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Objects as Hierarchical Structures: A Comprehensive Ontology

I. Introduction

It is a given of both everyday observation as well as of scientific experimentation and theory that ordinary three-dimensional objects we encounter in daily experience—apples, chairs, computers, trees, humans, etc.—are without exception composites consisting in *parts organized in specific ways*. That is, ordinary objects are *systems, complexes, structures, or networks*, where the various kinds of inter-relations—e.g., spatial and physical/causal, static and dynamic—among the parts are as essential to the nature of the resultant whole as are the related parts. And, in the systematic extension of these observations by instrumentation and theory, our scientific knowledge of material objects is of vastly complex hierarchical structures of structures, where at each level a given structure is itself the single subject for properties and relations that together form structures subsuming it. A chair, for example, consists of parts in certain static spatial and physical-causal relationships (e.g., mechanical or molecular forces at the structural level of artifact), parts that without some of the latter would reduce to a heap of fragments and not a chair. In turn and in wooden chairs, for example, the composing cellulose molecules contribute rigidity and strength to the wood due to their being each a polymerized chain-like structure of glucose molecules, each glucose molecule itself defined by a certain structure between its carbon, hydrogen, and oxygen atoms, and at a lower level still, each of these atoms having definitive characteristics because of various kinds of sub-atomic entities related in certain ways. Living organisms are even more spectacular examples of iterated structuring of static and dynamic systems, e.g., of bones and organs functioning in mutually beneficial ways, where each organ consists of a particular structure among specialized cells, the latter in turn specified by a particular set of molecules interrelated in certain ways. Perception itself is both possible due to certain types of neural systems and veridical precisely because these systems effect chains of homomorphic signal structures. Emerging at increased levels of living complexity are new ‘powers’, i.e., the possibility of *sui generis* properties and relations not available at the lower levels, e.g., as

in those distinguishing vegetative from sensible life, and as illustrated in the emergences of consciousness and then abstract thinking as functions of certain complexities of brains and nervous systems. This is an important generalizable explanatory point: at some levels of some structures there are emergent and *sui generis* properties and relations, e.g., the dispositional property of Is-a-Chair is an ontic predicate of certain macro-structures but not their molecular micro-structures, or, in the abstract, True and False are emergent properties on (what are conceptual) propositions but not on their subparts, say, individual concepts for subject terms.

Universally, then, analysis reveals ordinary objects to be hierarchies of structures of structures, higher levels having physical properties and relations non-existent at lower levels of structure. This downward iteration of subsumed sub-structures is extended by science all the way to the primary level of quantum entities. Significantly, however, quantum entities represent an apparent lower limit on structure as naively understood. For as realistically interpreted, quantum theory is said to imply that objects or 'substances' at its level dissipate completely into physical systems of *only properties and relations*—pure structures (e.g., French 2001; French and Ladyman 2003). The proposed proto-ontology, termed 'Structural Realism', is in regard to traditional ontic categories immediately stymied with the problem of how there can be properties and relations without supporting objects as subjects or relata? In the following I shall show how this question is necessitated on ontological grounds alone, and how it can be answered. It will follow that physical micro-reality can be purely structural, as must be all reality at some foundational level. This account is also offered as possibly shedding light on the 'underdetermination' of quantum particles insofar as it provides a perspicuous re-conceptualization of identity and indiscernibility in purely structural terms, one explaining how such entities can have a unique identity (be 'individuals') and can likewise be distinct but indiscernible without a simply posited individuator (be 'non-individuals') (Ibid.; Hilborn and Yuca 2002). In all these ways and others to be considered, the account given will have advantages over related trope theory sometimes appealed to in this context (e.g., Simons 1994; Wayne forthcoming).

Now, equally significant for ontology generally but in the opposite direction, this structural characterization extends upward from ordinary mid-size physical objects isolated in our attention for practical reasons to

also include more ‘scattered’ local, global, and cosmically subsuming spatial/physical systems. Moreover and meshing with these systems are abstract cognitive structures, including both contingent relations making up particular psyches as well as necessary relations composing the formal hierarchical systems of mathematics and logic, systems instrumentally essential to our scientific knowledge. There are also ethical and social structures, e.g., the complex and varied systems of relationships that constitute family, corporation, or citizenry. Succinctly then, structure is the ubiquitous given, and ordinary objects are examples of and metaphor for this universal feature. Crucial in this is the fact that relations of various intensions, contingent or necessary, as they exist among subject things are as fundamental in composing the resulting wholes as are the things themselves. What is required, then, to explain this ubiquitous given is a developed and comprehensive *ontology of structure* that as such will include, principally: a) an account of the defining and composing inter-subject/multi-relata ontic predicates—*polyadic relations*—as they each effect an intensional unification among the yet diverse, i.e., an account of relational facts or states of affairs, monadic properties being the easily distorted limiting case; b) an account of how facts are compounded to form both same-level and hierarchical molecular structural lattices or networks; and c) in order to avoid either intractable problems of traditional ontology or a vicious regress, an account of how at some atomic ontic level there can be pure structures composed exclusively of ontic predicates. I shall give herein what I argue are the principles of such an ontology. It is derived from an analysis of ontic predicates that shows them to have an irreducible substantiality and a primary ontic status not recognized in traditional ontology. Described in Aristotelian terms, ontic predicates are analyzed herein as: 1) each having a particularity or ‘thisness’, i.e., individuated as relation instance; 2) like traditional ‘forms’, they act to intensionally or qualitatively structure their subjects (though this structuring is *inter*-subject, not *intra*-subject as in the tradition); 3) at some atomic ontic level they can be ultimate subject substrata for other instances predicable of them, i.e., have the role of ‘prime matter’; and 4) mutually sustaining systems of the latter can found hierarchies of emergent structures that as single subjects endure through the ‘accidental’ change of certain property and relation instances, and can have ‘substantial’ change when composing instances of defining properties and relations are destroyed, leaving substructures, ‘matter’, that collectively are not then organized in these defining ways. So described, relation instances answer various criteria for ‘sub-

stance' Aristotle specified in the *Metaphysics* but could not find one type of entity to satisfy.

As a context motivating the principles of structural ontology, or what I have elsewhere termed more descriptively *network instance realism* (Mertz 1996, 2002), I shall first delineate key historical errors concerning the nature of ontic predication. Ontic predication is what the Scholastics explicitly referred to as 'material' predication and distinguished from 'formal' or linguistic predication, a distinction going back to but implicit in Aristotle. Linguistic or grammatical predication is itself a type of ontic or material predication, it being generic for a number of syntactic and semantic relations including those among grammatical units forming declarative sentences, or, relatedly, those among conceptual components forming propositions. In general, ontic predication is the qualitatively or intension controlled unifying agency among the yet distinct, what is the unity of facts or states of affairs, and is to be primarily contrasted with the arbitrary and nature-indifferent unity of elements in 'heaps', lists, sets, or mereological sums (all the latter being, I propose, formal fictions, useful for modeling but specious when identified with the modeled). Exactly contrary to the tradition, polyadic relations are the instructive paradigm case of ontic predication, monadic properties being the less determined and so easily misinterpreted limiting case. In particular, a proper understanding of ontic predication is as a unifying cause or agent—a combinator—controlled/determined in its unifying act to specific (but not necessarily distinct) subjects a_1, a_2, .., a_n, by a constituent intension or qualitative content R^n and effecting as a structured whole a fact $:R^n_i(a_1,a_2,..,a_n)$. (The colon locution is used herein to distinguish facts from corresponding propositions.) The unifying act of an ontic predicate is conditioned on a qualitative match or relevancy between intension R^n and the natures of each of a_1, a_2, .., a_n, what makes the resulting fact more than a mere list, and is what answers the classic Bradley's Regress argument (Mertz 1996, 2002). So understood, properties and relations as qualifying or characterizing their subjects join themselves to their subjects *externally*—they do not enter into the composition of each or any of their subjects. In contrast and classically, when monadic properties are considered primary and then easily mis-identified with their constituent and abstracted inert intensions, it becomes speciously plausible that these intensions, or their individuated versions (tropes), are *internal components* of their subjects. This is precisely the case with all the alternatives that follow from what I shall identify be-

low as the tradition's Inert Substrata Thesis. As we shall see, among the failures of these alternatives is the fact that they assign the essential ontic jobs of intensionally determined plural unification and the ordering among entities unified to anemic symmetric 'relations' that, in the case of the 'Compresence' (literally 'Present-Together') relation of trope theory is indifferent to any ordering among their relata, and in the case of the 'Tied-to' relation of bare particular theories is completely indifferent to the natures or intensions of these subjects and thus to any mutual relevance based upon this, i.e., the nature of the Tied-to 'relation' is contrary to the subject(s)-characterization or subject(s)-qualification definitive of all ontic predication. The Tied-to relation is necessarily a completely arbitrary linking of properties to a shared bare particular, and the Compresence relation is likewise arbitrary except perhaps for excluding the linking of contrary and contradictory properties. It is to be noted that, as such, both of these relations are distinct from the formal and once-removed relation of Exemplification (or Instantiation), e.g., Exemplification(*a*,Red), that is itself sometimes mistakenly used as the surrogate for what is the combinatorial aspect of *every ontic predicate*, not just for the Exemplification relation as needed to fulfill its role. Yet, even Exemplification implies a union between its subjects, e.g., *a* and Red, qualitatively controlled by a specific intension now as one of the subjects, e.g., Red. The arbitrariness of the Tied-to unifier and the near-arbitrariness of the Compresence unifier will be part of the following developed critiques against the alternatives implied by the Inert Substrata Thesis, and so the thesis itself.

