Cosmology 1. Reductionism
[with revisions from ± 1996[1]]

Cosmology

We now turn from a consideration of the sort of answer that can be given to questions about what there is to a consideration of the sort of answer that can be given to questions about why there is what there is, from the facts to the explanation of the facts[2]. According to Aristotle[3] there are four different types of explanation or 'causes' as he calls them, which can be given in answer to such questions as why something exists and why it has the particular characteristics that it does have:

(a) *Formal*,
(b) *Material*,
(c) *Efficient* and
(d) *Final*.

A *formal* cause or explanation is one which characterises the form, shape, arrangement or pattern in which the constituent parts or matter of a thing are disposed. A *material* cause or explanation is one in which a thing is characterised in terms of the constituent parts or matter of which it is composed. An *efficient* cause or explanation is one in which the existence of something is explained by reference to its causal antecedents in the modern sense of the words 'cause' and 'causal'. A *final* cause or explanation is one in which the existence and nature of something is explained by reference to the purpose or objective which [it] is intended to serve.

Although his terminology sounds archaic, Aristotle's scheme still provides a useful classification of the different types of explanation employed in the empirical sciences, both in the natural and biological sciences and in the social sciences. Aristotle's formal explanations correspond to descriptions of natural phenomena in terms of formal structures, systems and mathematical models; his material explanations correspond to reductive explanations in which natural phenomena are broken down into or analysed in terms of the constituent parts such as cells, molecules, atoms and sub-atomic particles of which they are composed; his efficient explanations correspond to explanations of the causal mechanical type; while his final explanations correspond to functional explanations in biology and teleological, purposive or mentalistic explanations in psychology and the social sciences.

Since 'form' and 'matter' for Aristotle are defined in terms of one another, it is impossible to discuss formal explanations without relating them to and contrasting them with material explanations and *vice versa*. I therefore propose to consider these two types of explanation under the general heading of Reductionism or Reductive Explanation. This is followed by a discussion of explanations of the efficient or causal-mechanical type. The discussion of final or teleological explanations will be postponed until we come to Section 3 & 4 of the course which are largely devoted to this topic.

Reductionism

'Reductionism' may be defined as an intellectual or scientific strategy in which explanations are sought and generated through the process of reduction. 'Reduction' in its turn may be defined as a process whereby one thing A is *analysed* or broken down into a number of constituent items $B_1 \ldots B_n$ such that the list of

[1] [Strikethrough: original text that is deleted or replaced; new text is between brackets.]
[2] For this distinction, see Bromberger (1965).
[3] *Physics*, 195 a18.

constituent items $B_1 \ldots B_n$ either with or without a specification of their form or arrangement may be said to provide a complete or exhaustive account of the *analysandum* A. In other words and, *pari passu*, by way of example the concept 'reduction' is analysable into two constituent concepts, the concept of a process of analysis and the concept of completeness or exhaustiveness, and in so far as that is all there is to it, these two concepts together may be said to constitute a reduction of the concept 'reduction' to or in terms of these two subordinate concepts.

Conceptual Analysis and Reduction

Analyses and reductions are of different kinds. The first and most important distinction to be drawn is between *conceptual* analysis and reduction on the one hand and *substantial* analysis and reduction on the other. In a *conceptual* analysis or reduction a concept, i.e. the sense or meaning of a word or expression, is broken down into a number of distinct conceptual elements which in the case of a complete analysis or reduction constitute what Aristotle calls the *essence* of the concept in question, as in the example already cited of the analysis of the concept 'reduction' into the two conceptual elements 'analysis' and 'completeness'. Another example is Aristotle's favourite case of a statue where the analysis and reduction of the concept might be:

(a) an object made of some durable material such as stone or metal,
(b) shaped by human artifice,
(c) in the form of a man, animal or mythical creature,
(d) free-standing, and
(e) intended to represent or depict a particular individual, a mythical being or a personified abstract idea.

The five conceptual elements which make up this analysis of the concept 'statue' and to which it may be said to have been reduced are properties which, in Aristotle's terms, constitute the *essence* of a statue in that any particular thing which possesses these properties is *ipso facto* a statue, while anything that lacks any one of them would not be a statue. Any particular statue has of course many other properties besides these five, but since these can and do vary from statue to statue without altering the way their owners are classified they are called by Aristotle 'accidents' or 'accidental properties'.

