closure at the level of the microphysical in both the senses given above.

Bedau holds that there are two hallmarks of the emergent: "(1) emergent phenomena are *dependent* on underlying processes, [and] (2) emergent phenomena are *autonomous* from underlying processes."[45] As he says, these two hallmarks are at least in tension with each other. Bedau's weak emergence relation resolves the tension by assigning the first hallmark to the ontological realm and the second hallmark to the realm of the explanatory. By contrast, Aquinas assigns both to the realm of the ontological. But because for him form or configuration has to be part of the ontological story, the tension between the two hallmarks is resolved by reference to form. The first hallmark is a matter of the properties and causal powers of the micro-level constituents of a macro-level whole. The second hallmark has its source in the form of the whole, which configures the parts and allows autonomous and irreducible causal powers to emerge.

On weak emergence, any top-down causation is compatible with complete causal closure at the level of elementary particles, because, ontologically considered, the macro-level properties are just an aggregate of the micro-level properties. On Aquinas's account,

at least some top-down causation is incompatible with causal closure at the level of elementary particles (in sense (i) above), because the form that configures the micro-level parts into the macro-level whole functions to give the macro-level whole systems-level causal powers that are not reducible to the aggregate of the causal powers of the micro-level parts.

So, Bedau's notion of weak emergence is distinct from Aquinas's account, too.

The moral of the story

In this paper, I have tried to show what Aquinas's account of an emergent property and a systems-level causal power is and how it differs from a representative account of emergent properties such as that given by O&C, or even from a weaker notion of emergence, such as that argued for by Bedau. But I have not argued for Aquinas's account. It seems to me that the argument O&C make against non-reductive physicalism does not apply to Aquinas's account, but I have not argued for this claim either. What I have tried to show is just the distinctive character of Aquinas's account and the ambiguity of some of the conditions and claims on which the argument against non-reductive physicalism given by O&C rests.

Of course, O&C are focused on the mental properties of a human being and the causal powers that are or are constituted by those properties; and I have concentrated on something vastly less complex and controverted, the properties and causal powers of a water molecule. But Aquinas would certainly apply his account to mental properties and their causal powers as well. The Thomistic view as I have illustrated it in the case of a water molecule is also the Thomistic view of the mental properties of a person and their causal powers.

For Aquinas, a human being is a material object too; the matter of a human being is configured by the substantial form of a human being. It is true that for Aquinas this substantial form, which is the soul, can exist apart from matter and does so after the death of the body. But nonetheless, before death, the substantial form of a human being is the form of the matter of that human being. Aquinas specifically identifies the intellect itself, which is the part of the substantial form that (on his view) survives death, with the form of the body.[46]

Consequently, the Thomistic view that I have illustrated with the systems-level properties of a water molecule apply also to the systems-level properties, such as mental properties, of a human being. The systems-level properties are not ontologically basic; they are realized in the lower-level properties of the components of the system. Nonetheless, they emerge at the level of the whole system, and they are or confer causal power on the system as a whole. So, for example, Aquinas says,

"We *can* say that the soul understands in the same way that we can say that the eye sees; but it would be more appropriate to say that *a human being* understands *by means* of the soul."[47]

The Thomistic account of the metaphysics of material objects applies also to a human being's mental properties and the causal powers that these properties are or constitute.

It is the highlighting of the role of the form or configuration of a whole that gives Aquinas's metaphysics of material objects its distinctive character. In my view, the emphasis on form is a position worth taking seriously. It remains an open question whether or not it is vulnerable to some variant of the argument O&C give against the combination of a causal powers metaphysics with non-reductive physicalism. Nonetheless, it does show the way in which some of the claims of that argument need to be disambiguated in order to move the discussion forward.[48]

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[1] Sandra D. Mitchell, *Unsimple Truths. Science, Complexity, and Policy,* (Chicago, Ill.: University of Chicago Press, 2009), p.26.

