6 LIR, METAPHYSICS AND PHILOSOPHY

Abstract The discussion in this chapter will provide the tools for analysis of several meta-philosophical questions, including deciding what kind of principle the PDO really is and what the meaning is of such a principle being 'constitutive'. LIR is proposed as a way of resolving the dichotomies of cause and non-cause, determinism and indeterminism, and continuity and discontinuity. These analyses will enable a definition of the specific form of scientific-structural realism, including a metaphysics of relations, that LIR supports. A critique of current realist and anti-realist views places LIR in relation to current controversies about laws of nature. The relationship to the dialectics of Hegel is explored, to avoid the misconception that the ternary LIR system of actualization, potentialization and T-state is equivalent to Hegel's triad. The chapter closes with a brief summary of the LIR view of the domains of philosophy, including the philosophy of mind and the related issues of the naturalization of phenomenology.

6.1 INTRODUCTION: CAUSE AND DETERMINISM

In the first half of this book, I have referred informally to a discipline or body of knowledge designated as metaphysics and to a number of different relations between metaphysics and my logic of/in reality, LIR. I have discussed the structure of reality and the relation between my ontology and its categories and metaphysics. There are several fundamental, closely related problem areas that are considered to lie in the domain of metaphysics, some of which I have alluded to, that I will now address in detail. They are generally presented in terms of dualities, but the LIR logical system is founded on these dualities as fundamental properties of nature. For this and other reasons, I believe the logic and ontology of the system I have designated as the logic of and in reality can provide a substantially new approach to the relations between them and the knowledge that this can occasion.

Let me first distinguish between determinism and cause and their opposites, indeterminism and effect. Determinism refers to a series of causes or the absence of them. Its relation to indeterminism is that of A to non-A. The relation of cause to effect is that of one entity to another one, A to B. The A/non-A case is clearly governed, in the LIR view, by the axioms of Conditional Contradiction, Functional Association and so on. LIR will apply in the A/B case in general if the

axiom of Functional Association holds. The task is therefore to show that it holds as a theorem in the cause-effect case.

In the discussion of determinism, the focus is on the time-dependent sequence of causes (and presumed effects) rather than on a specific instantiation of it. The sequence is often considered to begin concomitantly with the universe itself. Spontaneity, one of the terms I have just criticized, is usually presented as an effect *without* cause. I might characterize its use as irrational, were it not for the large number of respected thinkers who have had recourse to it in one context or another.

The problems of cause-effect and determinism-indeterminism are closely, not to say inextricably related, but I have to start somewhere, and I have chosen to start with the more experiential question of causality or causation.[1]

6.2 CAUSALITY IN LIR

The difficulties associated with the problem of causality and finality,[2] in my conception, is the consequence of a world-view based on a classical logic of identity. For Kant and his followers, causality was nothing more than a rational synthetic order imposed *a priori* on the a-logical, noumenal givens of diversity, such that experience could be possible. Cause and effect became condition and conditioned, and his implied rigorous determinism was equivalent to a conception of a non-contradictory universe. No chance, then, since this would have to arise from some irrational principle of negation, destroying the logic of identity. No efficient cause since this would look too much like a mysterious agent or power. This would also be outside classical logic, and which might imply the notion of an adverse agent, and thus contradiction or some other kind of functional interaction between instances of identity and diversity! No final cause either, because a finality, an effect that has not yet been completed, that is still virtual or potential, implies the antagonistic forces that were preventing or would prevent that completion, present at the same time, in other words, another contradictory dualism that would be contrary to classical logic.

In contrast, the LIR categories of ontological dynamic opposition and change as process in the elements of reality that are modeled in LIR can accomplish two tasks: (1) a basis for the existence of causality and finality is possible;

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[1] I shall use causality when focusing on the more theoretical or philosophical aspects of the phenomenon and causation on the more physical ones, but total consistency is difficult if not impossible, and I ask the reader's indulgence in adapting his own distinctions, if any, to my 'inconsistency'.

[2] The problem of causality has been referred to a the "black hole at the center of our universe" (Schaffer 2006).

and (2) the relation between them and an interpretation of where they should properly be applied can be established.

Without contradiction, if either affirmation and negation, or identity and non-identity were the absolute, non-developing bases for existence, one or the other always true and self-sufficient, there would be no place for change or cause. Self-causation would also be excluded, since this would also imply a change from an initial definitive state. A reality that is rigorously non-contradictory or rigorously contradictory in the physical/metaphysical sense I have proposed excludes both cause and effect, because it can only be a reality that is rigorously static. The same situation obtains as in the discussion of being in Chapter 3: being cannot be logically conceptualized without non-being.

The antagonistic structure of LIR not only implies cause, but that causality and finality themselves are logical processes. The results in the complexification of the notion of cause, as different species of causation correspond to the different entities in the category of process. The relativity of contradiction, the movement toward *both* limits of contradiction and non-contradiction, means that at the heart of logic in the expanded sense I have given to it, there are two inverse and antagonistic causalities: any identity, for example, that is more or less an identity, is the *effect* of all the series of identities which 'went' from potentiality to actuality, by the process of ortho-dialectics, and are, consequently, both effects and causes (Lupasco 1987b). The same scheme applies to a given non-identity (diversity), determined by the series of more or less actual diversities. This negative (diversifying, not negating) causality, like all negative logical functions, has been ignored for the usual reason of the general tendency to focus on positive identities as the only carriers of reality.

In addition to these two causalities, however, there exists an additional causality of antagonism that determines them, in which a given actualization is the cause of the contradictory potentialization. Thus, to the series of causes and effects, or cause-effects of the same order, of identity or non-identity, is added a series of contradictory cause-effects. A given identity or diversity causes, by its actualization, the potentialization of the given diversity or identity respectively, which becomes its contradictory effect. From this, it can be shown that each cause *C* is (1) the effect of (relatively) non-contradictory causes; and (2) causes non-contradictory effects of the same order, at the same time as it, *C*, is the cause of the contradictory effect and the effect of the contradictory cause.

No understanding of a dynamic view of phenomena can be had without following the implications of this form of argument, as can be seen in its application to necessity and universality, on the one hand, and contingency and particularity on the other. Both sets of terms are caused by themselves and, at the same time, each set is caused by the other. The series of relative necessities and contingencies are caused by the series itself, from the point of view of its being a dynamics going from actual to potential; at the same time, necessity is the cause of contingency and *vice versa*.

The same reasoning applies to the epistemological subject: as actualization, it is the cause and effect of itself and, at the same time, cause of the object that is the consequent effect, as a contradictory potentialization, of this actualization. The category of Subject-Object characterizes the process of cause-effect. Causality is thus, as actualization, always primarily subjective in the standard sense, the source of subjective idealism. Similarly, what is potentialized is also the cause-effect of itself, as object, and also the cause of the subject. The object is the knowable or known, the intelligible, the real, what has the function of reality and the 'truth' of reality, the source of realism, which is then just a logical function like idealism, both functions of the causality of antagonism. In order to visualize this, one has to imagine any movement from cause to effect as a highly non-linear, multi-dimensional process. Feedback occurs not only in the general systems sense, between, say a conscious objective of executing a plan of action (non-contradiction) and the unconscious elements that went into its creation (contradictions), but with the potentialized aspects of non-execution of the plan.

The contradictory interaction of the two main causalities of non-contradiction generate by mutual inhibition (semi-actualization and semi-potentialization of both), a causality of contradiction, a series of logical values in the category of T-states. The causalities of non-contradiction are the cause of the causality of contradiction, and the latter is the cause of the former. One can then make a key link with the concepts of immanence and transcendence, since (1) the causalities of non-contradiction, of rationality and irrationality respectively can be called transcendent to the extent they transcend contradiction; but (2) these causalities are the cause of the causality of contradiction, that can be called the causality of immanence or immanent causality. Logical values that imply immanence and transcendence 'cause' themselves reciprocally. An essential corollary of this point is that there are no 'pure' immanent and transcendent phenomena. One cannot, therefore, separate completely immanent 'real' events and transcendent 'abstract' facts (statements, propositions, categories, etc.) *qua* their existence but only *qua* their meaning by abstraction and elimination of any dynamics, that is, as non-spatio-temporal entities.

Since all energetic phenomena imply antagonism or dynamic opposition, this in turn implies, at some point, a potentialization becoming actual and an actualization becoming potential. The latter, as an efficient cause, generates a final cause, the locus of which is in the antagonistic dynamism that it potentializes. An antagonistic efficient cause is thus the source of every final cause and thus of every consequent process of actualization that results from it, and a final cause is the source of every efficient cause, by the corresponding process.

The LIR approach, that redefines causes and effects in dynamic terms, means that they are not to be separated from phenomena as such, provided the phenomena are sufficiently complex, that is, are in the sub-category of Non-Separability. LIR supports the view of some philosophers that properties just *are* dispositions, but with the dynamic logical structure suggested. The use of the copula 'is' and 'are' refers primarily to the exemplification of properties. It is in

this predicational sense that I have postulated above that the properties of intensity and extensity 'are' energy, and *vice versa*.[3]

This fundamental concept, that phenomena *are* their own causes and effects, or better cause-effects, can be illustrated by the following perhaps brutal example, which is nevertheless more pertinent that billiard balls or iron balls on cushions. It requires, but this should be a matter of course, that one distinguishes between proximate and distal causes: they may have different mechanisms. Progun lobbyists clamor that "Guns don't kill people; people kill people". They are right here (although wrong on everything else). My point is that the psychological intentional structure that is the actualized cause of the event is also the potentialized effect, to be actualized eventually in terms of recognition of guilt, acceptance of exposure to punishment by oneself or others, or total repression of the event into the unconscious. I believe most psychologists would accept the statement that such repression is a real process entity that has the 'potential' of being a cause of further behavior of some sort.