Substantial Analysis and Reduction

In a substantial analysis or reduction, by contrast, what is analysed is not a concept under which various particulars may or may not fall, but a particular existing thing, typically a substance in Aristotle's sense. Thus the substantial analysis of a particular statue would be that it was carved out of solid marble or consisted entirely of bronze as the case might be. Since substantial analysis applies to particular things rather than to concepts the correct analysis or reduction does not depend as does a correct conceptual analysis on the way the *analysandum* is conceptualised. Indeed it is often the case that it is only *after* a substantial analysis of a thing has been carried out that an adequate conceptualisation of it becomes possible. Thus only after inspection under a microscope and the discovery that it consists of red and white blood corpuscles does it become possible to identify what has been previously conceptualised only as a dirty brown patch as a patch of dried blood.

Needless to say, for such a substantial analysis to give us any kind of information about or understanding of the *analysandum* we must be able to conceptualise the parts, or stuff of which it is found to consist. In many cases, moreover, we classify things in terms of their characteristic substantial analysis. In such cases, the conceptual analysis or reduction of the concept under which the objects fall will coincide exactly with the substantial analysis and reduction of all the objects which fall under the concept and are thus members of the class in question. Thus different kinds of stuff or 'substances' in the modern (as opposed to the Aristotelian) sense have come to be distinguished by their standard chemical analysis, such as H_2O in the case of water. Chemical analysis is, of course, a typical case of what I am calling substantial analysis. Cases such as water illustrate the principle ~~to which Quine has drawn attention~~ whereby scientific discoveries change the definition of concepts so that what has previously been a contingent[4] truth verified by observation,

[4] ['Contingent' here in the traditional sense of 'deniable without self-contradiction' rather than in the sense, popularised by Kripke

namely that water always turns out to have the chemical and hence substantial analysis H_2O, becomes an analytic[5] proposition, true by virtue of the conventions of current usage, in that a liquid which had all the characteristics of water, but turned out to have a different chemical/substantial analysis would not now be accepted as a case of water.

Even in such cases however the distinction between the analysis and reduction of particular things still holds good, particularly if we consider how the truth of the two types of analysis is established. The truth of a conceptual analysis is established *a priori* by showing that to deny it entails a contradiction. Thus we can establish that it is now part of the analysis of the concept water that water has the chemical analysis H_2O simply by considering an imaginary case where someone asserts of a hypothetical liquid that it is water, but does not have the chemical analysis H_2O. Any substantial analysis of a particular thing, on the other hand, is always a contingent hypothesis whose truth can only be established by empirical investigation. It may now be a necessary analytic truth that water has the chemical/substantial analysis H_2O but it is still a matter of empirical determination whether the liquid in this particular bottle which looks like water, smells like water and feels like water has the substantial/chemical analysis H_2O, and, hence, really *is* water.[6]

Form and Matter

We have seen that the distinction which Aristotle draws between the essential and accidental attributes of a particular substance is a matter of the conceptual analysis of the concept under which it falls or under which it is subsumed for purposes of description. We now need to recognise that the distinction which he also draws between the Form and the Matter of a particular substance is a distinction which applies to its substantial analysis and reduction and is, therefore, independent of the way it is conceptualised. The matter of something for Aristotle is that of which it can be said to consist or be composed. It may be either a set of denumerable parts or subdivisions which in the case of a material substance like a motor car will themselves be material substances, but in the case of something as insubstantial as a lecture will be insubstantial entities like topics, arguments and propositions or, in the case of substances like the statue, which are not internally subdivided in the way that lectures and motor cars are, it will consist in the material or stuff of which the substance is made. Similarly the Form of something refers not merely as in the case of the statue to its external shape, but to the arrangement of the internal parts and subdivisions of which it is composed and their causal and functional relationships to one another.

Once this distinction is drawn it becomes apparent that a particular form is something that can only exist in so far as there exists some matter which is disposed or arranged in that particular way. If the matter is re-arranged, the form ceases to exist. The same matter, on the other hand, can appear in a number of different forms or arrangements. By the same token, different particular collections of matter constituting distinct particular things can share a common form as in the case of different copies of the same book or different motor cars of the same type. A given collection of matter, on the other hand, can only assume one form and can constitute only one unique individual at a given moment of time.