II. Historical Errors

In the historically influential Aristotelian/Scholastic substance/attribute ontology structure or complexity was both recognized as essential to the very natures of ordinary objects, whether 'substances' or 'artifacts', and yet by the same theory the concept of structure was doomed to obscurity. This obscurity, which persists more or less into contemporary times, was and is a function of the myopic focus on monadic ontic predication, reinforced at times by the false reductive elimination of polyadic relations (Mertz 2003). In the Aristotelian/Scholastic hylomorphic tradition structures were differentiated, on the one hand, into those of artifacts (e.g., a statue, a house), and, on the other, into the more spectacular dynamic and internally driven event structures that are the lives of 'natural' substances (e.g., Socrates, a tree). The latter structures were thought to each represent in its enduring

totality the fulfillment of an end (*telos*) for that substance, what is an inherent fixed 'program' or nature for that type of entity. To account for the structure of composite wholes (present in every composite except what was considered unstructured 'heaps'), Aristotle and the subsequent tradition posited the two correlative and exhaustive 'principles' of *form* and *matter*. Form, either substantial or accidental, gives structure to a resultant whole by being an *ontic predicate* of a subject or subjects where the latter *precisely in having this role* is matter relative to the former. This matter is either, for substantial forms, ultimate and absolutely undetermined and amorphous prime matter, or, for accidental forms, subjects already informed (i.e., substances as subjects of monadic accidents, e.g., Socrates as being white, or parts ('secondary matter') that a form structures into an artifact.) Importantly, the underlying but hazed insight here is that structure is a function of ontic predication, where an ontic predicate is the duality of an act of unification determined as to its subjects and their mutual 'ordering' by a correlative specific intension or qualitative content, e.g., Man or House. In the words of Aquinas, for example, "Each individual thing is actually a being through a form, whether in the case of actual substantial being or in the case of actual accidental being. And hence every form is an act, and as a consequence it is the reason for the unity whereby a given thing is one."(*De Spirit. Creat.*, Art. 3 (Aquinas 1949: 46)) The two aspects of act and intension are of a single entity—the form—that joins itself to a subject or subjects in such a way as to characterize or qualify it or them, essentially or accidentally, and this for multiple subjects in the manner of a structuring among them (See Aristotle, *Meta*. 1041b1-33; 10435-14). The view was that when the subject is prime matter, the single ontic predicate, e.g., Is-a-Man, causes a hierarchical emergence of the substructural parts, e.g., bones, organs, tissues, and among these a mutual structural ordering and functioning that is the resultant substance. When the subjects are already informed, as with the parts of a house, the ontic predication of an accidental form, e.g., a form with the intension House, among these ontically prior parts effects a structured artifact, e.g., a house. Now, it is precisely these examples that show a primary error of the hylomorphic tradition: that the nature of ontic predication so understood requires that all acts of characterizing union and thus structural formation be controlled by *monadic intensions*, e.g., Man, Tree, Statue, House, including those acts that require multiple subjects and that establish an order among them. In this latter and crucial multi-subject case, a monadic property is held to not only attach in a characterizing way to a single subject as

an already formed composite, e.g., a man or a house, but also and magically somehow it is to be the immediate cause/agent of the prior structural inter-connections among yet diverse parts that results in this composite as a single subject. In fact, however, the latter inter-connections require multiple intensionally determined ontic combinators each existing simultaneously among multiple subjects, and these are *polyadic relations,* e.g., in the case of a house the static relations such as Supports, Between, Covers, Entrance-to, or, in the case of a human body, dynamic relations such as Moves, Digests, Circulates, Purifies. The error here is abetted by the two further classic errors of the eliminative property reduction of relations and the maxim that all unity is by a shared one (i.e., a single entity). As seen below, the correction of the unity-by-the-one maxim is via observing the unity effected by chains of relation instances pair-wise sharing common relata, or complexes of the latter being single relata for further relations. And, I take it to be definitive on arguments by Russell (Russell 1938: 221ff.) and others (Hochberg 1981, 1988; Mertz 1996: 163-73) and based upon the non-reducible ordering inherent to certain relations (e.g., asymmetric and non-symmetric relations) that polyadic relations are not eliminable in favor of monadic properties of their relata or certain kinds of sets of their relata. More locally, Paul Teller (1986) has argued that the apparent fact of superposition or 'entanglement' in quantum mechanics implies the existence of 'inherent' or 'non-supervenient', i.e., irreducible, relations. Indeed, exactly contrary to the insidious reductionism of the tradition where relations dissolve into their relata things, on the analysis herein all things whatsoever dissolve ultimately and without remainder into their composing relations (including properties). The result is a precise and perspicuous *relational holism*, what is often called for as an ontology for micro-physics.

A second error of hylomorphism, though one not peculiar to it, and indeed one deeply ingrained and persistent up into contemporary ontology (e.g., found in the debates over quantum ontology (see French and Ladyman 2003)), is the thesis that ontic predicates ('forms') always require non-ontic-predicates (non-'forms') as subjects ('matter'). The pre-critical intuition here is that ontic predicates as intension-determined-combinators are incomplete and dependent entities in that they presuppose for their existences recipients or 'patients' of their unifying acts (each an '*ens ad aliud*' (a being-toward-something-else) or Fregean 'unsaturated'), *and* that these presupposed subjects cannot be further such acts, but rather must be com-

plete in the sense of combinatorially inert, e.g., 'substances' (each an '*ens in se*' (a being-in-itself) and '*ens per se*' (a being-through-itself)), or substance-like entities (e.g., prime matter or Fregean 'objects'). Otherwise stated, the second conjunct asserts that what is inherently dependent requires something inherently independent to sustain it in its being. Figuratively, the situation is thought to be that without the analog of *terra firma* we will have the explanatory failure of 'stacked turtles all the way down'. This view is false, and profoundly so: It is the case that at an atomic level ontic predicates as individuated relation (including property) instances, R^{n}_{i}, can have other relation instances as relata in the manner of a closed circle of combinatorial dependence, and where the resultant structural wholes are themselves non-dependent as non-predicable (each an '*ens in se*', though literally not an '*ens per se*'—not 'a being in virtue of itself'). How this is possible will be reviewed below. Denied this fact, the tradition concluded that in order to avoid an explanatory vicious infinite regress there must be for every structured entity, when subjected to a downwardly iterated analysis of structure into sub-structure, some bottommost level of absolutely unstructured and non-dependent entities, i.e., entities not themselves, or any of their constituents, having the natures of agent combinators, and hence, in this way, not themselves essentially dependent for their existences upon other entities. Or in short: Ontic predicates presuppose for their existence non-ontic-predicates as their subjects. This is the previously referenced *Inert Substrata Thesis*. Logically and in the literature these foundational non-predicable subjects divide according to possible combinations of (at least apparent) repeatability and unrepeatability treated as aspects of them. These possible self-sufficient substrata are accordingly: a) repeatable intensions i.e., abstracted universals, taken as non-combinatorial; b) individuated intensions in the form of substance-like, particularized (and necessarily) non-predicable and *monadic* 'qualities' or tropes, e.g., t-Red_{i}, t-Round_{j}, etc. ('t' for trope); or c) posited unrepeatable but internally non-qualitatively determined or natureless particulars known as 'bare particulars'. A physical object, or 'thick particular', is analyzed under a) and b) as *a compresent bundle* of either universals or tropes, respectively, and under c) as a plurality of universals *'tied-to' but not ontically predicated of* a bare particular, as such collected into and rendered unrepeatable as a single resultant 'thick' particular. Against each of these theories are serious challenges found in the literature (e.g., Loux 1998: 87, 93ff.; relevant essays in Laurence and Macdonald 1998; Stjernberg 2003), and though I shall mention some of them briefly in the course of the following, I shall offer other

arguments not generally exploited. The point will be that the Inert Substrata Thesis is untenable, making the alternative theory of only atomic mutually sustaining ontic predicates as urgent as I will show it is possible.

Consider first bare particulars and what I take to be the standard analysis leading to their posit (e.g., Moreland and Pickavance 2003). This analysis will also serve as context for eliminating option a) and the setting up of means for eliminating option b). The underlying theses are as follows (using 'B' to designate their introduction in the context of bare particulars).

Thesis B1: (Pure) monadic ontic predicates F(*x*), G(*x*), H(*x*),…, characterizing an unrepeatable subject individual *a* (i.e., such that propositions F(*a*), G(*a*), H(*a*),… are true) are or have intensions, respectively, F, G, H, …, that are *constituents of subject a*.