The concept of some kind of reciprocal relation between cause and effect is not novel. It is a commonplace that it may be difficult to decide whether A causes B, B causes A or both. Is a bad leader, for example, the result or cause of a bad social and political climate? What LIR does is place this concept in a *logical* context, in which it can be related to the functioning of other phenomena, as well as receive an explanation as another instance of a process of Conditional Contradiction.

6.2.1 The Metaphysics of Causation

In this section, I will make the discussion of LIR view more concrete by discussing it with reference to the questions generally posed about the metaphysics of causation, following the outline of an article by Schaffer (2003).

1. Relata

The entities in the cause–effect relationship are called *relata*; they are considered to be in the categories of events (coarse-grained) or else facts,

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[3] Cao (1997) mentions an early (1894) attempt by Hertz to describe the coupling between two particles: "The motion of the first body determines a force, and this force then determines the motion of a second body. In this way force can be with equal justice be regarded as being always a cause of motion, and at the same time a consequence of motion. Strictly speaking, it (force) is a middle term conceived only between two motions". Einstein replaced the mysterious "middle term" by the electromagnetic field, which can exist independently of the particles, but, given the LIR view of causality, Hertz' intuition of an included third term and cause-effect may be relevant at levels *above* those of fundamental physics.

situations, tropes, states of affairs, etc. (fine-grained), and their number varies from two to four, when it is considered to include causal alternatives (counter-factual events, ones that could have happened but didn't).
LIR: there are two relata that are processes, including events and some facts, in the category of non-separable entities. Other events and facts, also with two relata, including propositions *qua* their meaning, are in the sub-category of Separability. The former, which also may include the latter at the same time, instantiates the two chains of causality; the latter only the standard chain of simple proximate causes.

2. Immanence and Transcendence
Events, etc. are considered real and immanent, while facts, as true propositions, are considered abstract and non-spatio-temporal.
LIR: immanence and transcendence are related contradictorially, and are not absolute, but refer to the relative degree of contradiction and non-contradiction respectively. Both facts and events can be immanent or transcendent. If there is no antagonism, contradictorial interaction, there are only simple causes and effects in the everyday sense.

3. Absence
Since absences can be involved in causal relations, they are considered transcendent in one standard view as being non-occurrences, negative existential statements, involving negative properties, whereas another standard view denies that absences can be causal.
LIR: *It is practically a paradigm statement of the LIR view that absence can be causal – immanent or transcendent in the sense of 2.* This is what I meant earlier by the giving adequate ontological status to the negative aspects of phenomena.

4. Individuation
Individuation (see 1.) is supposed to lie on a continuum from extreme coarseness (simple events) to propositions, the most finely individuated.
LIR: I see the continuum in a different manner, in terms of antagonism, in the sense that there can be coarse events with little antagonism, and fine events involving substantial antagonism, and *vice versa*.

5. Relation, Determinacy and Connection
The nature of the causal link has been the source of the greatest controversy. One finds two sharply opposing views: the causal connection is indeterministic, defined in terms of probability; a cause raises the probability of an effect (see below, probabilistic causation). The other view that is an account that talks as in LIR about change, energy and process considers that cause is

physical producing. The way it is formulated, the standard process view leads to problems, and attempts have been made to combine the two to insure causal connectedness as well as explain the disjunction or disconnection between distal and proximate causes. The causal connection is understood in terms of the probabilities of processes.

The difficulties have led to further concepts such as *primitivism*, which says that causation is irreducible and in fact the notions of probability and process cannot be understood without reference to causation, and analysis is impossible because there *are no more basic concepts*. Similarly, *eliminativism* says that science has no need of causation: it is a "retrograde relic of Stone Age metaphysics" in the absence of some other scientific scheme.

LIR: The LIR argument from the dynamic opposition in physics is a more basic, scientific concept that allows one to retain the advantages of cause-effect against the arguments for primitivism and eliminativism.

Lowe's definition of the metaphysical concept of agent causation (Lowe 2002) requires, for agent A to cause event e, another event x that 'involves' A and it is x that causes A. Involvement might consist is something like x causing a change in the intrinsic or relational properties of A, but this is hardly satisfactory. The problem of involvement is resolved in the LIR picture: it is the dialectical connection between A actualized and e potentialized.

6. Direction: The Temporal Order of Cause-Effect

The standard view (which I share, to be perfectly clear) is that the causal order is the temporal order, but there are arguments for the alleged possibility of 'backward causation' in reality.

LIR: Most of the arguments, some of them from physics, depend on a form of counterfactuality which is contrary to experience. Gödel's proof of the possibility of time travel seems to be either an artifact of his mathematics, require an unlikely classically conceived topological structure of an independent space-time or some form of spontaneity. The fact that some equations of physics do not define a direction of time is true, but I am talking about the real, globally entropic world.

A corollary of this aspect is that the temporal order should be analyzed in terms of the causal order, rather than *vice versa*. This entails that the causal order cannot be based on the temporal order (circular argument). The temporal direction can be understood in terms of intrinsic physical asymmetries; an independent 'time' is not a primitive.

Another argument against a temporal causal order is that simultaneous causation is possible. This has already been undercut classically since any real event 'takes time'. The contradictorial view of simultaneity I will present also disposes of this argument.

6.2.2 Non-contradictory Causalities in Science and Philosophy

The complexity of this approach to causality notwithstanding, it can be used to show a certain order in varied aspects of thought, including developments in science and philosophy.

Classical science took into account, in my view, only the objective causality of identity, universality and necessity, because induction was its basic method. Deduction, defined in classic logic as a conceptual tautology, could not involve causality. An objective causality concentrates on the potential, that is, the object, losing its 'efficiency' of moving from potential to actual and looks more and more like a network of static relations, e.g., of condition to conditioned, of intelligible laws. The notion of cause disappears into the active subjective causality of diversity, of the particular and contingent, to which ignorance (not-knowing) and appearance are attributed. It is thus not surprising that the notion of cause disappeared from science.

The subjective causality of diversity is, however, that which is dynamic and operational, creating the configurations in which physical, biological and mental 'matter' are instantiated. The subjective causality of identity (the causality of deduction), in potentializing diversity, objectifies and makes cognizable the causality of diversification. There is no 'science' of this causality, but it can be considered as the source of intuitive, pre-scientific philosophies and metaphysics of negation, chaos, irrational change, of a fundamental anarchy. Here can be found the basis for the ideas of Schopenhauer, Bergson, Hume and some Eastern religious traditions, which, rather than a causality, tries to represent what *is*, an ultimate reality behind appearances.

In fact, the objective inductive causality of negation or heterogeneity, the contradictory cognitive effect of subjective deductive causality of identity, is the basis of the potential causality that actualizes itself as the apparent exclusively efficient cause of living matter or biological phenomena, that is, the operative causality of induction. These phenomena accordingly are characterized by the absence of an objective causality of identity and seem to behave according to some law or principle of intrinsic variability, of irrationality and contingency. This apparent principle is itself the result of a process of potentialization and hence of objectification of the negative causality of non-identity or diversity.

One can therefore speak of a negative causality and negative deduction, whose actualization potentializes positive causality and deduction and allows the existence of diversities and irrationalities and not nothing. The 'drive' of positive causality, toward homogeneity and identity, is that of macrophysical phenomena, and the inverse negative causality toward heterogeneity is that of living systems. As we will see in Chapter 8, while the former is accepted 'naturally' as a consequence of the application of the 2nd Law of Thermodynamics, there is little serious discussion of what might be any fundamental principles governing the latter.

6.2.3 Finality

Further to the above, I propose that final causes also instantiate the categorial features of potentiality and actuality. Every potentiality is a final cause for the dynamics of the process in which it is involved. Thus, if a process of identification or diversification is an efficient causality as it actualizes itself, this is, at the same time, a teleological operation. It becomes an effective cause, but it is caused, moved, as such, by the final cause that is its potentiality. A logical dynamism, as an actualization, negates its teleology, developing its causality and 'then', in potentializing itself, inhibits its causality and develops its finality. This is the origin of the reciprocity between causality and teleology as finality or final cause. One of the first consequences of this is that processes themselves will develop systems that are both efficient causes and final causes at the same time or neither. This well describes the complex causal behavior of quantum phenomena to which neither a rigorous causality nor teleology can be ascribed.

Lupasco put it as follows:

> Every logical value, vector or operation, precisely because it exists only because of the existence of a dynamics, that is, of a contradictory vector, comprises, in its nature and existential structure, a causality which is only possible because of a finality, and *vice versa*.

The *effective* cause of every event is the *passage* of its state or amount of potentiality to a state or amount of actuality, by overcoming the opposed, previously actualized amount of energy. What is in a state of potentialization, on the other hand, constitutes the *final* cause of what will occur.

Lupasco combined these notions in the following key passage:

> Thus every dynamism, every system, includes energetic events which can be, in turn, due to the intrinsic properties of energy, first effective cause by actualization, then final cause by potentialization.

This implies, further, two types of teleology, one of identity, universal and necessary, synthetic and spatial and one of heterogeneity, particular and contingent, analytic and temporal, as final causes, as potentialities, that is, as potential non-contradictions. Any entity, to the extent that it is partly potentialized, is also a finality, a final cause relative to its actualization, that is, to its subjectivity, to its own state as subject or agent. By looking at entities as effects of contradictory processes, *known* as effects of prior non-contradictory causes, one can show that they will eventually *look* less and less like final or efficient causes but rather a progressive stabilization, which nevertheless retains some causal or final aspects. One can see this by using the category of Dynamic Opposition applied to knowledge. By looking at causality in relation to the processes of knowledge of knowledge and knowledge of ignorance, one arrives at a basis for logical thought, the thinking processes that humans actually carry out of being able to even *conceive* of notions of cause and effect, because thought itself embodies processes of efficient causality and finality. One can see this relation in

the mental operations of a child or an animal: their intelligence includes relations of cause and effect, without knowledge of those relations as relations of cause to effect.