[2] In a recent paper that attempts to build a philosophical concept of emergence from a consideration of scientific developments, Carl Gillett outlines a kind of emergence that has at least some overlap with the Thomistic account at issue here, although conversation with Gillett has left me with the impression that he would not be happy with all the features of the Thomistic account. See Carl Gillett, "On the Implications of Scientific Composition and Completeness: Or, The Troubles, and *Troubles,* of Non-Reductive Physicalism", in *Emergence in Science and Philosophy,* ed. Antonella Corradini and Timothy O'Connor, (New York and London: Routledge, 2010), pp.25-45.

[3] Timothy O'Connor and John Ross Churchill, "Is Non-reductive Physicalism Viable Within a Causal Powers Metaphysics", in *Emergence in Mind,* ed. Cynthia MacDonald and Graham MacDonald, (Oxford: Oxford University Press, 2010), p.44.

[4] O&C 2008, p.45.

[5] O&C 2008, p. 45.

[6] O&C 2008, p.46.

[7] O&C 2008, p.47.

[8] O&C 2008, cf. p.47.

[9] O&C 2008, p.49.

[10] O&C 2008, p.56.

[11] O&C 2008, p.56.

[12] O&C 2008, P.56, ftn.16.

[13] There is a helpful discussion of Aristotle's concept of form in Marjorie Grene's "Aristotle and Modern Biology," *Journal of the History of Ideas* 33 (1972) 395-424. She argues that Aristotle's concept of form is very like the contemporary biological concepts of organization or information. (I am grateful to Shawn Floyd for calling Grene's article to my attention.) For a helpful attempt to explicate a notion at least closely related to the Aristotelian concept of form which is at issue in this part of Aquinas's metaphysics, see Kit Fine, "Things and Their Parts", in *Midwest Studies in Philosophy* 23 (1999) 61-74. Fine does an admirable job of discussing this notion in the context of contemporary mereology and showing what the Aristotelian notion can do that cannot be done equally well with mereological schemes. He says, "I should like to suggest that we take the bold step of recognizing a new kind of whole. Given objects *a, b, c, ...* and given a relation *R* that may hold or fail to hold of those objects at any given time, we suppose that there is a new object -- what one may call 'the objects *a, b, c, ...* in the relation *R.'* " (p.65) He also makes a helpful distinction between what he calls 'temporary' and 'timeless' parts. This distinction has some resemblance to the distinction I make later between integral and metaphysical parts (though perhaps Fine himself might think the resemblance fairly attenuated).

[14] For a helpful discussion of the general problem of reductionism relevant to the issues considered here, see Alan Garfinkel, "Reductionism", in *The Philosophy of Science*, ed. Richard Boyd, Philip Gasper, and J.D.Trout, (Cambridge, Mass.: MIT Press, 1993), pp.443-459. Discussing reductionism as it concerns explanation, Garfinkel himself recognizes the aptness of the historical distinction between matter and form for his argument against reductionism. He says, "the independence of levels of explanation ... can be found in Aristotle's remark that in explanation it is the form and not the matter that counts." (p.149). See also Philip Kitcher, "1953 and All That: A Tale of Two Sciences", in *The Philosophy of Science*, op.cit., pp.553-570.

[15] For an interesting contemporary argument against the reduction of wholes to their parts, see Peter van Inwagen, "Composition as Identity", in James Tomberlin, ed., *Philosophical Perspectives*, vol. 8, (Atascadero, CA: Ridgeview Publishing Co., 1994), pp.207-219.
[16] *In M* VII.17.1673-1674. (The translation in this and the other quotations from Aquinas are my own.) Someone might suppose that on this argument a heap is something more than the sum of its parts. For a detailed explanation of the parts of Aquinas's metaphysics that block this apparent implication, see Chapter 1 of my *Aquinas* (London and New York: Routledge, 2003).
[17] *DPN* 2 (349); see also *In M* VII.2.1289-1292.
[18] *DPN* 1 (340).
[19] For the claims about what substantial and accidental forms configure, see, for example, *DPN* 1 (339).
[20] To avoid confusion, it might also be helpful here to emphasize that Aquinas's point is a point about substances. Statues are not substances but artifacts; for Aquinas there can be more than one substantial form in an artifact.
[21] Cf. *DPN* 3 (354), where Aquinas talks about water being divided into water until it is divided into the smallest bits that are still water, namely, the element *water*.
[22] See, for example, *CT* 211 (410), where Aquinas discusses the case in which the combination of elements constitutes a complete inanimate thing which is a suppositum, that is, an individual in the genus of substance.
[23] The point of saying that they go out of existence as things in their own right is to preclude the misunderstanding that these things cease to exist simpliciter. They continue to exist as components of the whole. Analogously, when an apple is eaten, it ceases to exist as the apple it was, but all its matter continues to exist and (at least for a time) constitutes some of the components within the eater.
[24] An objector might suppose here that, for example, flesh in an animal is the same as flesh existing on its own. Since Aquinas is willing to grant that flesh existing on its own is a substance, it seems that it must be a substance when it is in an animal as well. Consequently, the objector might maintain, Aquinas's principle that there cannot be more than one substantial form in a thing is violated. In an animal, there will be at least both the substantial form of the flesh and the substantial form of the animal.