This is the classic containment or inherence model of ontic predication; *praedicatum inest subjecto*.

Thesis B2: An individual *a* exists if and only if *a* has at least one monadic ontic predicate P(*x*), i.e., *a* exemplifies P, and thus the proposition that P(*a*) is true.

Thesis B2 is a version of the common assertion that entities cannot exist without being subjects of characterizing properties (and relations) any more than properties (and relations) can exist without subjects to characterize (though the dependencies are of different types).

Thesis B3: Intensions in themselves are repeatable, i.e., universals, in being numerically the same constituents of numerically distinct subjects and thereby accounting for these subjects being of the same kind, and, any collection or bundle of them is likewise repeatable.

Here we have the simple and decisive reason why an ordinary thick *particular* cannot be simply a bundle of universals, and hence the standard observation that option a) must reduce to option c). I note also the arguments against option a) that it would make the Principle of the Identity of Indiscernibles a necessary truth, which it is not, and that intensions in themselves and therefore their bundles are causally inert—they cannot enter into

causal relations with other bundles, i.e., there would be no causal relations among thick particulars. It must be the case, then, that:

Thesis B4: If an unrepeatable entity *a* is composed in part of repeatable intensions, then it must have in addition at least one constituent that is unrepeatable so as to account for the unrepeatability of resultant whole *a*.

The most economical way to satisfy these theses and to account for the unity into a whole of all the constituents is with:

Thesis B5: An ordinary individual *a*, e.g., an apple, consists solely and essentially in—has as its sole identity-bestowing constituents—the repeatable intensions of its monadic ontic predicates *and* a single individuator p_a that unifies the former intensions by each being in some manner tied-to it.

Now, the problem with these theses taken jointly and as is is that they lead to a vicious infinite regress. On the assumption that particular p_a exists, then by Thesis B2 there is some ontic predicate P(*x*) such that P(p_a). In the literature these properties have been given to include Is-Unrepeatable, Is-Simple, Is-Constitutive-of-One-Object-at-a-Time, Has-No-Other-Properties-than-These. Then, by Thesis B1, repeatable intension P is a proper constituent of unrepeatable p_a, and this requires by Thesis B4 at least one additional individuator as a proper constituent of p_a itself, p_a'. Clearly this is the beginning of a vicious infinite regress, i.e., p_a' must succumb to the same analysis as did p_a, requiring that p_a' have a further constituent individuator p_a'', which in turn must succumb to the same analysis, and so on.

Advocates of individuating substrata p_a must avoid this regress, and they do so by limiting Thesis B2 so as to exclude them. That is, as sole and saving (*ad hoc*?) exceptions, individuating substrata p_a are held to exist without any *exemplifying* properties in the proper sense—they are *characterizable* by no properties and hence the designation ‘bare’ particulars. Trading on the intuitiveness of Thesis B2, advocates likewise insist that bare particulars cannot exist without associated properties, but, crucially, the ‘association’ here must be just that: a nature/intension-irrelevant conjunction or blank association, e.g., by a ‘Tied-to’ relation. In the words of J. P. Moreland, “It is open to an advocate of bare particulars to claim that it is a primitive fact that properties are tied to them and this does not need to

be grounded in some further capacity or property within them", the latter as "contained within the inner nature of the bare particular."(Moreland 1998: 258) This character of 'having' properties only by non-descriptive arbitrary association is, as we shall emphasize, a principal nemesis to bare particulars. Preliminary to this, however, note the standard challenges that, first, if a bare particular exemplifies no intensions and so has no properties then it can not be a relatum for any causal relation whatsoever, and, in particular, we could have no epistemic access to it, i.e., nothing individual *qua* individual would be given in experience, which is counter-factual. Moreover, an entity that does not enter into causal relations is neither destructible nor creatable, and this not only gives bare particulars a metaphysical status that should give one pause but also presents the following problem: What happens to a bare particular p_a when its thick particular *a* goes out of existence? Can it be recycled? It could not by any subsequent thick particular *b* having all the same properties as *a*, for in this case *a* would be numerically identical to *b*. This means that p_a's 'experience' with the set of properties as they jointly went into the making of *a* had to leave a positive mark on p_a preventing it from being associated with these properties again, as in *b*. But such a mark can only be a property of p_a and this contradicts its propertyless status as a bare particular.

Secondly, a bare particular would have to be a natureless entity, a status openly admitted by, for example, Gustav Bergmann: "Bare particulars neither are nor have natures."(Bergmann 1967: 24) If it were otherwise a bare particular would be the subject of ontic predicates characterizing its nature and so resulting in the above regress. Yet, something without a nature is *no*-thing—it can not be the 'nature of' a entity to be a natureless entity. Indeed, the intuition behind Thesis B2 would seem to be that an entity exists if and only if it is a *specific something*, and this specificity is a qualitatively determinate nature, relevant as such to intensions of certain ontic predicates (and not others) and because of which these properties (and relations) are combinatorial of and descriptive of it. To have no ontic predicates is to have no nature and so not to exist. Even a bare particular would have to have a specific essence or nature that makes it to be what it is and distinguishes it not only from, say, a tree, an intension, the number three, etc., but also from other bare particulars—what makes p_a's 'thisness' distinct from p_b´'s 'thisness'. Without these differentiating constituting essences all bare particulars would reduce to a single one and hence, absurdly, there would be but one extant thick particular. Thirdly, if a bare

particular can exemplify no properties it cannot have what are nevertheless its apparent *prima facie* essential properties of Is-Unrepeatable, Is-Simple, etc. Recently, J. Moreland and T. Pickavance have attempted to account for this counter-intuition by arguing that, in fact, expressions 'Is-Unrepeatable', 'Is-Simple', etc., are linguistic predicates that do not correspond to any genuine ontic predicates (Moreland and Pickavance 2003). The argument is that these are all less perspicuous versions of negative linguistic predicates, e.g., 'Is-Unrepeatable' is the same as 'Is-not-Repeatable', and as such they mark the extra-linguistic absence of the mentioned positive property. The true proposition Is-not-Repeatable(*a*) asserts that subject *a lacks* the property with intension Repeatable, and hence this proposition and negative propositions generally do not require commitment to any nature of *a*. I have argued to the contrary, that true negative propositions require as grounds or 'truth-makers' specific essences for the subjects referenced. Specifically, the properties or relations referenced in these propositions do not obtain among the referenced subjects because the latter have combinatorial of them ontic predicates that exclude the denied attributes, and to have these positive attributes presupposes their subjects have inherent determinate natures founding them. Both of the propositions: that Apple *a* is green, and, that Apple *a* is not green, have true-values determined in part by the nature of *a*. Apple *a* is not green because it has a contrary property, say, of being red, and, for spatial entities *a* and *b*, *a* is not to the left of *b* because *a* and *b* have some other contrary spatial relations, the latter obtaining on at least the condition that *a* and *b* have the natures of extended/spatial-relevant entities. Even the true negative proposition that 2 is not left of 3 turns on the specific natures of 2 and 3, putting them in a category distinct from that of spatial entities. If all of this were otherwise then all negative assertions would be neither true nor false but simply arbitrary denial independent and non-descriptive of reality.

Finally, in addition to these mostly familiar arguments against bare particulars, there are two further arguments, the first being the promised simple and, I propose, more obviously fatal argument that turns on the fact that a bare particular has intensions attached to it, not by characterizing ontic predication, but only by nature-irrelevant arbitrary conjunction, e.g., the Tied-to relation. This undiscriminating unification is the type of unity found among the elements of a list, set, or mereological fusion where the essences of the elements is irrelevant to their being linked. The key propositions at issue here are: A bare particular p_a is characterized by no proper-

ties, or alternately, exemplifies no intensions whatsoever; and, a thick particular *a* has properties exemplifying intensions F, G, H, ..., if and only if F, G, H, ..., are tied-to *a*'s underlying bare particular p_a. Now, what the completely arbitrary nature of the Tied-to relation implies is that any intensions *whatsoever* can be equally linked to a bare particular p_a, *including contrary or contradictory intensions*, e.g., it could be true that Tied-to(Round,p_a) and Tied-to(Square,p_a). That is, there is nothing inherent to a set of intensions tied to a bare particular that would preclude it from containing contrary or contradictory intensions, anymore that it can be held impossible that intensions Round and Square could be jointly associated with some entity *x* in a set: {Round,*x*,Square}. In order for the linking of an intension P with an entity *x* to preclude the linking with *x* of intensions contrary or contradictory to P, this linking must be that of nature-relevant ontic predication, not that of free association as with the Tied-to relation. Alternately said, for an intension P of *x* to be exclusionary of other intensions of *x*, P must be a component of a property as it is characterizingly predicable of ('says something about the nature of') *x*, and not just arbitrarily juxtaposed with (and so indifferent to the nature of) *x*. Now, what this means is that there is no non-arbitrary reason why in this ontology of bare particulars there could not exist a thick particular *a* resulting from the bundling of contrary or contradictory properties with a unifying bare particular, or more explicitly on the second proposition above, why a thick particular could not exemplify contrary or contradictory properties, and this is absurd. Finally, there is the related argument that if an ordinary thick particular *a* reduces to intensions each arbitrarily tied to bare particular p_a then the distinction between accidental and essential properties of *a* cannot be explained. In sum, the concept of a bare particular is incoherent. Moreover, on the analysis advanced herein the necessity of positing a substratum bare particular to account for either the collective unity of the properties of an ordinary particular or for its individuation disappears.