Material Analysis and Reduction

In the ~~same~~ sense in which I am using the term ~~for a substantial analysis of something to be complete and hence constitute a reduction, the analysis must mention both the matter of which a thing consists and its form~~[, a substantial analysis or reduction is a form of microanalysis or microreduction which mentions both the matter of which the *analysandum* consists and its form], i.e. the way the matter is arranged or disposed. However, since the form or arrangement ceases to exist when the matter is rearranged and can only exist at all in so far as there is some matter which takes on that form, there is a sense in which substances can be said to consist of nothing but the matter of which they are composed. ~~From this we get the notion of a *material analysis* of a particular thing~~ This gives us the notion of another form of microanalysis which I call

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(1972; 1980) since this piece was written, in which it is interpreted as 'true in some, but not all, possible worlds'. For a critique of this view, see Place (1989).]

[5] [For a reply to Quine's (1953) critique of the analytic/synthetic distinction, see Place (1991).]

[6] [It will be noted that this analysis (written in 1973) is in direct opposition to Putnam's (1975) treatment of the same issue in his now (1990) well-known example of Twin-Earth in which everything is as it is on Earth, except that the stuff that has the chemical composition H_2O on Earth has the chemical composition XYZ on Twin-Earth.]

"material analysis"] which lists the different parts or different kinds of material or stuff of which a thing is composed without attempting to describe their form or arrangement ~~and~~[. Hence also,] the notion of a *material reduction* which is complete or exhaustive in the sense that it lists all the different parts or types of material that go to make up the *analysandum*. ~~It should be noted that~~ [But], although a material reduction is a genuine reduction in the sense of our initial definition in that the *analysandum* can be said to consist of nothing over and above the list of items which constitute its material reduction, we cannot say that a particular thing is identical with, in the sense of being the same thing as, its material reduction. A particular ~~thing~~ can only be said to be identical with its substantial reduction~~, that is~~[. In other words, a particular is identical] with the matter of which it is composed ~~when~~[, if and only if the matter is] arranged in the particular way it *is* arranged [when it constitutes the entity in question]. [Not only is an entity not identical with a mere collection of its parts, the collection also lacks many of the properties which come into existence once the parts are assembled in such a way as to constitute the whole.] It is in this sense that the whole is indeed greater than the sum of its parts[, that the whole has "emergent" properties that a mere collection of the parts of which it is composed does not have].

[It thus appears that a material reduction of an entity to its constituent parts cannot by itself provide an understanding of an entity and its properties.] ~~Material analysis and reduction has n~~[N]evertheless ~~proved to be a strategy of immense importance and value in the development of the natural sciences in biology as well as in chemistry and physics~~[, the history of science demonstrates unequivocally that an exhaustive material analysis of an entity is an essential first step towards understanding the nature and properties of any entity that lends itself to this kind of microanalysis]. ~~The reason for this is that when naturally occurring substances~~ [The success of this strategy depends on the fact that whenever naturally occurring substances (in Aristotle's sense)] are subjected to material analysis they are invariably found to reduce to units ~~which are themselves substances~~ of the same general type [and size which are themselves discrete substances in that sense]. ~~Further t~~[T]hese units ~~are~~[,] in their turn ~~found to be susceptible to further material analysis into smaller units again of the same general type~~[, are likewise susceptible to material analysis into yet smaller units;] and the process can be repeated until we arrive at the smallest units currently recognised by physicists, the sub-atomic particles. This is the basis for the claim that is often made that everything in the universe consists of nothing but sub-atomic particles ~~and of the more misleading claim that is sometimes made~~[. It is also the basis for the much less defensible claim] that sub-atomic particles are the only things that *really exist*.

From this too we get the notion of a ~~series of hierarchical ordered~~ [hierarchy of levels] of analysis from the most macroscopic level at the top down to the most microscopic level at the bottom. Thus, if we follow the organic-biological branch of this hierarchy, we can start at the most macroscopic level with ~~the different species of living organism to be found on this planet. Each species as it actually exists can then, at least in some cases, be subdivided into separate colonies of social groups occupying different geographical territories. These can be subdivided into the individual organisms~~ [an aggregation or social group composed of living organisms of the same species occupying or roaming as a unit across a particular geographical territory. These colonies or social groups can then be subdivided into the individual organisms of which they are composed]. Each organism can be analysed into a set of organs, skin, muscles, bones, blood vessels, nervous system etc. ~~which~~ [These] in their turn can be reduced to individual cells; cells to membrane, nucleus and organelles; these in their turn to individual molecules; molecules to atoms; and atoms to sub-atomic particles.