But this objection to Aquinas fails to take into proper consideration his understanding of form. On his view, flesh existing on its own does not have the same form as flesh in an animal. That is because flesh in an animal can perform the functions proper to that flesh, as flesh existing on its own cannot. The proper function of flesh (or any other constituent of the whole) is given by the substantial form of the whole. When it exists on its own, without being configured by the form of the whole animal, no part of an animal functions as it does when it is in the whole. And so flesh in an animal, unlike flesh which exists on its own, is configured by the one substantial form of the animal and not by the substantial form of flesh. See, for example, *ST* IIIa.5.3, where Aquinas explains that flesh which is not informed by the substantial form of a human being is called 'flesh' only equivocally, and *ST* IIIa.5.4 where he makes the more general claim that there is no true human flesh which is not completed by a human soul. (Cf. *In DA*, II.1.226 and *In M*, VII.9.1519.) See also *In M* VII.11.1519 and *SCG* IV.36 (3740) where Aquinas explains that the substantial form of a thing confers on that thing operations proper to it.
[25] *SCG* IV.35 (3732); cf. also *In M* VII.17.1680 and VII.16.1633.
[26] *In M* VII.16.1633. It is easy to become confused about Aquinas's position here. He does not deny that in a living human body, for example, there is a part that is the eye. It is just that, as an eye in a living body, its substantial form is the substantial form of the whole living body. In the living body, the eye is not an independent substance with its own substantial form. That is why, for Aquinas, an eye detached from a living body and existing separately is not the same thing it was as part of the living body and configured by the substantial form of the body.
[27] See, for example, *SCG* IV.36 (3740).
[28] *ST* Ia.76.1.
[29] *QDSC* un.2.
[30] See for example Mitchell 2009, p.26.
[31] Mitchell 2009, p.24.
[32] Mitchell 2009, p.25.
[33] Mitchell 2009, p.36.
[34] Mitchell 2009, p.36.
[35] From www.aquadyntech.com/watermolecule.html.

[36] From en.wikipedia.org/wiki/Hydrogen_bond.
[37] For an excellent paper discussing this difference, see Michael Rota, "Substance and Artifact in Thomas Aquinas," *History of Philosophy Quarterly*, 21:3 (July 2004): 241-259.
[38] Brian McLaughlin, "Emergence and Supervenience", in *Emergence: Contemporary Readings in Philosophy and Science,* ed. Mark A Bedau and Paul Humphreys, (Cambridge, Mass.: MIT Press, 2008), p.84. See also his "The Rise and Fall of British Emergentism" in the same volume, pp.19-60.
[39] Quoted in McLaughlin 2008, p.82.
[40] McLaughlin 2008, p.82.
[41] "Downward Causation and Weak Emergence", in *Emergence: Contemporary Readings in Philosophy and Science,* ed. Mark A Bedau and Paul Humphreys, (Cambridge, Mass.: MIT Press, 2008), pp. 155-188.
[42] Bedau 2008, p.160.
[43] Bedau 2008, p.160-161.
[44] Bedau 2008, p.157.
[45] Bedua 2008, p.155.
[46] So, for example, he says, "the intellect, which is the source of intellective function, is the form of the human body." (*ST* Ia.76.1).
[47] *ST* Ia.75.2 ad 2; emphasis added.
[48] I am grateful to John Greco for helpful comments on an earlier draft of this paper.