A tendency to ascribe the functioning of the universe as involving solely equilibrium and non-equilibrium thermodynamics as the *only* operative causal principle remains strong. The key conceptions are those of Prigogine of dissipative systems far from equilibrium, continued by Salthe among many others. "The thermodynamic view focuses upon a final causality that operates universally.[4]" I will give a LIR interpretation of the thermodynamic view in Chapter 8.

Although the development given here includes an explanation of how commonsense, everyday notions of cause and effect arise, it will not (and probably did not) satisfy people who look only at bare (simple) events (I hit the key and a letter appears on the screen, etc.). In *L'énergie et la matière psychique* (1987a) Lupasco wrote:

> This causality of antagonism adds, to the classic unilateral causality, linear, on the surface, mono-dimensional, gliding, so to speak, from one fact to another, a second causality, in depth, of facts which are perturbed and potentialized by the antagonism of the classical causality and which are ignored by current science. To every causal sequence corresponds an antagonistic causal sequence, inherent in the nature of the energy that constitutes them both.

It should thus be clear that the causality of antagonism and its resulting contradictorial determinism do not replace the chain of causes and effects of commonsense causality and determinism; they add another parallel chain with the indicated dual antagonistic and contradictorial structure. One or the other system of causality is the dominant one, depending on the complexity of the entity or process.

However, that there is by no means a consensus even on what constitutes 'commonsense' or 'classical unilateral causality' will be seen in the following sections. Do these remarks weaken the contradictorial approach? I do not think so; the domain of operation of classical causality, could be considered, in my view, a domain of processes and events that, if not abstract and transcendent, are primarily at the macrophysical level of reality to which a binary logic applies. As suggested, it would be in a dialectic relation with the mental and quantum domains, in which the primarily applicable causality would be one of antagonism or contradiction and the applicable logic LIR.

When he writes on causality, Peirce shows his essential, but in my view partial grasp of the problem (Peirce 1955): "Final causality cannot be imagined without efficient causality; but no whit the less on that account are their modes of action polar contraries." Thus, he can envisage that an efficient cause could in some way be detached from a final cause, and then would "not even possess efficiency." *Post hoc* and *propter hoc* remained disconnected for Peirce. It is very interesting to read how he pursued this thought in relation to his concept of class:

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[4] Salthe (2004). I note again here the recourse to spontaneity and putative external higher scale structures as final causes in preference to any inherent, internal constitutive dualism or antagonism.

"Every class has its definition, which is an idea (?); but it is not every class where the *existence*, that is, the occurrence in the universe of its members is due to the active causality of the defining idea of the class." This seems to be a clear, negative consequence of maintaining, in the absence of contradiction, a functional separation of class and member of class, as well as of efficient and final causality.[5]

6.2.4 Dispositions and Powers

Potentialization and actualization thus have a central role in the LIR theory of cause, but I would be remiss not to refer in a little more detail here to philosophical attempts to account for the operation of cause by appeal to the notions of dispositions or powers, properties of an entity that are alleged to confer causal powers on their instances, enabling them to effect change.

It is far from clear what these powers, dispositions or capacities mean, that is, are these in some sense additional properties over and above the initial property (see discussion of properties in Chapter 3)?

The following initial distinctions can be made between categorial and dispositional properties:

Categorial Properties	***Dispositional Properties***
Contingent	Metaphysically necessary
Inward-directed (Intrinsic); Actual	Outward-directed; Modal (possible)
Non-causal	Causal

The debate involves, among many other things, whether all of these distinctions are real. For example, even though the manifestations of dispositions may be non-actual, this does not mean that dispositions themselves are non-actual. Thus, everything would be categorial. From another point of view, properties are all dispositional, both or neither. One can retain some of the intuitive difference between the two by assuming, first that categorial means non-dispositional, and that it suffices for a property to be dispositional that it play some causal role essentially, where that causal role is described purely in terms of the relations between categorial properties, and it is a necessary condition of a property's being categorial that it play no such role.

The LIR approach cuts through the analytical debate about the relation between categorical and dispositional properties and their role in cause. The NEO category of Dynamic Opposition supports the view that properties may be both

[5] The application of LIR to a theory of classes and sets must be postponed to Appendix 1.

categorial and dispositional in the sense that properties instantiate, contradictorially, all of the elements of the two descriptions, as actualities and potentialities, elimination of the inward-outward 'cut', and so on. Throughout this book, elimination of a cut or separation is to be understood as a reference to the existence in reality of a contradictorial interaction. In NEO, only properties in the subcategory of Separability (SC) combine 'freely' without necessitating anything real, but in NSC, dispositional properties, which are equivalent to real potentialities, cannot combine or operate without something changing or being changed. These dispositional properties are in this sense more fundamental aspects of nature, but my theory retains the advantages of the categorial perspective in the sense of its capacity for implications 'upstream', that is, the area of *categorial* inference.

As far as the conception of properties as dispositions or powers is concerned, powers to act and be acted upon, there seems to me to be no need for a separate category. In the LIR conception, properties are active and passive, or better active/passive processes. Dispositions, powers and propensities (Popper's term) are equivalent. Properties may be categorial and/or dispositional, as indicated above, but in neither case do they 'bestow' powers on particulars: they *are* powers. Another statement of this, again in the perspective that properties are causal powers, is that of Shoemaker (1982): "What makes a property the property it is, what determines its identity, is its potential for contributing to the causal powers of the things that have it." I only would add to this that a property is characterized by its diversity, and by the interaction between identity and diversity as well.

The contradictorial relation between actuality and potentiality in LIR thus provides additional arguments against attacks on the reality of 'potencies', defined as dispositional properties that include potential manifestations (Bird 2006). My demonstration that what is potential as well as what is actual is real answers the critique that only the actual is real. The modal argument (*possibilia* are not things that exist in other worlds but not in this one) against the objection that potencies involve unrealized manifestations of possibilities that, accordingly, violate naturalism is supported by a view of unrealized possibilities as real potentialities, whose reality does not depend on their manifestation if this is prevented by an actuality.

My picture is supported by the position of Heil (2005), that manifestation of a disposition is the manifestation of reciprocal dispositional partners, and that in such a manifestation it is often – perhaps always – impossible to characterize one object (sic) as cause and another as effect. Heil argues that properties have both dispositional and qualitative intrinsic aspects, but he does not say why or how they have them. I of course agree with these concepts of 'co-dependence' and dual-aspect and only point out that it they make even more sense in the context of the LIR process metaphysics.

This is 'in essence' an argument *against* kind essentialism and *for* the existence of some metaphysically necessary laws of nature. If electrons, for example, are defined with respect to their ungrounded dispositional properties, including charge and spin, essentialists would claim that there is no deeper structural

explanation than the behavioral dispositions of the electrons and their essence: to be an electron is just to have those behavioral dispositions. I am thus in agreement with Drewery (2005) when she states that for this conclusion to be valid, the nature of the properties must include their possible causal powers as well as their actual ones; one needs only to replace possible by potential and add their alternation to recover LIR. This conclusion fits the category of Energy in NEO: the existence of energy (as we know it) and its underlying field (as we postulate it) are the only contingent things in the universe; they are the universe.

6.2.5 Probabilistic Causation

Probabilistic Causation designates a group of philosophical theories whose objective is the characterization of the relationship between cause and effect using the tools of probability theory (Hitchcock 2002). These are of direct interest for the understanding of the LIR view of cause and effect, or better cause-effect. My approach is also probabilistic, in the sense that the logical values of LIR were axiomatized as something like probabilities, but one may legitimately ask the question as to whether and how LIR is similar to or different from current theories of probabilistic causation.[6] The following discussion amplifies the argument in Section 6.2.1 above.

The motivation of probabilistic approaches to causation has been the difficulties with the current regularity theories of causation, derived from the simplistic Humean concept that effects simply invariably follow causes.

Probabilistic theories of causation handle a number of correlations between events that are causal in nature, and describe spurious correlations where events follow in time but the prior is not the cause of the latter. The problem, similar to that in causation itself, are the connection between causation and probability is the requirement that causal relata be propositional in character in the sense in which propositions are conjoined, extended or negated.

The principle of antagonism provides a structure of reality that embodies causes and effects as operators with the same logical structure as the rest of reality I claim, therefore, that LIR can also provide the causal 'structure' needed for a theory of probabilistic reduction of causation. In LIR, It is not a significant issue that effects do not invariably follow potential causes. The example of the smoker who does not contract lung cancer is only a specific case of potentiality not automatically leading to actuality. This implied partial indeterminism is of course acceptable to me, although apparently it is not to regularity theorists. Since probabilistic theories of causation require only that a cause raise the probability of its effect, these are also compatible with indeterminism.

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[6] Some current theories of causation result in the failure of reduction of causation to probability, but in those that do not, a theory of the systematic connections between causation and probability is of philosophical interest.