Furthermore, as we proceed from one level of analysis to another, it becomes necessary ~~to develop a new of concepts~~ for descriptive and theoretical purposes ~~at the new level of analysis~~ [to devise a different set of concepts each with its own "range of convenience", to use George Kelly's (1955, pp. 17-18) term, appropriate to that level of material analysis]. ~~Thus it comes about that many of the conventional divisions between the different branches of natural science that have become institutionalised within our academic system correspond more or less to these different levels of analysis and 'the range of convenience', to use Kelly's term, of the concepts appropriate to a particular level of material analysis. Thus, the highest level of the hierarchy as described above is the field of general biology; the second level belongs to such sciences as ecology and sociology~~ [Conceptual schemes restricted in this way to a particular level of material analysis form the basis for many of the divisions between different sciences. Moreover, it is this restriction of particular sciences to a particular level of material analysis which supports the idea that the various sciences

are arranged in a kind of natural hierarchy with those dealing with the most macroscopic level of analysis at the top and those dealing with the most microscopic level at the bottom. Thus, we can say that the highest level of this hierarchy is occupied by the science of astronomy. The second level specific to this planet belongs to geology. At the level of particular environments we have ecology, and at the level of the social group such human sciences as ethnography and sociology]; at the level of the single organism we have psychology and ethology; at the level of the organ, anatomy and physiology; at the level of the cell and its components, histology and microbiology; at the molecular level, biochemistry; and then through organic and inorganic chemistry at the level of the atom to the sub-atomic realm of atomic physics.

Theoretical Analysis and Reduction

The scientific importance of material reduction and of the pattern of hierarchically ordered levels which it yields derives from the fact that it makes possible a theoretical explanation of the properties of units at one level of analysis in terms of the interaction of units at the level immediately below it on the molar-molecular scale. Where such an explanation is attempted we can speak of a *theoretical analysis* and where all the properties of a unit at a superordinate level have been accounted for in terms of the interaction of units at the subordinate level we can speak of a *theoretical reduction* from one level to the one below. Successful theoretical reductions have been demonstrated particularly at the interfaces between the molecular, atomic and subatomic levels and increasingly in the area of microbiology and biochemistry. This combined with the notion of different conceptual systems or theoretical languages being required at each level of analysis has given rise to what I call "the Reductionist Myth" propagated by many philosophers of science in recent years (e.g., Oppenheim and Putnam 1958) according to which the ultimate objective of all scientific research both can and should be to develop a theoretical system at the sub-atomic level of analysis from which all true empirical propositions will ultimately be derived. This project, it is assumed, will be carried out in a series of stages in which all the propositions at one level of analysis will be deduced from the propositions belonging to the level immediately below it. Since each level has its own set of concepts and its own theoretical language, the realisation of this project requires the possibility of translating from one theoretical language into another and of conceptually analysing and reducing the concepts at one level of analysis to concepts at the level immediately below it.

This view seems to me to be mistaken on three counts. In the first place it exaggerates the theoretical and conceptual gulf between the different levels of substantial and material analysis and the difficulty of passing from one level to another. In sciences like physiology which spread across a number of different levels it is common for an explanation of a particular physiological phenomenon to include such things as the gross anatomical structure of a particular organ of the body, the properties of cells of which it is composed, the biochemistry of the metabolic processes involved and even the principles of electronics in a single logically coherent explanation. In neurophysiology, for example, the explanation of the propagation of nerve impulses along the nerve fibre involves a description of the anatomy of the neuron which distinguishes such features as the nerve cell, the axon, the dendrites, the medullary sheath and the nerve membrane, a description of the chemical changes at the molecular level that occurs in the membrane as the nerve impulse is conducted along it and the movement of electrons involved in the consequent changes in electrical potential between the inside and outside of the membrane.