This leaves us to consider briefly entities under option b)—tropes—as the last of the alternatives required under the Inert Substrata Thesis. Trope nominalists reject repeatable intensions and all *monadic* (note!) ontic predicates as subject-dependent entities, and in this reject as stated all of the prior Theses B1-B5. The strategy of trope theorists is to explicitly admit the qualitative aspect of entities but in such a way that it is consistent with their nominalism; that it avoids the necessity of positing an underlying bare particular; and that it conforms to the Inert Substrata Thesis. This

is done by construing *monadic* properties as unrepeatable, non-composite, non-ontic-predicates, i.e., by positing the collapsing together of an apparently repeatable qualitative aspect of single entities, e.g., the quality Red, with an individuating aspect so as to form an absolutely simple, non-composite individuated property that is substance-like in being itself non-combinatorial of any subject. The theses characterizing trope theory are then as follows (using 'T' to designate the relevance to trope theory):

Thesis T1: Given monadic linguistic predicates F, G, H, …, of a prescribed class (usually phenomenal or physicalistic) such that for a particular *a* propositions F(*a*), G(*a*), H(*a*), … , are true, then there exist corresponding to each a non-composite natured individual or trope, t-F_i, t-G_j, t-H_k, …(e.g., t-Red_i, t-$Round_j$, t-$Mass_k$), that are each constituents of *a*.

Thesis T2: A set of tropes each compose a thick particular *a* by being pairwise joined via a Compresence (or similar) relation.

Thesis T3: Tropes may enter into a (exact) Resemblance relation with other tropes, e.g., t-Red_i exactly resembles t-Red_j, where, though the obtaining of the relation is a function of the qualitative content of its relata, it is primitive in the sense that there is nothing numerically identical in each relata that founds the relation.

For trope theory, then, an ordinary thick particular is a compresent bundle of 'non-bare' yet 'very thin' particulars—each with a single qualitative, though not numerically repeatable, aspect that determines it to fall within a certain resemblance equivalence class, the latter being nominalism's surrogate for an intension universal. Now, as was noted, there are a number of objections to trope theory found in the literature. I will mention two of these. First, equivalence classes or sets of resembling tropes, e.g., the set of all red-resembling tropes or the set of mass-resembling tropes, are claimed to do the work of the realists' shared universals, e.g., Red or Mass, in explaining non-arbitrary classifications. In other words, the commonality that makes, say, a group of tropes to be red-tropes is not explained intensionally by a shared universal, Red, composing each, but rather, in the opposite direction and extensionally, by just these tropes composing a fixed whole—the equivalence class. This class is the single feature that all these and only these tropes have in common, and it defines their 'kind', e.g., their being red. But this tack fails, and it fails even under

the ontically more accurate analysis where the whole is identified with the structure consisting jointly of tropes interrelated by the Resemblance relation. This is so because the whole as either a set or resemblance structure has its constituents necessarily, and would not be the same whole if it had more or less constituents. Hence, the sets or structures that are surrogates for Red or Mass could not have different mutually resembling tropes than they do. In other words, there could not have been more or less red things, or, indeed, more or less physical objects having mass. Of course, this generalizes to all such equivalence classes or structures: there could not have been more or less of any kind whatsoever. And, this is false. For, just as there is nothing inherent in a contingently exemplified intension, e.g., Red or Mass, that fixes its extension, there is nothing inherent in tropes (each an 'individuated intension'), whether individually or collectively in resemblance classes or structures, that precludes there being more or less of them resembling in the same way, and thus no single such whole could serve as an account of why certain tropes are classified as the 'same kind', e.g., as red. In short, there is no fixed class that could act as a surrogate for contingently exemplified universals, or, alternately, intensionality cannot be explained in terms of extensionality. Nominalism in whatever guise cannot escape the recognition of shared intension universals. A second common argument against tropes starts with the observation that tropes themselves have (pure) properties, e.g., trope t-Square$_i$ has the properties Is-Polygonal, Is-a-Shape, Is-Concrete (i.e., is in space and time), Is-Unrepeatable, Is-Qualitatively-Determined (i.e., is a non-'bare' particular). On the same analysis trope theory gives properties of ordinary particulars, viz., construing them as tropes bundled to compose the particulars, likewise properties of tropes would have to be construed as further tropes bundled to compose their subject tropes, and hence, contrary to T1, tropes would be composite. Indeed, with iterations of properties like Is-Unrepeatable, a given trope, e.g., t-Red$_i$, would be composed of a downward infinite regression of contained t-Unrepeatable$_j$ containing t-Unrepeatable$_k$ containing t-Unrepeatable$_l$ containing… To avoid all of this proponents would have to generate some tortured theory as to why these linguistic predicates, despite all appearances, have no corresponding properties or tropes. The underlying problem here is the assumption that what characterizes an entity must be a constituent of it, as specified in T1.

In addition to these arguments against trope theory, I offer the following: First, as broached above, the Compresence relation cannot be

simply arbitrary or blank association, or we would have the same difficulties as with the Tied-to relation above. The Compresence relation must have as part of its minimal content or 'meaning' a precluding of contraries as relata, e.g., it is necessarily false that Compresence(t-Red_i,t-$Yellow_j$). If it were otherwise then, as with the Tied-to relation, it would be possible for the same complex entity to be, say, both red and yellow. But now there exist complex entities that have contrary properties in the sense of, for example, a metal bar with what here would be trope t-Red_i composing part of one end and trope t-$Yellow_j$ composing part of the other. Now, if tropes and the Compresence relation are the only ontic ingredients making up complex entities in this ontology, and if the bar is such an entity, then, because the Compresence relation is transitive, we would have as true the proposition Compresence(t-Red_i,t-$Yellow_j$). So the alternatives are that we either give up the vast class of entities of which the bar is representative as only illusionally single entities, or admit that such entities are composed of additional things—what could only be relations other than and not reducible to Compresence or other tropes. Secondly and relatedly, trope bundles, whether unified by the standard Compresence relation or a relation expressing some further intension-relevance between its subjects, such as Peter Simons' Husserl-type 'mutual founding' relation (Simons 1994), are, because either composing relation is symmetric, virtually without internal order, system or structure. Yet, our initiating point in this essay was that robust internal structure and this at each level in emerging hierarchies is precisely the ubiquitous ontological given and what must be explained. Compresence or Mutual-Founding take only tropes as relata, not other bundles and so cannot generate from the bottom up hierarchies of nested entities. Moreover, it is a given that distinct complexes can have the same parts differently structured, i.e., differently related (either by relations with different intensions or by the same other-than-symmetric relation but in different relata positions), but this is not possible when the only unifying cause of a complex entity is a symmetric relation. What are required are ordering asymmetric and non-symmetric relations, and this ordering generalized to 3-adic, 4-adic, etc., relations (a point made without specifics by Simons (1998)). However, once such polyadic relations are admitted into trope theory, we have the following cobbled bifurcated ontology. First, we are reminded that such *n*-adic relations are irreducible to monadic properties of their relata, and so must be admitted as existing fully 'between' and combinatorial of ('actually relating') their *n*-subjects as they qualify these subjects jointly (hence the error of the inherence model of predication).

That is, definitionally a relation is an intension-determined-linking of multiple subjects, and as there can be no linking without something linked, there can be no polyadic relation without subjects standing in this relation. A relation in the full sense depends for existence upon the simultaneous existences of other entities and its unifying agency among them—it is a dependent *ens ad aliud* that cannot exist outside of a fact. Assisted by language it is possible to cognitively abstract from a relation in a fact, e.g., :Is-Between(*a*,*b*,*c*) or :Loves(*a*,*b*), a combinatorialless/inert intension, e.g., Between/Betweenness or Love, that when compared to the former are clearly derivative and would be called relations only in a secondary sense. So now in regard to countenancing trope theory we have the following situation: Intrinsic to both properties and relations is the uniform fact of intensions involved in qualitatively characterizing/being-attributable-of one or more subjects, with the only difference being the accidental one of the number of subjects characterized. Further and reinforcing the latter, both properties and relations are seamlessly formalized in our standard logics as equally in the category of predicates. Yet contrary to both this ontic and logical continuity, we have intrinsic to trope theory the ontological bifurcation of monadic predicates treated as non-combinatorial, non-dependent, atomic 'little substances' (i.e., 'subjects' or 'objects' only—each an *ens per se*), and polyadic predicates treated as just the opposite. This bifurcation should strike us as not only suspiciously artificial, but at this point as an error based upon confusing a derivative inert monadic intension, e.g., Red or Mass, with a predicable-of/subject-qualifying and so subject-dependent property, e.g., Is-Red or Has-Mass, and further as an error motivated by—indeed required by—what is the background assumption of the Inert Substrata Thesis. The Thesis applied to an ontology exclusively of attributes requires some class of non-dependent/non-combinatorial entities to support all other dependent/combinatorial entities, and since polyadic relations are clearly the latter, this leaves monadic properties so construed (what are easily misconstrued as the limiting 1-adic case) to fit the bill, viz., predicable properties turned into non-predicable tropes.