I defined the logic of/in reality as, among other things, a theory of change. In it, change follows some fundamental dynamic pattern of alternating movement from a state of actualization to one of potentialization. The change from predominately one to predominately the other of two opposing elements depends on statistical and probabilistic parameters at some stage of the process at all levels of reality. However, I have not discussed whether or not the statistical generalizations of standard statistical mechanics are appropriate here. As pointed out by Sklar (1992), it is not clear what could ground the introduction of probabilistic and statistical notions even in simple macrophysical systems. Non-equilibrium systems in LIR follow the rules of entropic asymmetry insofar as they are physical, following the 'arrow of time'. However, at, for example, the biological level of reality, anti-thermodynamic processes (of heterogenization or diversification) take place, only part of which is subject to statistical factors. The PDO applies most clearly, outside the quantum world, at the level of mental and social phenomena, when the opposing elements are often close to equal in energy, leading to an emergent included middle (T-state). To the extent that statistical probability issues remain open in all physics, it is clearly beyond the scope of this study to decide *how* the energy necessary to effect a change at these higher levels 'gets where it should go'. The massing of people outside the Ukrainian Parliament building in the winter of 2004 was followed by a change of government, although identifying the point at which change became inevitable is not obvious.

Perhaps the simplest statement that can be made at this stage of development of LIR is that statistical and probabilistic effects, as implied by the axiomatization of the logical values of actuality, potentiality and T-state as probability-like are not incompatible with the overall determinacy and indeterminacy of the universe discussed in Section 6.5. Also, the deterministic but highly irregular behavior of chaotic systems, although they tend to be relatively simple ones, can be discussed in LIR provided scope is retained for some degree of return from chaos toward order. I can agree that the property of chaotic systems to magnify or amplify non-deterministic quantum events could mean that chaotic unpredictability is physical/metaphysical rather than epistemological.

LIR can shed light on the debate about common cause principles, the idea that simultaneous correlated events must have prior common causes (Arntzenius 1999). I will not go into the details of the various principles, especially as most of them seem to fail at least part of the time. One is left with simple local situations, in which one has a correlation among fairly natural localized quantities that are not related as cause and effect, and one can find a fairly natural localized prior common cause that confirms the absence of such relation (screens off the correlation). In complex systems, such as the coordinated flights of certain flocks of birds, there are so many scattered microscopic causes that specifying them as common is a practical impossibility and would trivialize the notion of common cause principles. I regard such systems as single unified systems, and do not demand a common cause explanation for the correlated motions or properties of their parts. In the case of the flock of birds, at 'equilibrium', it acts more or less as

a unit, and reacts as a unit, possibly in a very complicated way, in response to its environment, due to the myriad connections between its parts that 'make' it act as a unit. I rather focus on the very complicated way the shared contradictory dynamic aspects of the bird–flock relation (the same as those of a set and its elements), as well as external environmental constraints, as the source of the correlated behavior. There is no need for a 'leader bird'.

Summarizing, the fundamental PDO is a principle of physical causal order at whatever the level of system happens to be, from microscopic to macroscopic. LIR is in this sense a hybrid theory, but rather than combining a spatio-temporal connection between cause and effect with a problematic probabilistic theory of causation, it states that the elements of the spatio-temporal connection, the cause-effect processes themselves, have the characteristics of probabilities.

Hitchcock (2002) sees a causal principle in operation in the microphysical world, but wonders to what extent, as I claim, it 'percolates up' to the macrophysical world. He devises test situations that bring out a distinction between *A* being 'causally relevant' to *B* when it makes some difference, positive or negative, to the probability of *B* in some test situations, a promoting, inhibiting or interacting cause. *A* is a positive or promoting cause of *B* if it raises the probability of *B* in all test situations. One can test this by substituting non-*A* for *B*. The relation of dynamic opposition is then one first of causal relevance, since *A* inhibits or potentializes non-*A*, which then becomes the promoting cause of *B*. My postulate, again, is that one can combine the probabilistic aspects of cause and effect with a requirement of spatio-temporal connection between cause and effect (contiguous process). This can be considered a relation of causal dependence that reflects the transitivity of causation, and perhaps also provides an explanation of the asymmetry of causation, in that the asymmetry between cause and effect is that of the actualized or potentialized probabilities themselves.

Hitchcock discusses the work of Spirtes, Glymour and Scheines and proposes the following scheme: (1) given a set of factors and a system of causal relations among those factors, call this the *causal structure* (*CS*). In LIR, this would be a series of causes and effects of alternating antagonistic terms (factors). (2) Let *T* be a theory connecting causal relations among factors with probabilistic relations among factors. This is what I have proposed as the relation between the degrees of actualization and potentialization and probability (see below). (3) Then the causal structure *CS* will be *probabilistically distinguishable* relative to *T*, if for every assignment of the probabilities to the factors in *CS* that is compatible with *CS* and *T*, *CS* is the unique causal structure compatible with *T* and those probabilities. Hitchcock says that this probabilistic theory of causation can have many "properties of distinguishability", but the one of most interest that he mentions is that the "actual causal structure of the world (assuming there is such a thing) is probabilistically distinguishable relative to *T*". It seems rather as if the property of *T* was the content of *T*, but this confusion disappears when the relation between them is seen as contradictorial in the two-level sense of Chapter 5.

It is not obvious what type of distinguishability properties a theory must have in order to constitute a reduction of causation to probabilities. This is a

somewhat tautological way of saying that there is a certain unicity to structural cause and effect relations, something that emerges naturally from LIR. The problem is to insure that the reality values of LIR, which I have proposed as having probability-like properties, can be modeled by the notion of probability in the more standard sense, as here. However, there is no reason to assume that values of probability and values of reality are unrelated. In fact, the latter reduce to the former, in the physicists' sense of reduction to something simpler, for simple phenomena, mirrored by the reduction of thermodynamics to statistics. Probabilities in dice-throwing are not different from the probability of changing one's mind: they lack the latter's dynamic elements.

6.2.6 Possibility, Potentiality and Probability

The difference between the terms of possibility and potentiality follow the general LIR scheme of domains to which binary and ternary logics apply respectively, that is, the former does not involve dynamic interactions, and the latter does (Lupasco 1967). That something *s* is possible implies only its own negation, that of the impossibility of it happening (not the negation of possibility "it is not possible that *s*"). An element being potential does not *imply* its non-actualization. The actualization may not occur, but it would require an input of energy, via an accident or event, that is extrinsic and unpredictable, even if deterministic.

The possible involves a random choice without any determinism or energetic capacity, a disjunction between a yes and a no, without an antagonistic 'partner'.[7] This contradiction is suspended and disappears in the yes or no as isolated states, that is, in pure non-contradiction. The potential, on the other hand, contains or is always accompanied by the actual – that which opposes it and prevents the potential from becoming actual or actualizing itself. Potentiality thus not only implies a rigorous form of determinism, which is not found in the possible, namely the energetic capacity, or oriented dynamisms, but also what maintains the phenomena in their potential state, that is, the actualization, more or less strong, of the inverse and antagonistic dynamisms. One can still use the term possible in the sense that the potential is the 'possible' consequence of some input and then effect an abduction from the observation of an energy state to its causes. The possible can give the impression of a finality, a final cause, as if it were energy in potentialized form. Once actualized, acting, this energy appears as an efficient cause. As discussed above, however, every phenomenon must be considered as combining both efficient and final causes, which is not possible for the merely 'possible'.

At any point in time, every dynamic phenomenon will be actualized and potentialized to a certain, probabilistically determined degree. The key point is

[7] On one recent view, epistemic possibility, what one knows about a possibility, is context-dependent and shades over into probability. This concept does not affect the distinction made here, since the set of binary choices still applies as the only one available.

that the sum of the probabilities of the event must be greater than zero but less than 1, since complete final states cannot be achieved by complex process entities. As with all potential entities or processes, potential probabilities, the non-observed values of a system, are also realities. They consist of different degrees of actualization and potentialization and intensity gradients and orientations as well as levels of antagonism and the aspects and characteristics of the categorial properties of their energetic make-up. A potential structure is thus not a structure that is simply possible. The former is either realizable or already realized, which is not true for the latter, which is simply imagined.

6.2.7 Actualism and Possibilism

The reason for making clear the difference between possible and potential refers to the philosophical discussions surrounding the truth of claims about what might have been possible in the past. Actualism is the philosophical position that everything there is, everything that can be said to exist in any sense, is actual (Thesis A) (Menzel 2003). To be is to be actual; being is actual. Possibilism is the denial of this thesis, that is, it states there are things which are not actual, but could have been, and the things that *are* include possible but non-actual objects. Actualists agree that certain things could have been, but wish to account for the truth of this statement without assuming the existence of any non-actual objects (*possibilia*).

The system outlined in this book rejects the basic thesis of actualism, which is again classical logic in yet another form: what exists is not only actual, but also *potential*. Something is both actual and potential, however, if and only if a relation of dynamic opposition exists between the phenomenon and its energetic contradictory complement. Possible but non-actual objects, in the possibilist account, abstract entities, are acceptable as imaginary objects, ideas or concepts with only a 'mathematical', non-spatio-temporal existence, but it is classical logic that applies to these.

As indicated in Chapter 1, philosophers interested in this field use the tools of modal logic, in particular the concept of *possible worlds* to investigate the truth of modal statements like "it is possible that" or "it is necessary that". Even these abstractly conceived worlds have given rise to extensive discussion as to whether they consist of sets, states of affairs, or properties or propositions. Irrespective of their exact nature, possible worlds have certain theoretical tasks based on a notion of classical truth, and the concept cannot be used for the logic of reality without modification, if at all.

The arguments of the two sides are extremely complex, and will not be reproduced here. One line leads to the introduction of a distinction between concrete and non-concrete objects and a consequence that objects that are concrete on our world are non-concrete in another world, i.e., contingent. The 'new actualism' that results is virtually the same as possibilism, as contingent non-concreteness is nothing but the possibilists' mere possibility. Both new actualists

and possibilists define two modes of being: actuality and contingent non-actuality, using different terms. Nothing in this philosophical discussion seems to me to describe the interactions obtaining in the real world and in being in the sense of Chapter 3, to which the logic of/in reality applies.