In the second place to talk of conceptual analysis and translation from one language or set of concepts into another in this connection is to confuse the distinction ~~I have tried to draw here~~ between conceptual analysis and reduction on the one hand and substantial, material, theoretical analysis, reduction on the other. The principle which Oppenheim and Putnam (1955) call *microreduction* in which a set of theoretical propositions relating to units at a higher level of analysis are deduced from theoretical propositions relating units at a lower level of analysis which constitute the parts of the units at the higher level is clearly the same thing as what I am proposing to call *theoretical reduction* which presupposes both material reduction of units at the higher level to units at the lower level and a substantial reduction which includes a description of how the units at the lower level are organised so as to form units at the higher level on the macroscopic-microscopic scale. But, as we have seen the substantial and material reduction of an entity in the sense in which I am using those terms is a matter of contingent and empirically determined fact about particular entities existing in the universe and not about the concepts under which they fall. Conceptual

analysis, by contrast, does not typically involve anything resembling a translation from one language or universe of discourse into another. Consider, for example, a conceptual reduction of the concept of 'living organism' which might be stated by saying that a living organism is a self-regulating, self sustaining system which has the capacity both to reproduce itself so as to form a new organism of the same kind and to reproduce and thus replace some of the components of which it consists. Such a conceptual reduction may be characterised as a *horizontal* reduction in contrast to the *vertical* reduction that is characteristic of substantial, material or microreduction. It follows from this that when we assert an equivalence or identity between units at a higher more macroscopic level of analysis with a particular arrangement of units at a lower more microscopic level of analysis, as we do in the case of what I am calling substantial analysis, the identity involved is always, in the first instance at least, a *contingent identity* verified by empirical observation in which the description of an entity in terms of the parts of which it is composed and the description of it as a unit in its own right have the *same referent*, but *different senses*. The only exception here is in the case where the description at the molar level has been redefined in terms of what has turned out to be the standard substantial reduction of things of that kind. Such redefinitions only occur when the standard substantial reduction of entities of a certain kind has ceased to be a matter of hypothesis and become a matter of established scientific fact. Only then does the conceptual analysis of the concept at the molar level coincide with the material analysis of ~~things of that kind~~ the entities that fall under it ~~and only~~[. Only] then does it become ~~appropriate~~ [possible] to ~~talk of translating statements, at one level into statements at another level~~ [translate, without change or loss of meaning, statements describing entities at the molar level into statements at a more molecular level about the constituents of those entities].

My third objection to ~~what I have called~~ the Reductionist Myth is that it fails to take account of the distinction between 'a material reduction' which characterises a unit at a higher level on the molar-molecular scale in terms solely of the matter of parts at a lower level of which the higher level unit is composed and 'a substantial reduction' which includes, alongside the parts or matter of which an entity is composed, their form, the way they are arranged so as to form the substance in question. It is true that we can go on subdividing a substance by material analysis into smaller and smaller units until we get down to the sub-atomic level, and that for each level we can say that the whole substance consists entirely of units belonging to that level~~, w~~[. W]hat we cannot do, even in principle, is to start with propositions about units at the lowest most microscopic level of analysis and from this deduce all the propositions that are true of all the units at all the other higher levels of analysis.

The reason for this is that although we may reasonably hope to be able to deduce the intrinsic properties of units at a higher level analysis from a knowledge of (a) the properties of units [at] a lower level and (b) their form or arrangement within the unit of which they form part, what we cannot reasonably hope to do is to deduce the form or arrangement of the parts at the higher level within the units at the next level up the scale. Thus ~~although a physicist~~ [physicists] can reasonably hope to deduce the intrinsic properties of different atoms from a knowledge of the particles of which they are composed and their arrangement within the atom~~, and although a chemist~~[. Chemists] can reasonably hope to deduce the intrinsic properties of different molecules from knowledge of the properties of the different atoms of which they are composed and the way they are arranged within the molecule~~, the physicist~~[. What physicists] cannot reasonably hope to do is deduce from a knowledge of the properties of sub-atomic particles which particular arrangements of them will actually occur (as opposed to which arrangements are possible)~~; nor will he be able to predict~~ [or] exactly how many cases of a given arrangement there will be or precisely when and where they will occur~~; and t~~[. T]he same goes for the occurrence and spatio-temporal distribution of different arrangements of the units at each of the higher levels of analysis. In other words the incidence of particular forms or arrangements of the units at any given level is a residual which can never be deduced from a knowledge of the intrinsic properties of the units themselves or the way they are constituted out of units at a lower more microscopic level of analysis.