In sum, the argument thus far is that all the options a)-c) under the Inert Substrata Thesis, i.e., theories advocating either intensions, tropes, or bare particulars as required ultimate non-predicable substrata, are equally defective. What is needed in response to this negative necessity is an ontology that actually displays the positive possibility of an alternative to the

Thesis. We shall now observe how this is provided in an ontology of network instance realism.

III. Ontic predicates as Individuated Substrata, and Their Compounds

The errors of the Inert Substrata Thesis and the various theories attempting to enforce it are abetted by the naïve assumption that monadic ontic predicates—properties—are paradigm and fundamental. Theses B1 and T1 are plausible only on this assumption. As in the tradition the assumption requires that polyadic relations be given either some 'quasi-real' status (Aristotle, *Meta*. 1088a22), e.g., they 'supervene' on their relata or properties thereof but represent no ontic addition, or they reduce without remainder to properties of their relata. Both of these strategies are unsuccessful upon analysis, to say nothing of being *prima facie* contrived and forced. Indeed, when polyadic relations are recognized full and unreduced, with monadic properties the limiting though easily distorted case, there are liberating and profound implications for ontology, implications that correct the above theses and provide an alternative to the Inert Substrata Thesis. I have given a full analysis of polyadic ontic predicates elsewhere (Mertz 2002, 2003, 2004) and shall here mostly summarize the results. Summarizing general points made above, the perspicuous feature of relations is that they are externally 'between' or 'among' their relata (in medieval terms, each an '*intervallum*' = 'interval'), and, historically less perspicuous (principally because of the distorting bias of the inherence model of predication) though crucial, each is an agent unifier of ('actually relates') its relata, effecting as such a plural whole that is a fact or state of affairs. The latter is the lesson of the classic Bradley's Regress argument. When fully analyzed we have the following detailed principles characterizing ontic predicates:

Principle I: Constitutive of every fact :$R^n_i(a_1,a_2,\ldots,a_n)$, for $n \geq 1$, is an ontic predicate, $R^n_i(x_1,x_2,\ldots,x_n)$, that is the external agent/cause of the characterizing predicable unity of itself with its relata, a_1, a_2,…, a_n, a unification whose type is to result in a fact, as opposed to a list, set, or mereological sum.

Principle II: Every ontic predicate $R^n_i(x_1,x_2,\ldots,x_n)$ has as a constituent a single universal intension R^n whose ontic role is that of delimiting or determining non-arbitrarily the possible *n*-tuples of relata, $<a_1,a_2,\ldots,a_n>$, that predicate $R^n_i(x_1, x_2,\ldots, x_n)$ can unify into a fact. However, an intension R^n

of itself has no causal agency whatsoever as a unifier (it is 'predicably inert' or 'substance-like').

Principle III: In addition to and distinct from intension R^n, there is constitutive of ontic predicate $R^n_i(x_1,x_2,\ldots,x_n)$ its actual mode of union, its combinatorial or linking agency, among and to its particular *n*-tuple of subjects. The linking aspect of predicate $R^n_i(x_1,x_2,\ldots,x_n)$ is itself not a further intension in addition to R^n, but a *causal act of unification* that is 'joined' with intension R^n that controls its effects. This joining is the unity of a *continuous composite*, i.e., a union of two distinct entities without the agency of a further interposing ontic predicate or act of unification. Of fundamental importance, the unifying act of an ontic predicate is unrepeatable and particular, rendering the containing predicate an individual, i.e., a unit attribute (hence the subscripts, e.g., 'i').

Principle IV: The unifying act among an *n*-tuple of subjects is unique to than *n*-tuple. Hence, an instance ontic predicate subsuming this act is unique to this *n*-tuple of subjects, i.e., if $R^n_i(a_1,a_2,..,a_n)$ and $R^n_i(b_1,b_2,..,b_n)$, then $a_1 = b_1$, $a_2 = b_2$, … , $a_n = b_n$. In the opposite way, ontic economy requires that no *n*-tuple of subjects have more than one instance of the same intension R^n, i.e., if $R^n_i(a_1,a_2,..,a_n)$ and $R^n_j(a_1,a_2,..,a_n)$, then $R^n_i = R^n_j$. Also, because it is intrinsic to an instance ontic predicate to be an agent unifier of an *n*-tuple of subjects, it cannot exist independent of this *n*-tuple except cognitively in selective abstraction.

Henceforth I shall abbreviate individuated ontic predicates or relation instances by dropping the variables designating the subject places, e.g., '$R^n_i(x_1,x_2,\ldots,x_n)$' will simply be '$R^n_i$', this being sufficiently distinguished from 'R^n' (i.e., without the subscript) used to refer to instance R^n_i's contained and determining intension. Now profound in its consequences, that ontic predicates are individuated to particular *n*-tuples of subjects follows immediately from their natures as unifying acts, and is perspicuous in the case of contingent relations. Assume, for example, that facts $:Loves^2(a,b)$ and $:Loves^2(c,d)$ both obtain, for pair-wise non-identical *a*, *b*, *c*, and *d*. The combinatorial act linking $<a,b>$ under the intension $Love^2$ cannot be numerically the same as the unifying act under intension $Love^2$ for $<c,d>$, though the intension is numerically the same. This is so because fact $:Loves^2(a,b)$ can go out of existence, i.e., *a* can cease to love *b*, without fact $:Loves^2(c,d)$ ceasing to exist. If it were exactly and numerically the

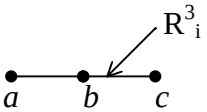
same unifying act for both facts they would have to come into and go out of existence together. It is more appropriate, then, that our facts given as ':Loves^2(*a*,*b*)' and ':Loves^2(*c*,*d*)' be designated as ':Loves^2_i(*a*,*b*)' and ':Loves^2_j(*c*,*d*)', where, as instance constituents of these facts, Loves$^2_i \neq$ Loves^2_j. In general, fact-effecting acts of predicable unification are as individual and unrepeatable as any other acts, e.g., events. Importantly, what this means is that the combinatorial agency of ontic predicates is ontology's *principium individuationis*—an insight that completely reverses the historical metaphysical role and status of ontic predicates. With this ontology we have a straightforward *account* of individuation without having to resort to simply positing either primitive 'thisness' (*haecceitas*) or incoherent bare particulars.

As an introduction to the implications of Principles I-IV let us contrast them with previous Theses B1-B5 and T1-T3. All of trope theory's T1-T3 are rejected, as are B1 and B5, but with B3 and B4 retained. Thesis B2 is independent of the above principles, yet is, I propose, true when extended as: An individual *a* exits if and only if *a* has at least one ontic predicate P^n_i, i.e., *a* as a subject exemplifies intension P^n, and thus the proposition that P^n_i(..,*a*,..) is true. Crucially and contrary to the misleading inherence model of predication inspiring theses B1 and T1, Principles I and II do not require that an ontic predicate or its contained intension enter into the composition of the subject(s) of the predicate, but rather in characterizing its subjects attaches itself externally to it (or them). The combinatorial act of attachment is a function of a qualitative relevance between the intension of the agent instance and the nature(s) of the instance's subject(s). In general, ontic predicates are not downwardly subsumed parts of their subjects, but rather are the instruments for themselves and their subjects to form upwardly emergent and subsuming wholes. It is the thesis of containment of ontic predicates by their subject individuals that necessitates their being construed either as individual non-combinatorial and only monadic tropes, or as repeatable intensions requiring the posit as a further constituent of an absolutely qualityless individuator. Principle II agrees with B3 and contradicts T1 in admitting intension universals. Principle III details the requirement of Thesis B4 applied to ontic predicates, i.e., a repeatable intension R^n is joined in a non-predicable way with an unrepeatable combinatorial act that determines the particularity of resultant instance R^n_i. Neither intension nor unifying act are aspects or modes of the other, but are each abstractable aspects of the simple instance R^n_i, existing as

separate only in the intellect (see Mertz 2004). Likewise, by Principle IV, an instance R^n_i exists separated from its *n*-tuple of subjects, and so from the fact they jointly compose, only in abstraction. Principle IV places conditions on how instances exist relative to *n*-tuples of subjects, conditions essential to the following further principles explicating the ontology of network instance realism.