6.2.8 Potentiality and Micro-causation: Manipulability and Intervention

The LIR theory of causation dynamically links cause and effect explains them in terms of the potentialities of the entities present at the microphysical, biological and mental levels of reality. This approach provides a natural explanation for Sober's picture of causation (Sober and Shapiro, 2007) *vs*. epiphenomenalism in terms of the relation between macro-causation and micro-causation.

Sober's theory is one of a group of formal philosophical approaches to causation that depend on the relatively new notion of manipulability. According to these theories (Woodward 2001), causes are regarded as handles or devices for manipulating effects. In the versions of interest here, the anthropomorphic aspects of manipulability are avoided by a concept of an 'intervention' I, which does not have to involve a human being, effecting a specific change on a variable X with respect to another variable Y that characterizes what it is for X to cause Y.

Sober's major objective was to prove that such a macroscopic property X, in particular a mental one, with a physical (neurobiological) micro-supervenience base, MSB(X) need not be causally inert, that is, it can have causal powers that are those possessed by the MSB(X).

The apparent absence of these additional causal powers provides the master argument for epiphenomenalism, taken to show that the mental property X is causally inert. The crucial mistake in this line of reasoning is that it requires one to consider a counterfactual situation that is in fact impossible: the two elements, X and MSB(X), as in a theorem of LIR, can never be separated in reality, and it is in any case irrelevant to the question of whether the mental property X, or any other supervening property, is epiphenomenal with respect to the candidate effect term Y.

The key points of this picture, without giving the entire argument, are the following:

- Definitions: For two phenomena (macro-variables) X and Y, where X is the putative cause of Y, are associated macro-states of X and micro-states X_{ij} of micro-variables MSB(X), where MSB(X) is the micro-supervenience base of X. Micro-supervenience is defined as
- Claims:

(S1) Macro-causation entails, that is, implies and requires micro-causation. Some properties of the micro-variables of X cause Y, together with X.
(S2) The converse is not inevitable: one can have micro-causation without macro-causation.
(S3) Some macro-variables are causally inert (epiphenomenal) even if their MSB's are causally efficacious with respect to Y.
(S4) The source of an instance of epiphenomenality as a 'pseudo-process' is to be found in a common cause of X and Y, inducing the relation described by the term 'screening-off'. If one does not see the common cause, it looks as if the relation between X and Y is not one of cause and effect but of some non-causal 'correlation'.

The basis for S1 is that if X is to cause Y, then there must exist macro-states of the variable X, X_i and X_j, such that an intervention on X that changes X's state from X_i to X_j will be associated with a change in the state of Y. If true, then there also will be an intervention on the micro-variable B(X), changing it from some state X_{ik} to some state X_{jl} that also must be associated with a change in Y.

My first remark refers back to my definitions of properties and processes, in which I showed that they, also, are related dialectically. 'X' above should be also seen as a process, and this is suggested by the reference to X as a macro-variable.

The core concept I propose is that of the structure of the micro-supervenience base, the micro-variables, in terms of *potentialities*. Specifically, the changes in state from X_i to X_j and from X_{ik} to X_{jl} are changes from potential to actual, following the scheme of LIR. It is the residual potentialities of the molecules of the billiard balls that, actualized, cause them to rebound (quasi-elastically, to all intents and purposes), but it is the absence of such potentialities at the macro-level that makes them causally inert, and requires us to look for the origin of causality in the mind of the player. I accordingly formulate the following theorem:

Theorem 6.1: Phenomena are causally efficacious at their level of reality, as a consequence of their micro-supervenience base, if and only if they are involved in interactive dynamic processes at that level.

I can now give an interpretation of the two critical terms in this combined approach – intervention and association (of X_i to X_j and X_{ik} to X_{jl} with a change in the state of Y). In reality, in any dynamic system, e.g., a mind, there is always some process in progress that has the potential of being a cause and, accordingly, constitutes the intervention that starts the causal process. But its potentialities and actualities are contradictorially linked to those at the lower level of the MSB(X), and their association is the Functional Association of Axiom **LIR5**. As I will

suggest in Chapter 8, the causal role of micro-potentialities is the same here as for emergent processes of morphogenesis.

The difference between the billiard balls and mind is that, at the higher mental level, dynamic oppositions of the same form as those at the atomic and molecular level are present. If this is the case, then it becomes straightforward to discuss situations, in particular at more complex cognitive and social levels, where it difficult to decide which variables are macro- and which micro-. The relation becomes that suggested above: X and Y are both cause-effects, and in the Sober formulation, micro-causation *may* entail macro-causation. This aspect of the LIR view is one of causal realism, namely, that a thing or entity at level *n* may have its own causal powers interacting with other entities at the same and/or a higher level (Emmeche 2003).

LIR supports Sober's contention, *contra* Kim, that qualia can be causes. From the empirical standpoint, whether a macro-property is functionalizable, that is, reducible to some physical functional role, makes no difference to whether it may have causal powers. Function and cause are not mutually exclusive. To see whether a quale causally influences a behavioral event, one needs to hold fixed any common causes they have; however, one should not hold fixed the micro-supervenience base of the quale, since it is not licit in either theory to assume that higher level properties operate by some kind of 'magic'.

The LIR picture resolves, I believe, another issue, namely, whether explanations made at and for higher levels of reality are in some way more valid than those at micro-levels, that is, whether macro-explanations might not entail micro-explanations. The two-level system outlined in Chapter 5 also applies to explanations: explanatory, logical and causal 'talk' all follow the same principles, because the micro-explanations refer back to the fundamental physical oppositions involved.

6.2.8.1 Intervention

Intervention is defined so as to include not only counterfactual changes in variables but also *bona fide* experimental changes or manipulations that one can make, in some cases, in order to observe effects. Such moves are, however, considered from an LIR standpoint as dynamic processes. The two views could be considered compatible, were it not for the fact that the variables are generally considered, in the manipulationist theory, to be classical, involving idealized, absolute entities. A functional separation is maintained between cause and effect, reifying them as entities separate from the property-processes they are supposed to operate on. For example, the intervention I must completely change any causal relationships between X and *its* prior causes. Nevertheless, one comment of Woodward suggests some underlying common intuition. He suggests that philosophers do tend to think of causes as properties or events, but that it is possible to move back and forth between such talk and a representation in terms of variables.

When there is no well-defined notion of change or variation in value, a manipulability theory will not see genuine cause, but some form of epiphenomenality.

LIR not only defines values of actualization and potentialization as applying to causes-as-events, but to the 'moving back and forth', the epistemological shift, also considered as a physical, dynamic process. A domain in which there is no well-defined notion of change is likely to be, in my theory, one in which the only connection is absolute disjunction (cf. Appendix 1), and where, to all intents and purposes, a binary logic is adequate.

6.2.8.2 Some Remarks on Self-Organization

If there is one area to which concepts of causality have been applied in a non-rigorous manner, it is that of self-organization. If I assume a standard definition of a system (an LIR discussion is provided in Appendix 2), a self-organizing system is defined as distinguished by the formation of some states or entities arising from the reciprocal or collective interactions (encounters) between its components, *quite independently of outside inputs*. In the light of LIR theory, however, the critical terms of 'self' and 'independent' are seen to involve question-begging assumptions, as discussed earlier in connection with Axiom **LIR5** of Functional Association and the sub-category of Non-Separability.

In a standard discussion of self-organization, such as that of Debrun (2000), the encounters are between elements that are really, as opposed to analytically, distinct. Debrun sees self-organization occurring in two situations, which he calls primary and secondary, referring to simple elements and organisms respectively.

The consequence of any self-organizational process is the constitution of emergence of a new form, or of a restructuring, by complexification, of an existing form. The problem is how this comes about in the absence, by definition, of any organizing identity in the case of primary self-organization. Debrun proposed that although, here, the elements are totally distinct, and no global finality is present in the system, finalities – intentions or projects – do exist at the element level. In LIR, however, all elements instantiate both diversity and identity, that are related dialectically. The finalities or final causes can be seen to be the residual potentialities in and of the elements that are the effects of their constitution by prior processes.

The chemist George Whitesides has designed and fabricated elements of plastic and metal, using nanotechnology, that indeed self-organize into rather complex structures when placed in the appropriate environmental context. But the 'self-organization' of these inert elements exhausts their potentialities. No further change can occur without further input of energy as information. The original input came from Professor Whitesides as an identity and efficient cause, and he then exits and is absent from the system.

In self-organization at the higher level of an organism, one is dealing with a system of processes that already expresses identity, diversity and their conjunction in T-states. For the elements involved in processes and processes of processes, the distinction between them is clearly less absolute (Debrun used the rather Lupascian term "semi-real"). The LIR explanation of the dynamics of what is called self-organization is made in terms of alternating dominance of actualizations and potentializations. The potentialities present, for example, in a mental entity, have the critical role for an actualizable restructuring. In LIR terms, even in the case of primary self-organization, some residual identities are always present to provide 'direction' in addition to the obvious diversity of the distinct elements. At their level, to repeat, it is exactly these potential identities that are the finalities in the Debrun description. They are the carriers of the structural information required for any further organization to proceed. In the LIR description, an additional level of physical/metaphysical explanation is provided for the phenomenon of self-organization *via* the PDO.

Under these circumstances, the most reasonable view is that self-organization is not, in and of itself, a 'self '-evident mode of system formation and change. All systems involving alleged self-organization also involve some degree of organization-by-external-agent, although the two are, again, dialectically related. Varela refers to something like my view of self-organization (Varela 1999) when he states that coupled non-linear oscillators can give rise to kinds of self-organization that result in the emergence of neural structures from the component level. A local-global interdependence is necessary to understand the emergence. The components "attain relevance" through their relation with their global correlate.