It is true, of course, that the intrinsic properties of the units at a given level will determine which particular arrangements are possible and may also determine the probability of the occurrence of a given arrangement at any one place over a given period of time. But beyond that we are in an area where what happens is either a matter of pure chance and historical accident or is determined by principles such as that

of natural selection in biology whose microreduction to the principles of atomic physics is a palpable absurdity.

The Scope of Analysis and Reduction

It remains to say something about the different kinds of things to which these different types of analysis and reduction apply. Since all analysis involves breaking something down into its constituent sub-units, it follows that there must always be some fundamental units which are not susceptible to further analysis. In the case of substantial, material or micro-analysis the ultimate units at the present state of knowledge are the sub-atomic particles of physics. Likewise in the case of conceptual analysis, there are certain concepts and propositions which may be described as atomic concepts and atomic propositions in the sense that they are not susceptible to further analysis, though which particular concepts and propositions these are and how they are to be recognised is a matter of philosophical debate to which no firm answer can at present be given. The restrictions which apply in the case of substantial and material analysis are much easier to specify. Here, as we have seen, we are analysing actually existing features of the universe and not just concepts; but it is evident that there are certain kinds of things that can quite properly be said to exist, occur or be as a matter of fact the case in the universe besides the ultimate units of analysis, the sub-atomic particles, which cannot be broken down into their constituent parts in this way.

Consider such things as actual relations like Amsterdam being north of Rotterdam or Peter Geach being married to Elizabeth Anscombe and dispositional properties such as Einstein's intelligence, my car's horse-power or the flexibility of this piece of rubber. In ~~all~~ [none] of ~~the concepts involved~~ [these cases are the relations or properties involved,] 'north of', 'married to', 'intelligent', 'horse-power' and 'flexibility' ~~are susceptible to conceptual analysis, but the particular instance is not susceptible to any kind of substantial, material or microanalysis~~ [susceptible to any kind of microanalysis, whether substantial or material]. Relations and dispositional properties are not that kind of thing. This is because particular relations and dispositional properties, though extended in time,[7] are neither extended nor, strictly speaking, located in space.[8] [Geographical points, such as the top of Mt. Everest, which are located but not extended in space, together with geographical lines, such as the Arctic Circle, which are located *and* extended, but only in a single spatial dimension, are likewise not susceptible to microanalysis.] Relations, dispositional properties and geographical points and lines are not that kind of thing.

~~The reason for this would seem to be that particular relations and dispositional properties, though extended in time are neither extended nor located in space. Geographical points, such as the top of Mt. Everest, which are located but not extended in space are likewise not susceptible to substantial, material or microanalysis.~~ [This is because in order to have parts and a microstructure whereby those parts are organised so as to constitute the whole of which they are the parts, an entity needs to be extended both in time and in at least two, if not three, dimensions of space.] ~~This includes~~ [Examples of things which qualify in this respect include] substances, like living organisms and motor cars, features of substances, like my nose or Mt. Everest, particular instances of substantial properties, like a particular patch of colour, perceptible phenomena like sounds, optical images, and rainbows, and processes, like the melting of a candle, the boiling of water in a kettle or the sensations that you are experiencing at this moment. Substantial analysis though of a slightly different kind would also appear to apply to organisations ~~and types composed of particular substances or processes where the constituent individuals are located and extended in space and time, but the organisation or type to which they belong is not~~ [and universals (types) whose members or instances (tokens) are particular substances or particular processes which are located and extended in two or three dimensions of space and one of time, even though the organisation or universal of which they are members or instances is not].

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[7] [Strictly speaking, it is not the relation or property as such which is extended in time, but the *state of affairs* whereby it connects the *relata* (in the case of a relation) or is possessed by the property bearer (in the case of a dispositional property). I am indebted to Hanoch Ben-Yami for drawing my attention to this point (personal communication September 1996).]

[8] [There is a difference between relations and dispositional properties in this respect in that, although the property itself is not extended and located in space and is not, therefore, susceptible to microanalysis, dispositional properties *are* in most cases causally dependent on and explicable in terms of the microstructure of the property-bearer. Except in the case of particular causal relations where the effect is determined by the reciprocally related dispositional properties of the interacting entities and hence indirectly by their respective microstructures, relations do not lend themselves to this kind of micro-reductive explanation.]

Examples are such things as social institutions like clubs or societies with a widely distributed memberships, books, plays, and propositions.

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