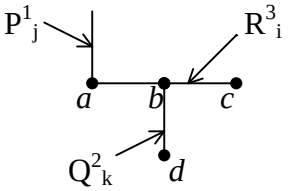
Let us now turn to the central issues of how relation instances characterized by Principles I-IV above can compose hierarchies of structures that are ordinary particulars, e.g., Socrates or a computer, and can at some atomic level be mutually sustaining and collectively complete and non-dependent. Consider first as an example of the simplest type of complex or structure, i.e., single facts, the fact :$R^3_i(a,b,c)$ as modeled with the following diagram:

Complex A:



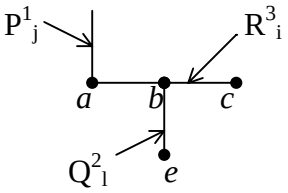
The horizontal line segment represents the instance R^3_i as the shared unifier among subjects *a*, *b*, and *c*. Now consider two further facts, $P^1_j(a)$ and $Q^2_k(b,d)$, where monadic instance P^1_j shares its only subject *a* (hence a line segment with one subject dot) with triadic instance R^3_i, and dyadic instance Q^2_k shares subject relata *b* with R^3_i. This would be diagrammed as:

Complex B:



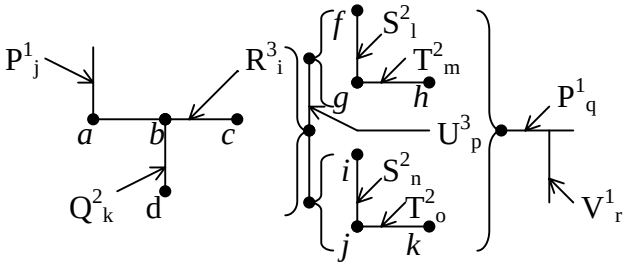
Complex B is a compound or molecular structure, and it is so by what can be called 'horizontal composition', i.e., a 'chain' of connectedness across pairs of relation instances sharing one or more relata, and a transitivity across such pairs via the sharing of an instance, e.g., R^3_i is the shared instance and so common link between relata-sharing pairs P^1_j and R^3_i, and, R^3_i and Q^2_k. Note that, because instances are unique to their ordered *n*-tuples of subjects, if a relata is changed then a relation instance of the same intension combinatorial of the replacement and the remaining relata will be numerically different. For example, if *d* is replaced by *e*, $e \neq d$, then instance Q^2_k changes to Q^2_l, where $Q^2_k \neq Q^2_l$. Consider such a change made in the Complex B yielding the following distinct structure.

Complex C:

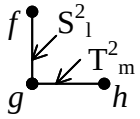


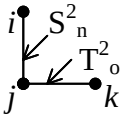
There are two important points to note in comparing Complexes B and C. First and intuitively, though B and C are not identical, they have *exactly the same structure*, i.e., they are isomorphic. Secondly, though a change of one relata, *d*, to a non-identical relata, *e*, necessitated a change of instance Q^2_k to Q^2_l, there are no other 'reverberations', i.e., changes, caused within the larger complex. This is not the case for the second type of structural composition, what is hierarchical or 'vertical composition'. Here entire structures get treated as themselves single relata for further properties and relations, what can be indicated diagrammatically with the use of braces. Consider the following diagram utilizing B as a sub-structure.

Complex D:



Complex D illustrates both horizontal and vertical composition, with two levels of vertical composition. The left-most brace indicates that Complex B on the left of it is, as a whole, a single relata for relation instance U^3_p, as are each of the isomorphic structures

Complex E: 

and **Complex F**: 

The right-most brace of Complex D indicates that the entire vertical compound to its left is itself a single subject for the property instance P^1_q. One could think of Complex D as representing, for example, the structure resulting from three molecules—Complex B and the two 'identical', i.e., isomorphic, Complexes E and F—structured among themselves by an instance of a triadic inter-molecular relation U^3, this compound in turn and as a whole having an instance of, say, causal property, P^1. Now, it is easy to conceive how this vertical compounding could be continued indefinitely up

through further and further levels, and how at certain levels there could be properties and relations, say U^3, whose instances emerge *sui generis*, i.e., do not occur at lower levels and presuppose as at least some of their relata certain types of sub-structures. This fits the bill precisely for an ontology of ordinary objects set as the desideratum in the introduction: ordinary objects are immense though finite hierarchies of horizontally and vertically composed structures generated upwardly from what science determines are the ultimate sub-atomic entities. Similarly, once alerted to these two forms of composition one can see their iterations exemplified in cognitive, mathematical, logical, social, etc., structures. Vertical composition and its distinction from horizontal composition are the conditions *sine qua non* for a proper understanding of emergent properties and relations.

What is now required is that we make precise these intuitive notions of horizontal and vertical composition. This is done iteratively in the following principle, one asserted to characterize all forms of plural unity, starting with and built up from facts as atomic complexes. This in turn will afford refined and differentiated definitions of identity and indiscernibility, that for indiscernibility being particularly promising for solving philosophical problems concerning persistence through change of composition, e.g., the Ship of Theseus problem, and the problem of 'metaphysical underdetermination' for quantum objects.

Principle V: All plural unity—and thus plural wholes (complexes or structures)—is by the following:

(a) A relation instance R^n_i predicable of an *n*-tuple of relata, $<a_1,a_2,..,a_n>$, is the cause of an individual plural whole, viz., a fact $:R^n_i(a_1,a_2,..,a_n)$, having R^n_i, a_1, a_2, .., a_n, as its only constituents.

(b) If R^n_i is a constituent of a plural whole *x* and S^n_j is a constituent of a plural whole *y*, and R^n_i and S^n_j, share one or more relata, then there is an individual plural whole *z* that has as constituents all and only the combined constituents of *x* and *y* (horizontal composition).

(c) For any fact $:R^n_i(a_1,a_2,..,a_n)$, if for $1 \leq j \leq n$, a_j is a plural whole, then there exists an individual plural whole whose constituents are all and only the constituents of the fact and constituents of a_j (vertical composition).

Principle V is the account of all forms of composition and so of plural wholes whatsoever, and in this regard corrects the erroneous and anemic Theses B5 and T2 above. It likewise serves to highlight what is the debilitating misanalogy of sets or mereological sums used as models for complex entities. Consider next the instance analog of the standard definition of identity:

Principle VI: Entities *a* and *b* are identical, $a = b$, if and only if, for every monadic property P^1 and every instance P^1_i of P^1, $P^1_i(a)$ if and only if $P^1_i(b)$.

The more specific identity condition on complexes is given by:

Principle VII: For complexes *x* and *y*, $x = y$ if and only if, for every intension R^n and every instance R^n_i of R^n, R^n_i is a constituent of *x* if and only if R^n_i is a constituent of *y*.

This is so because predicate instances do not exist independently of their relata and, by Principle IV, numerically the same instances have numerically the same relata, combined with the central thesis of this ontology that the being of a complex entity consists solely in its constituent ontic predicates and their relata. Principle VII explicates accurately the intuition that 'constitution is identity', and corrects the common but crude version of 'mereological extensionality' that ignores component (individuated) ontic predicates that are nevertheless essential to every plural whole.

The final principle makes perspicuous the traditionally obscure notion of indiscernibility and how it is derived from the primitive but transparent indiscernibility of relation instances of the same type. For if, as we are about to see, at some atomic ontic level relation (including property) instances can be horizontally mutually combinatorial and that all other extants are built up by vertical and horizontal composition on these atomic structures as relata, then indiscernibility can be specified *universally* and iteratively as:

Principle VIII: Entities *x* and *y* are indiscernible if and only if
(a) $x = R^n_i$ and $y = R^n_j$, where R^n_i and R^n_j are instances of the same intension R^n.

b) $x = :R^n_i(a_1,a_2,..,a_n)$ and $y = :R^n_j(b_1,b_2,..,b_n)$ and a_k and b_k are indiscernible for $1 \leq k \leq n$.

c) x and y are complexes such that there is a one-to-one correspondence ϕ between their constituent facts where $\phi(:R^n_i(a_1,a_2,..,a_n)) = :R^n_j(b_1,b_2,..,b_n)$ and where $:R^n_i(a_1,a_2,..,a_n)$ and $:R^n_j(b_1,b_2,..,b_n)$ are indiscernible.