In the further dynamical systems language used by Varela (and also by van Gelder, see Appendix 2), a satisfactory description incorporates a role for both stability and instability, defining both stable and unstable regions in the phase space of the system. However, the system then, allegedly, flops *spontaneously* (emphasis mine) between them even in the absence of external driving forces, and by definition, of any internal physical attractors (identities that would function as organizers). Varela makes the geometry of the phase space and the trajectories of the dynamics, which enfold both the boundary conditions and the "current arising" in one synthetic whole do the organizational work. This is considered quite a general characterization, applicable to complex non-linear and chaotic systems.

This is perhaps all right as far as it goes, but as I discuss in relation to Varela's view of time, it does not go far enough. One is again left with critical process terms that fail to describe the structure and the dynamics of the relation or correlation. I suggest again that the critical step in the organization process is not spontaneous, in the sense of uncaused by outside agents, which the use of "self-" without qualification implies. New organizational structures are the effective consequences of the potentialities residing in the components and/or introduced during the original constitution of the natural system or artificial experiment.

There exist, in addition, mathematical theories of self-organization. However, that is just *all* they are – ways of showing how ideal objects can organize themselves into more complex states or structures. These will not be discussed further as I consider that they do not apply to my current critique of a principle of self-organization that allegedly applies to physical, spatio-temporal entities.

6.3 CONTINUITY AND DISCONTINUITY

A further major area of metaphysical debate is that of the nature and role in the universe of continuity and discontinuity. It seems to be characterized, among other things, by a substantial amount of apologetics: 'space' and 'time' are alleged to share the property of continuity, which is the basis for space, time and space-time continua, all composed of infinitely many dimensionless points. However, whether there are such continua composed of such points in reality "remains a legitimate question in both physics and philosophy (van Inwagen 2002)". As Penrose has pointed out, and as discussed in detail in Chapter 7, both Einstein's theories and standard quantum mechanics depend on the assumption of real number space-time continuity, but there is serious doubt as to whether its mathematics is appropriate for describing the ultimate constituents of nature (Penrose 2005).

Further, if the concept of continuity is problematic, what about the basis for the appearance of discontinuity? How can one go in biology, as discussed for example in catastrophe theory, from factors involving continuous thermodynamic change to mechanisms of genetic regulation that involve the discontinuous intervention of the biochemical structures needed for hereditary control? How can one conceive a discrete categorization of the continuous substrates of biological or higher-level systems by some immanent operation of discontinuity (Petitot-Cocorda 1992)?

We thus have a series of explanations of continuity, but they seem questionable. We have a concept of discontinuity, but no explanation. Two essential concepts must be introduced here to prepare a description of the situation in LIR terms: the continuum hypothesis and the foundations of differential calculus.

6.3.1 The Continuum Hypothesis

The continuum hypothesis refers to a conception of the universe founded on geometry, the Cantor-Dedekind view, as discussed by Longo (1999), which sees not only in mathematics, but everywhere, continuity as ontologically preceding the discrete: "The latter is merely an accident coming out of the continuum background." Points are derived concepts, even if 'non-dimensional'. In this view, geometry (statism, cf. the next section on statism and dynamism) is in some deep

sense more fundamental than dynamics, that is, energy in the standard view. This hypothesis has the advantage of corresponding to our intuition and experience, integrated into and confirmed by mathematics, of continuity in our perception of 'time' and linear movement.

Penrose, on the other hand, had the strong intuition that "physics and space-time structure should be based, at root, on *discreteness* (emphasis his), rather than continuity". This discreteness is evidenced in quantum mechanical spin, combined, however, with a fundamental notion of expressing phenomena in terms of a relation between objects, rather than between an object and some background space (Penrose 2005).[8]

It is clear as discussed in Section 3.7.1 on abstract objects that in the construction of the mathematical continuum, objective realities are not found in the mathematical entities involved, but in the process of constituting these entities as conceptions. There can an interaction, dynamic in LIR terms, between the applicable *mathematical* logic and intuitions about continuity. Stating this somewhat more strongly, since the establishment by Gödel of the reciprocal relation between consistency and completeness in formal mathematical systems, the situation is no longer absolute. One should not be forced to choose between geometry and discontinuous objects and their relations. This opens the door to a different foundational principle, using the principles of LIR, in which both continuity and discontinuity are fundamental and are dialectically related.

A more serious critique of the above conception of the continuum is that it is restatement of a conception of general relativity (GR) as a pure geometrization of the world, from which the subjective aspects of space and time involving observers have been eliminated as inessential ontologically. It is one of the major conclusions of this book that the other readings of the physics and mathematics of GR that are possible, that restore the balance between geometry and energy that exists in reality are supported by LIR.

6.3.2 The Problem of Differential Calculus

In principle, the usual notion of differential calculus captures the apparently simultaneously continuous and discrete nature of changing phenomena. According to LIR, however, this position only displaces the philosophical and metaphysical problem. Change at an instant is what differential calculus presents in formal terms. It is well recognized, however, that this implies an inconsistency – continuity and discontinuity at the same time. It begs the question of whether reality is composed of 'points' and 'instants' in the sense used in the theory. If it is not, then differential calculus, like classical logic, is *not* capturing the essential

[8] Penrose saw larger cosmological structures as being possible ('spin networks' and 'spin foams').

property of real processes and systems, since it assumes that such points exist. Only in the most recent work on general relativity is the concept of a 'point-event', first codified in the Buddhist logic of the 6th century AD,[9] receiving an adequate interpretation (see Section 7.6).

One possible mathematical language for formalizing the contradictorial view of continuity and discontinuity is that of Smooth Infinitesimal Analysis (SIA), developed by Bell (1998), and discussed in detail below as an exercise in the application of LIR principles. Bell quotes Weyl to the effect that "we are employing the principle of gaining knowledge of the external world from the behavior of *its* (emphasis mine) infinitesimal parts." However, I feel that Weyl made an error in the 'its'. Nothing has yet been adduced to prove that Bell's infinitesimals (or any others in standard calculus) and those of the external world (if such exist), are the same.

I propose the following physical and metaphysical arguments in favor of an interactive, contradictorial relation between continuity and discontinuity. The physical argument runs something like this: if there is continuity and discontinuity of real entities at the quantum level, that is, both discrete quanta and continuous frequency of wave phenomena, and they are intuitively and mathematically opposite, by the LIR theory, they must also instantiate the key axioms of Conditional Contradiction, Functional Association and Asymptoticity. Accordingly, continuity cannot exist without discontinuity (or discreteness) throughout nature, and continuity actualized implies discontinuity potentialized. Asymptoticity has another consequence: no real element can be an infinitely small point of space or time since in reality, a lower bound is determined by the Planck constant, 6.62×10^{-34} Joule-seconds. The infinitesimal quantities of space and time of differential calculus cannot exist in reality.

I suggested above that continuity and discontinuity is a pair of ontological predicates, where the former is inherent to or related to homogeneous extensity and the latter to changes in levels of energy in phenomena. The differences in level between which energy as heterogeneous intensity falls are themselves extensities. It is the discontinuous *passage* from one level to another that represents the intensive quantity, the movement of transformation; higher and lower forms (e.g., chemical energy and heat) are actualized extensities, with greater or lesser potential for further transformation.

The LIR metaphysical approach also looks at the implications of the logical reasoning process for continuity and discontinuity: the contradiction between continuity and discontinuity, the impossibility of their simultaneous co-instantiation at the quantum level is mirrored in the processes of logic and thought. From the point of view of logic, the dynamisms, as processes, of affirmation and negation (better, affirming and negating) do not show any obvious or conceivable

[9] The 'point event' language, or jargon, in the authors' own terms, continues to be used in the branching-space-time (BST) explanation of the existence of causal probabilities. By, again, the authors' own admission, their account is "decidedly preliminary" (Weiner and Belnap 2006). Cf. the discussion and reference in Section 5.5.1.1.

discontinuity. In other words when we affirm or negate something, we do not do so in steps. But logical thought itself, insofar as it is the potentiality of these two contradictory, antagonistic actions and both coexist, as inverse possibilities, demonstrates the existence of an immanent, constitutive discontinuity in reality at this level as well as at the quantum level.

In the LIR approach, the heterogeneity of intensity is not a series of independent elements or extensive stages, it is an attempt to differentiate (movement of differentiation of) something that wants to stay the same, the extensity of which resists and opposes this change. In this movement, there is a continuity that is not measurable by extensive values. As these values are potentialized, it looks as if extensity contains discontinuity and intensity is a continuous dynamics. Lupasco saw the continuity in extensity, despite its divisibility and capacity for adding new entities, as for example, new premises are added in defeasible deductive logic, in its aspect of identity extending from one thing to another. Thus, intensity is a continuous non-identity with respect to itself; extensity is a continuous identity with respect to the other. Intensity and extensity are continuous as dynamisms, considered as independent of one another, and from this point of view accessible to the techniques of differential calculus. But, discontinuity is inherent in their existentiality, since neither can exist without the other, without operating on the other: intensity and extensity reciprocally 'discontinuate' each other. The differences of energy level that result in 'something happening' are not due to intensity or extensity alone but to their intersection. Analysis and synthesis are continuous dynamisms, homogenizing and heterogenizing respectively, but their necessary discontinuity is what constitutes their existentiality.

6.3.3 Paracontinuity and Paradiscontinuity

The current 'non-constructive' trend in mathematics (Longo 1999) based on the availability of the Gödel theorems and the non-standard mathematical analysis of Robinson (NSA) support alternate intuitions about the continuum that logic can 'offer'.

D'Ottaviano and her students (Carvalho 2006)[10] have studied the foundations of differential and integral calculus using tools available from paraconsistent logic and non-standard mathematical analysis. This is an important current issue, since, for example, dynamic systems theory (DST) claims that the same basic laws that govern simple physical systems also govern the laws of complex systems, e.g. cognitive (or cognizing) systems. Therefore, such systems can be described by the mathematics of physics, especially, of non-linear dynamics rather than by the computational symbolic systems approach (which uses the rules of classical and neo-classical logic and syntax.) Thus proponents of DST believe that standard differential equations are the most appropriate tool for modeling human behavior and human knowledge. My critique is therefore also directed against DST.

[10] The term paracontinuity is sometimes referred to as quasi-continuity.

D'Ottaviano and Carvalho show that the principle of L'Hospital, the 17th century mathematician who codified infinitesimal calculus, can be formulated rigorously. This principle states that it cannot be said of any two quantities separated by an infinitesimal whether they are the same or different. The continuity in an interval on the (real or hyperreal) number line is to be replaced by a paracontinuity.[11] This concept also defines a para*dis*continuity, and that paracontinuity and paradiscontinuity are in fact the same. The principle also holds for relational *entities*.

This does not mean that the standard calculus is wrong for the real world; it is valid for simple phenomena, is capable of making predictions and so on. My proposal is that, for complex process phenomena in the real world, a dynamic relation between continuity and discontinuity extends the indicated relation between paracontinuity and paradiscontinuity for an abstract line composed of abstract points. The calculus for the LIR picture remains to be formalized; it should not contain either infinite or infinitesimal elements, and it will depend on the contradictorial notion of the structure of space and time discussed in the next chapter. Nevertheless, it can already be postulated that since, by Axioms **LIR1** and **LIR2**, two elements of the real extended world can be, alternately, almost equal, the paraconsistent picture can apply (D'Ottaviano Itala, 2006, private communication).

6.3.4 Smooth Infinitesimal Analysis (SIA)

As indicated above, my conclusion is that SIA is not appropriate as a description of the real world, but the description of the domain of thought to which it applies enables the contrast with the realistic concepts of LIR to be clearly delineated.

Bell states that SIA applies to *smooth worlds* and that the fundamental object in any smooth world ***S*** is an indefinitely extensible homogeneous straight line ***R*** – the *smooth*, *affine* or *real (number) line*. Applications of SIA are presented for differential and integral calculus, physics and hydrodynamics of macroscopic systems, and synthetic differential geometry.

Any reasonable division of the world, however, must involve something like the following categories, although one can argue (indefinitely) about the best grouping:

- Abstract mathematical or other non-spatio-temporal objects
- Macroscopic physical objects and processes

[11] The term has been applied to certain geologic strata, characterized by moderate discontinuities between them.

- Microscopic physical objects, biological and psychological agents and emergent processes

Whatever else may be true of the above, the real world of the third category is not a smooth one. As suggested above, in my theory, it instantiates *both* continuity and discontinuity which are both present in any phenomenon, e.g., the quantum of action (frequency and quantum number).

Poli has proposed (Poli 2004) that SIA provides "the conceptual background for development of a non-speculative mathematically based theory of *tendency* and *potentiality*," which seems required by a processual interpretation of ontology, in which processes are the basic ontological items. The points of the 'life trajectory' of actual events are identified with the 'linelets' used in SIA as the fundamental units of objects in it. Linelets are too small to have either possibilities or directions, but potentiality and tendency can be ascribed to them.

This thesis thus appears to depend on three interlocking assumptions: the real world is (only) smooth; potentiality and tendency can be ascribed to linelets (and to timelets, the corresponding infinitesimals of time in SIA); because SIA has its origins in category theory, and category theory can apply to physical phenomena, SIA can apply to physical phenomena.

I do not feel these assumptions regarding SIA are justified, and other explanations of potentiality and tendency, such as LIR, are possible. The reasons will appear in the following discussion of the basic concepts of SIA, their logic and the comparison that Bell makes between SIA and NSA, which is derived from standard logic.

The fact that the infinitesimals of SIA (and its precursors) prove to be useful heuristic devices is not *en soi* a proof of their existence, except as entities in an idealist ontology. The way Bell (or Thom) defines a continuum, several things follow in the consequent theory, *viz*., its consistency and the failure of the law of the excluded middle (LEM). The formulation (used by Bell) for LEM – every statement is either definitely true or definitely false – cannot be generally affirmed within smooth worlds. In both Peirce and Brouwer one finds the requirement that a faithful account of the *truly* (emphasis mine) continuous will involve jettisoning LEM as is required in intuitionist logic.

In LIR, LEM fails in reality, in the sense of Axiom **LIR3** above. There is no logical price to be paid if it fails in SIA. However, this failure does not imply that the real world is a true continuum; discontinuities, including the 'flip' from actual to potential, are also present and require explication. Similarly, Peirce's proposal that immediate consciousness involves a non-punctiform, extended infinitesimal of time can be explained by a contradictorial view of simultaneity and succession, and space-time that is deployed by objects, rather than being a locus of them (see Chapter 7 on the origin of 'space-time').

Bell states that non-zero infinitesimals exist only in a potential sense, and this potential existence suffices for the development of infinitesimal analysis in

smooth worlds (SIA). Also, that the law of non-contradiction (Axiom **CL2**) continues to be upheld in ***S***.

This is my point! In such worlds, there is no transfer of energy in any form. In the real world, for change to occur, one needs both actuality *and* potentiality, and this distinguishes them from smooth worlds. Further, Bell shows correctly that one cannot, in ***S***, single out an actual non-zero infinitesimal, "for such an entity would possess the property of being both distinguishable and indistinguishable from 0, which is clearly impossible". In the real world, again, these two predicates are contradictorially related as per Axiom **LIR2**, and can be ascribed to the same real element.

It is clear by this time, as Bell confirms, that we are dealing with an intuitionist or constructive logic. Note that LEM is not even explicitly denied, it is not affirmed, and thus can remain in those parts of SIA and related systems, such as topos theory, in which classical logic holds.

There are additional points in Bell's SIA, however, that are *prima facie* contradictions in terms, despite the (inconsistent!) fact that they are intended to guarantee consistency! For example, infinitesimals are alleged to be intrinsically varying quantities, as a consequence of their being in a "nascent or evanescent state", and this varying takes place over a definite domain, with a definite co-domain in which it takes values.

The above contradicts the assumptions of a *smooth* world since discontinuities have been reintroduced in the form of definite domains and as change in the form of a needed reversal between nascent and evanescent (virtual particles appear from and disappear to the vacuum discontinuously). The principal applications in calculus, geometry and physics are only possible because they have been restricted to abstract areas in which classical or consistent intuitionist logics hold. Thus, Bell has arrived at the limits of thought of iteration that Priest has shown involve *dialetheias*, true contradictions (Priest 1995). In mathematics, of course, such problems do not arise: two functions can, by Bell's Constancy Principle, have identical derivatives that differ at most by a constant.

I conclude that Bell's SIA is a theory of abstractions, unsuitable for an ontology that purports to deal with the world of real change. As Bell himself concludes, SIA is a theory of infinitesimal geometric objects, designed to provide an intrinsic formulation of the concept of differentiability (see Section 6.3.1), and perhaps not more than that. The real world is not differentiable as a whole, although a continuum of states exists between (almost) fully actual and (almost) fully potential. The infinitesimal units of which Bell's objects are constructed are, from my point of view, pure *intensity*, and thus cannot exist, any more than can any idealized, abstract constructs. Despite their interesting properties, to assign them any role in real phenomena, with the exception of description of pure physical processes totally dominated by the 2nd Law of Thermodynamics, seems to me abusive. Applications to systems such as computer science, artificial intelligence and data processing are included in this group, but all of these require no more than a binary logical system, sufficient when there is no exchange of energy *qua* the elements or terms of analysis. They thus clearly belong in the

sub-category of Separability.[12] Everything else, life, growth and mind, as well as photons and the vacuum, requires a ternary logic capable of handling the fundamental antagonism inherent in energy, and hence throughout nature, and the inconsistencies and contradictions that derive from it.

6.4 STATISM AND DYNAMISM

One of the oldest debates in classical philosophy is whether statism is more fundamental than dynamism, in other words whether there is some static, geometric identity underlying all dynamic phenomena, or whether it is a self-sufficient force or energy that is responsible for them in some still unexplained fashion. This debate appeared in the discussion of catastrophe theory in the previous chapter. Let me say that if the ideas in this book are valid for discussion, the classical question is reopened, since neither statism nor dynamism is required to be rigorous or absolute. Every factor in some static view of the world, say, of intensity or extensity, cannot by Axiom **LIR6** be a pure potential nor an absolute actualized entity. Similarly, no pure dynamism exists in the classical sense, due to the antagonism with statism that constitutes it. There can only be, accordingly, dynamic geometries and geometric dynamics.[13] Statism is thus no more absolute than dynamism, and those who had difficulty deciding whether energy was a static quantity or a dynamic order, or neither one or the other while looking like both, or some form of mathematical symbolization, were closer to the truth as I see it.

Another problem had been to try to reconcile the conflict between an appearance of continuity in time and space with an intuition of the existence of its divisibility into "instants" of time and "points" of space of indeterminable size. The problems of the homogeneity of space, and its 'divisibility by itself', and a similar homogeneity of time and the existence of idealized 'points' of space and 'instants' of time can be superseded by a dynamic view of relativistic space-time, presented in the next chapter, that might be seen as part of a 'dialectical turn' toward a cosmology (and a cosmogony) involving opposition in the LIR sense.

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[12] Elsewhere, Bell discusses variable sets that are intended to provide a feature of continuous variation, since abstract sets are not only discrete but static, and their elements undergo no change. However, all the entities involved remain abstract in my conception, instantiate *Separability* and are therefore inadequate to provide a model of real physical change. The unification described of the continuous and the discrete is an achievement of category theory that applies to mathematics (Bell 2006).