Foundational section VIII-a asserts relation instances to be what I propose are the unambiguous counter-examples to the Leibnizean Principle of the Identity of Indiscernibles, viz., instances R^n_i and R^n_j (e.g., Is-Between^2_i and Is-Between^2_j) can differ only numerically in that the sole remaining aspect of their beings, qualitative content R^n (e.g., Between^2), is numerically identical across both. And recall that instances with the same intension differ, not by each having some simply posited and inscrutable *haecceitas* or bare individuator, but by their unrepeatable combinatorial agencies, what is both the intuitive nature of ontic predicates and the requisite *ontoglial* for a plural reality. If other entities are built up from indiscernible atomic instances in accordance with VIII-b and –c, then we would have structures with complexity to any degree that are *numerically distinct but qualitatively identical*. This is so in the full sense that such structures would be both composed exclusively of corresponding internal component instances differing only in number but not in intension, as well as, as wholes, would be the subjects of corresponding external ontic predicates of the same (pure) monadic intensions but differing only numerically. That is in regard to the latter, indiscernible complexes will themselves have all the 'same properties' in the now precise sense of indiscernible instances of the same monadic intensions. In this we have for indiscernibility the analog of the formal specification in Principle VI for identity: Entities a and b are indiscernible, $a \equiv b$, if and only if, for every monadic property P^1, there is an instance P^1_i such that $P^1_i(a)$ if and only if there is an instance P^1_j such that $P^1_j(b)$ (Mertz 1999: 92). Indiscernible complexes may, of course, also share indiscernible instances of some polyadic intensions. We can illustrate and extend these points but in reverse direction by considering isomorphic complexes E and F above. They would be indiscernible if under VIII-c and the one-to-one correspondence ϕ where $\phi(:S^2_l(f,g)) = :S^2_n(i,j)$, and $\phi(:T^2_m(g,h)) = :T^2_o(j,k)$, the facts in the pairs $:S^2_l(f,g)$ and $:S^2_n(i,j)$, and, $:T^2_m(g,h)$ and $:T^2_o(j,k)$, are indiscernible. The latter would be the case under VIII-b if corresponding relata f and i, g and j, and h and k are, as paired, indiscernible. The latter would obtain, in turn, if the relata in each

pair were again either complexes indiscernible under VIII-c or facts indiscernible under VIII-b. Now this regress for determining indiscernibility would stop if in the downward analysis we reach in each case a bottom level of compound complexes where the composing facts of each have only property or relation instances of its other composing facts as relata—the same demonstration needed to negate the Inert Substrata Thesis and what will be given below. In this situation VIII-a would apply and no entity would be left outside of the scope of the applicability of VIII as a criterion for indiscernibility. Hence, built exclusively of relation instances that differ only numerically, indiscernible complexes so specified would differ only numerically, in whole and in every corresponding part. These complexes would be intrinsically and objectively indiscernible prior to epistemological considerations of re-identification by a knower.

Consider the issue from the opposite side of discernibility. Instances differ other than only numerically in two ways: either by having non-synonymous intensions, or, having the same intension, they have different relata *n*-tuples, the exception to the latter being when the *n*-tuples differ only in order of relata and this is irrelevant to the intension (e.g., for facts :Next-To^2_i(*a*,*b*) and :Next-To^2_j(*b*,*a*), the distinction in *n*-tuples <*a*,*b*> and <*b*,*a*> is irrelevant to symmetric intension Next-To^2, i.e., the facts are identical, but not so if the intension had been, say, the non-symmetric Love^2). Consequently, two hierarchical complexes, say two leaves, differ other than numerically by having at some level sub-complexes that are not indiscernible, which means formally that for every possible one-to-one correspondence of composing facts of these sub-complexes there exists one or more corresponding composing instances that differ in one of the above ways. In practice, discernible complexes are known to be such because they are known as wholes to be subjects of contrary properties or relations.

Significantly then, including the possibly of resolving current problems of ‘particle identity’ in quantum mechanics, indiscernible complexes so specified would be epistemically differentiated—known as numerically not the same—only when known as jointly embedded in a further meta-structure composed of them as relata for instances of differentiating irreflexive or non-reflexive relations, e.g., spatial or causal relations. Now consider the following situation. If, say, these indiscernible sub-structures, *a* and *b*, were permuted back and forth several times in the context of a meta-structure that ‘remained constant’ throughout, i.e., resulting in a tem-

porally extended meta-meta-structure consisting in a connected sequence of these meta-structures chronicling the permutations, then a knower cognizant of the full unbroken sequence, and in this the 'continuous spatio-temporal trajectories' of both *a* and *b*, would, of course, be able to re-identify in the last permutation meta-structure of the sequence which of the permuted indiscernible sub-structures was *a* and which was *b*. That is, *a* would be known as *a* and *b* would be known as *b* throughout and so each would retain its 'identity', or more accurately, its identification, throughout the sequence known in its continuity. However, if for a knower knowledge of the complete sequence of permutations were 'broken'—incomplete or unavailable (e.g., spatio-temporal trajectories from quantum particles are not precisely defined)—then cognizance of the last permutation meta-structure would still be sufficient to discern the *numerical differentiation* of *a* from *b* but not sufficient for their particular identifications, i.e., not sufficient to re-identify which one was which. Now, this would seem to describe the apparent and ontologically challenging situation with the 'vague' entities of micro-physics. Under the 'Indistinguishability Postulate' of quantum statistics, permutations of quantum particles are not counted as representing new arrangements, there being no observational means for distinguishing the permutations (French 1988; 1998; 2003: Hilborn and Yuca 2002). In this way quantum mechanics describes states of indistinguishable but numerically distinct particles, particles said to be cardinally but not ordinally distinct. Now, the instance ontology outlined here would seem to account for this nicely: if indiscernible complexes specified by VIII (say E and F where their corresponding relata are indiscernible, which rests ultimately on the proof below) are permuted an unknown number of times in a subsuming 'constant' meta-structure-type (including experimental context), then the first meta-structure, say D above, and the last meta-structure, D′, would themselves be numerically distinct but indiscernible, and in this sense there would be no qualitative 'observational difference', i.e., intensionally different composing properties or relations, distinguishing the subsuming contexts, D and D′. Relative to these alterations we could say that the complex type of D and D′ is 'permutation invariant'. Just as it can be said of quantum particles, it is true here of two or more indiscernible entities in the same fixed context/meta-structure, and without a knowable continuous 'trajectory' for each entity, that relative to any possible permutation 'no measurement whatsoever could serve in principle to determine which of the indiscernible entities are which'. In such contexts indiscernible complexes E and F could not be 'named individually', i.e.,

re-identified, and so in jointly composing the D-type structure would have a cardinality of two but no ordinality.

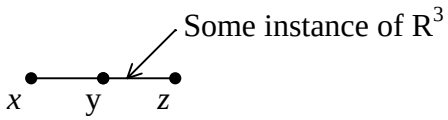
More generally, quantum particles are said to violate even the weakest form of the Principle of the Identity of Indiscernibles, and thus in not differing by repeatable properties (i.e., construed as intension universals) these particles either differ by some other non-property, non-universal constituent individuators (the options cited being *haecceitas* or bare particulars—known in this context as 'transcendental individuators'), or they differ neither by uniquely possessed intensions nor individuators and are thus some sort of strange 'non-individuals' or 'quanta'. It has been proposed but has remained undeveloped how a 'Structural Realism' might reconcile the individual/non-individual dichotomy by providing a precise formulation of the relational holism characterizing quantum particles and fields (e.g., French 2001; French and Ladyman 2003). The ontology presented herein—what I have called network instance realism—details what has promise as such a synthesizing structuralism. It provides a precise specification of indiscernibility showing perspicuously how entities of any degree of complexity can be numerically distinct but qualitatively the same, this for qualities of any polyacities and without the need to simply posit a thus suspicious 'transcendental individuator'. It answers the question of how from a level of quantum entities that violate the Principle of the Identity of Indiscernibles there can be built up at some levels entities for which the Principle holds, i.e., entities whose differences are marked by different monadic properties (Hilborn and Yuca 2002: 368). This is so simply by the fact that the same kinds of indiscernible structures inter-related in different ways, e.g., by relations with distinct intensions, make for emergent structures themselves with different properties. The instance structuralism given herein demonstrates in what manner an individual can be composed exclusively of attributes, and in this it makes precise the often-made characterization of the quantum world as a realm 'where all is structure'(Ibid.). That is, the analysis takes a Kantian-like view expressed by Cassirer that quantum entities are to be construed exclusively as '"points of intersection" of certain relations' and renders it explanatorily precise and potent by demonstrating in what manner they can be 'mutual intersections of individuated relations'(Cassirer 1956: 180; see French 2001). And in regard to the purely structural nature of quantum entities, a relational hybrid of trope theory is often proposed as a candidate ontology (e.g., Simons 1994; Wayne forthcoming). In contrast to trope theory, however, the above in-

stance ontology retains uniformly the combinatorial nature of ontic predicates of every *n*-adicity, thus providing an account for individuation across the board, and does so without the need for positing non-combinatorial underlying subjects, disarming in this way a persistent objection to Structural Realism—the Inert Substrata Thesis that we cannot have ontic predicates without non-ontic-predicates as subjects. Further, instance ontology has a concomitant formalizable logic that has promise as the sought after more metaphysically accurate *organon* for describing micro-reality than current group theory or set theory (French and Ladyman 2003; for the logic see Mertz 1999). To what extent these promises have substance for microphysics I must leave to the experts.

Along this structuralist line it is important to also point briefly to the promise the above instance ontology has for solving more traditional problems of composition, e.g., the Ship of Theseus problem (Rea 1995). All physical entities, though enduring, nevertheless change more or less continually, parts being added, removed, or replaced (e.g., the repair of a ship by replacing one plank by another, or of a body by replacing one cell by another). Intuitively, though an entity before such a change of part and the entity resulting from the change are not materially the same—not numerically identical—they can be, depending upon the change, in some legitimate and essential sense 'the same' entity, e.g., the Ship of Theseus before and after every plank in the hull and every other part is successively replaced with one exactly like it. Loosely, the distinction here is between sameness as 'continuity of matter' and sameness as 'continuity of form', where the ship, for example, loses the former but retains the latter. Rea identifies five assumptions involved in classic puzzles over composition and that are jointly contradictory. Central to these and what the above instance ontology rectifies is the assumption that 'sameness' must be numerically identity and this under the 'identity assumption': $(x)(t)[(x$ is a constituent of a at time t & x is a constituent of b at time $t) \supset a = b]$. In the postulate the variable x is taken to either range over only non-structural/non-predicable entities that would compose a and b (the mereological interpretation), or, if including these structuring elements they are taken to be numerically the same (i.e., universals) in all the entities of which they are parts, e.g., a and b. In either case we have trouble. For under either interpretation, the Ship of Theseus, for example, with all the parts systematically replaced by exactly similar parts, what would seem to be the 'same ship' before and throughout the replacements, and a distinct

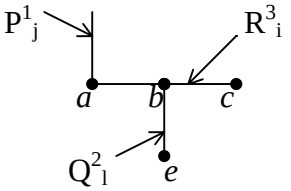
second ship reconstructed from exactly the replaced parts and in exactly the 'same order', would have to be identical. The refined precision of instance predicates allows us not only to differentiate composition identity, Principle VII, from indiscernibility, Principle VIII, as two forms of sameness, but also to specify a looser form of sameness: isomorphism. Though I will not give the details of a precise formal definition here it can be put inaccurately but instructively as: $(R^n)(R^n_i)(R^n_j)[(R^n_i$ an instance of R^n is a structuring element of $a \equiv R^n_j$ an instance of R^n is a structuring element of $b) \equiv a$ is isomorphic to $b]$. I.e., isomorphism is a corresponding exact similarity of structural components (the 'roads') without the structured relata (the 'nodes') being necessarily similar. Indiscernibility is the strictest form of isomorphism, as is identity the strictest form of indiscernibility. It is, I propose, isomorphism as one-to-one correspondence between instances of identical intensions that is essential to solving at least some of the key problems of composition. Specifically, what I am suggesting is that ordinary objects are definitionally carved out of the dynamic total-structure that is reality by specifying for each a delimited sub-structure that is itself a temporally extended continuous sequence of isomorphic structures, A1-A2-A3-…, and where what endures across all of them is the same isomorphic structure-type A. Let, for example, the form of Complex A above applied to an initial Complex C above be a simplistic model for the specification of the Ship of Theseus. For unrepeatable Complex A its repeatable general form is:

Form A:



where *x*, *y*, and *z* are variables ranging over the categories that intension R^3 delimits, respectively, for each of them. Reproducing Complex C for convenience,

Complex C:



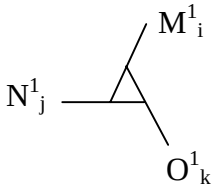
Complex C is the first state, A1, of the ship's existence as here defined, e.g., when, say, Theseus takes ownership (in at least this way there is a conventional element in the identity of the Ship *of Theseus*). Importantly,

Complex C has more complexity in its general form than Form A in having properties and relations with relata-places which Form A does not. As parts of C, *a* and *c* might be particular hull-halves, *b* a particular deck of a particular shape, and relation instance R^3_i an instance of a specific spatial configuration among entities of just these kinds. These parts properly ordered by intension R^3 conform to what is definitionally essential under Form A. However, remaining parts of Complex C outside the defining structural form A are as such accidental to the Ship of Theseus; say here, *e* a particular mast and sail, Q^2_l a relation instance relating positionally this mast and sail *e* to deck *b*, and property instance P^1_j could be the property of a particular defect of particular hull-half *a*. If as the ship changes over time, e.g., hull-halves *a* and *c* are successively replaced, and the deck is replaced in a manner like *b*, each time the replacement and remaining parts are so configured as to conform to intension R^3's delimiting and ordering, then there will result a sequence of A-isomorphic structures starting with A1, i.e., A1-A2-A3-…, and this will be the defined Ship of Theseus—a continuity of form-type of the whole over time. Accidental entities (e.g., *e*), and instances of accidental properties (e.g., P^1) and relations 'attached' to a particular A-form complex in the sequence A1-A2-A3-… may be absent in other complexes in the sequence without rendering the sequence no longer the Ship of Theseus. This would not, or course, be the only form of definitional identity for continuously changing structures. For example, what gives identity to a continuous sequence of particular structures may not be a persistent structural form had by the whole, but rather a structural form had by every sub-structure at some level, and these as related to a subsuming meta-structural form that sustains the formers' existences, e.g., the particular genetic code in every cell making up the body of Socrates, together with this body's metabolic structure that sustains these cells and their contained DNA molecules. Socrates, at least as a biological/physical being, is then the continuous sequence of structures starting with the zygote initiated by his parents and evolving from the dictates of the genetic code of every subsequent cell collectively forming his body and its sustaining metabolic system, a body that in macro-structural form is not constant over time. If Socrates loses a limb, then this sub-structure would no longer be part of *Socrates* since its cells would no longer be part of the subsuming metabolic structure keeping the remaining part of Socrates' body alive. Though introductory, this is, I propose, sufficient to show the promise of this ontology in regard to the traditional problems of composition.

IV. Conclusion: No Inert Substrata, No Regress

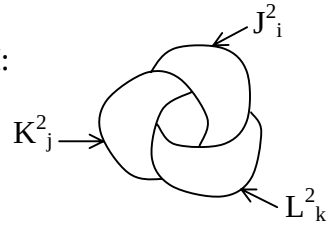
This brings us to the final but ontologically crucial obligation of demonstrating that, contrary to the Inert Substrata Thesis, instance ontology can rest on a base of only mutually dependent property and relation instances. Contrary to the general tradition, and specifically to some parties in the debate over an ontology for quantum particles (see French and Ladyman 2003), the absence of a base of non-dependent entities does not precipitate an infinite regress of dependent entities—as it were, 'turtles all the way down'. Relations (including properties) do not need non-relational relata. The demonstration is at this point in the analysis obvious and simple: Consider first that predicate instances can have as relata other predicate instances, e.g., an instance of a causal relation may be a relata for instances of spatial relations, or, an instance of Is-Prime^1 would be the subject of an instance of Is-Abstract^1. This is diagrammed, for example, on the right side of Complex D above where instance V^1_r intersects at its end point instance P^1_q, doing so without a shared relata dot indicating that the former is a property directly of the latter, i.e., that fact $:V^1_r(P^1_q)$ obtains. Based upon this it is then possible that there can be closed chains or networks of instances of any polyacities having only other instances in the whole as relata. A diagram of one of the simplest such 'closed systems' would be:

Complex G:



This diagram represents the closed chain of horizontally composed monadic facts $:M^1_i(N^1_j)$, $:N^1_j(O^1_k)$, and $:O^1_k(M^1_i)$. Each of the composing instances are dependent predicable entities but jointly they form a non-predicable and in this way an independent whole, a 'substance', an *ens in se*. The same mutual support can be seen among dyadic relations in following diagram:

Complex H:



Here we have the closed chain of dyadic facts $:J^2_i(K^2_j,L^2_k)$, $:K^2_j(L^2_k,J^2_i)$, $:L^2_k(J^2_i,K^2_j)$. It is easily seen that this scheme of mutually sustaining instances can be extended logically to networks composed of any number of relation instances and of any mixture of *n*-adicities, as long as each instance has as subjects in its relata *n*-tuple only other instances of the network. The only constraints in these regards would be via the intension of each composing instance and what it allows as to the natures of and the ordering among its relata. With these observations, then, we prove the falsity of the Inert Substrata Thesis. Concerning absolute indiscernibility, numerically distinct instances of, say, intensions M^1, N^1, and O^1, organized in the same way as those composing Complex G, would compose complexes numerically distinct but indiscernible from G: G′, G″, … Similarly for the intensions involved in the instances composing Complex H, and generally for all other atomic complexes of mutually sustaining instances. Now, if such indiscernible complexes were the respective bottom-most relata for isomorphic meta-structures on them, then the latter would be in a total and absolute sense numerically distinct but qualitatively indiscernible. In this way indiscernibility and its distinction from identity is rendered ontologically precise, and made more perspicuously explanatory of the 'indiscernibility problem' of quantum particles widely described as systems of properties and relations.

In sum, combinatorial ontic predicates, each a dependent *ens ad aliud*, do not presuppose an ultimate substratum of inert non-ontic-predicates, each an independent *ens per se*. The key insight of the agent unifier nature of ontic predicates establishes this and so founds the subsequent and universal ontology of hierarchically structured entities. The unsuccessful theories that would attempt to build structured entities from a base of either intensions, tropes, or bare particulars, become simply irrelevant. Indeed, mutually sustaining relation instance and the networks that emerge from them invert the philosophical tradition: 'substance' is derivative of attributes. We have, then, with the above ontology of individuated ontic predicates not only solutions to traditional problems of substance and a clarification of the logical and ontological concepts of identity and indiscernibility, but also an ontology specifically relevant to micro-physics. In this way the ontology of ultimate entities and their derivatives, and the science of ultimate physical entities and their derivatives, would seem to converge and reinforce each other—plural reality of every kind and at every level, even at its lowest, is structural. In all these ways the network in-

stance realism specified by Principles I-VIII recommends itself as a powerful and economic one-category ontology.

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