[13] "Geometrodynamics", a concept of John Archibald Wheeler, should be examined in this context, as well as its recent developments, e.g., the topological geometrodynamics of the Finnish mathematical physicist Matti Pitkänen.

This eliminates the need for arguments against statism and in order to insure the existence of dynamism and discontinuity in addition to those suggested in the previous section.

It is nevertheless useful to see the relation of the concepts of extensity and intensity, as well as of homogeneity and heterogeneity, to another metaphysical duality that I have not previously dealt with, namely limits and their absence, non-limits, or limitation and illimitability. In this discussion, I will refer to the continuities of time and space as their homogeneity and the result of any metaphysical divisibility as their heterogeneity.

The first step in the development is to differentiate between homogenization and heterogenization as processes, acting on some substrate, and their result, a homogeneity, an entity consisting essentially of an identity or a heterogeneity, consisting essentially of a diversity. Taken as independent dynamisms, neither extensity nor intensity has conceptual limits, but the limits of real entities are a kind of extensive property, an identity. In contrast, intensity is non-limiting.

Let us then see what this means in terms of the further properties of identity and diversity, as these might impact on the properties of the entities involved, specifically, what happens to their limits or the boundaries between them. The best way to put this is that heterogeneous entities indeed instantiate individual limits, despite the fact that heterogenization is a dynamism *en soi* that destroys limits that, so to speak, previously existed. Homogenization involves the destruction of limits also, but only insofar as these were differences, expressions of diversity, with the result being a new identity.

These dynamisms are also related: they consist of an intensive heterogenization that is accompanied by the inverse of an extensive homogenization. Through the first process, there is fragmentation of limits in principle to infinity; through the second, a reconstruction of limits up to the limit of the ‘same’ by the ‘same’, the idealized limit of identity of A by A. An example is that of rock cliff near a sand beach. Sand is produced (many small limits) when part of the cliff, a single large limit, is destroyed by ‘heterogenizing forces’ (erosion). The differences between individual grains are an expression of diversity, while being at the same time an identity (the beach). The sand limits could be suppressed by homogenizing forces. For example, heat and soda ash (energies) could transform the sand into a glass object, a new identity, the size of the original cliff, going in the direction of, but obviously never reaching, the original identity. The LIR logical universe is thus never entirely finite or infinite, but is a transfinite complex in which one of the aspects of its formal dynamic constitution is an ‘eternal’ conflict of illimitability and limitation.

6.5 DETERMINISM AND INDETERMINISM

A complete discussion of the concepts of determinism and indeterminism, of necessity and chance, and of the controversies around the implications of quantum mechanics is obviously beyond the scope of this book. Nevertheless, the *form* of many of the controversies and arguments for one view or the other being more fundamental suggests that we may be witnessing the phenomenon of dynamic opposition in operation at the levels both of reality and of theory.

It is generally agreed that some more or less complex forms of prior cause determine all processes and events at macroscopic levels. As noted, there are substantial problems with the commonsense notion of cause, and LIR suggests two major conceptual additions: a set of contradictorial relations between cause and effect for entities in the sub-category of Non-Separability, and that these relations constitute a chain of causality that is instantiated in parallel with the standard one. The problem is at the quantum level, since it is also generally agreed that at this level, the world is indeterministic; for example, one cannot define *any* causes, hidden or not, that determine when a given radioactive nucleus will decay. The further and greater difficulty is that local statistical or probabilistic causes also seem ruled out. The correlation between distant particles (cf. the Bell inequality experiments) can be explained by referring back to their origin, as components of a single system, but the existence of the correlation cannot be explained probabilistically. The correlation seems to be an irreducible fact, totally unlike any commonsense notion of a causal chain of occurrence.

As Sklar and others have pointed out, the 'weirdness' of quantum phenomena have a psychologically destabilizing effect on people, so that they tend to seek explanations that will insure that either determinism or indeterminism is the prevailing mode of existence at the human level, such as the denial of any notion of an objective world, branching worlds, and so on.

The simplest statement of the LIR view is the following: the world is both deterministic and indeterministic, and, in addition, cause and effect are not separable, but are in the contradictorial relation suggested above. However, the possibilities offered by this view have not been explored primarily if not exclusively because of the tendency of people to avoid apparent contradiction. The first proposal is to change the view of causality at the nuclear level. Does this mean that radioactive decay the 'effect' is somehow its own cause? This starts to look too much like the theological argument of the uncaused cause, but I believe Lucas (1961, 1990) has shown a way out. He suggests that entities involved in quantum relations are not simple events, but possible (I would say potential) events, which are far from simple. Above all, one needs to include a concept of potential causes between such events, although it was not clear to Lucas if there was a "more straightforward way" in which these entities existed or could be known than the standard space-time they were supposed to supplant. I made one suggestion above of the existence of two chains of causality, and propose that the contradictorial LIR causality would apply to 'possible events'.

I cannot state what, at the nuclear level, the potentialities are that are operative in radioactive decay in the same way that I can describe the potential of the carbon atom for forming covalent bonds. I can only say that given the apparent ubiquity of such potentialities, and the dualism of the effective quantum field, suggests their existence at this level as well. The key idea here is that of the 'influence' of the quantum level. As discussed elsewhere in this book, it is the potentialities that are the carriers of dynamic opposition to higher levels and not actualized quanta. In any event, effective indeterminism at this level does not preclude determinism at any other, but only that it is, effectively, potentialized.

These ideas clarify the concept of Nicolescu that quantum indeterminacy is fundamental but the concepts of the trajectories, speeds and positions of particles are not. A generalized indeterminacy, which would go beyond the problem of trajectories of particles and agree with the concept, first considered by Heisenberg, of the indeterminacy of natural language, is of course possible. "Natural language can not express with arbitrary high precision all of its elements, because the way of expressing acts[14] in an essential manner on what is expressed. The indeterminacy of natural language is just one example of the generalized indeterminacy generated by the Gödelian structure of Nature and knowledge." This is only one of many expressions of the failure of natural language to conform to the principles of bivalent logic.

Any such indeterminacy must, however, be associated with determinacy, by Axiom **LIR5**. In the LIR view, natural language, as well as quantum phenomena, is both determinate and indeterminate in a manner that ultimately undercuts Wittgensteinian skepticism about the impossibilities of communication between individuals. Extension of the Gödelian argument outside the domain of mathematics and number theory is justified if a functional association is made with the PDO in complex, macroscopic emergent systems, that is, in those domains in which T-states are instantiated.

6.5.1 A Philosophical Argument

In the section on continuity and discontinuity above, I noted that there are two continuities, one extensive and the other intensive, related antagonistically, that could give rise, when and where they are of equal force, to the actualization of discontinuity. The principle of determinism can be introduced essentially as a quality, something that exists as a phenomenality in physical and logical systems, in relation to the continuities – an extensive determinism and an intensive determinism or indeterminism. The argument runs as follows: in the same existential form, the two continuities cannot exist with equal reality; therefore every physical system, as well as each logical thought, can only be hybrid phenomenalities,

[14] One might justly say 'interacts' here.

oscillating between determinism and indeterminism At the point of semi-actualization and semi-potentialization of each, an a-determinism emerges, what Lupasco called "the discontinuity immanent in logic". (The two terms determinism and determinacy, for a principle and a quality respectively, exist in English, but the latter seems more appropriate and will be used subsequently.)

To describe a physical entity, one requires, as a minimum, two factors, one each of intensity and extensity, that is, of speed or momentum and position. When Heisenberg discovered the principle of indeterminacy (or uncertainty) he initially attributed the inability to determine both with the same precision not to a relation of opposition or interaction, but some combination of fundamental indeterminacy and determinacy of the "two faces of Nature", in other words, some kind of independent identity behind phenomena, either a geometric extensity, pure causality or some other abstract invariant. Regardless of what choice of this type is made, one falls into the same metaphysical trap: if everything is determined, a logical (in the standard sense) chain, everything is identity, in which case from where and how can, even in our minds, the unpredictable, the continuous, non-identity emerge? If on the other hand, everything is indeterminate, from where and how can necessity and invariability emerge, however ideal or ephemeral they may be? The only solution is to ascribe, to all phenomena, aspects of both determinacy and indeterminacy that are related contradictorially, that is, when one is actualized, and the other potentialized. If quantum mechanics suggests that the world, at the deepest level, is genuinely indeterministic, the logic of/in reality supports Einstein's intuition that a *deterministic* theory of systems is *also* required at some level to provide a necessary underpinning for an essentially statistical description (Sklar 1992). LIR thus provides a place for both concepts and the relation between them.

6.5.2 Contingency and Necessity: Bohmian Determinism

The absence, in the philosophical, scientific and logical literature of today, of any *language* of antagonism or of contradiction, and the prevalence of logics that are not *intended* to apply to real existence, suggest that the discussion of chance and necessity will remain problematical.

For Aristotle, the only modality of change in the universe was the possible, capable of evolving toward the necessary or contingent. In LIR, each logical value of a process or process element is a *probability* that is more or less necessary and more or less contingent. In addition to the two inverse probable processes of evolution toward non-contradiction (identity and diversity) or logical transcendence, there is a third probable process that evolves towards contradiction or immanence, the symmetrical reciprocal inhibition of chance and necessity. If we look back at this point at some of the entities in the category of T-states, things that I have characterized as emergent included middles, ideas, works of art,

innovations of all kinds, all seem to have components of both chance and necessity. To my knowledge, no one has provided a place in *logic* for such events, as logical values. Accordingly, in LIR terms, one could perhaps best say that the universe overall is a-deterministic, an included middle T-state with local domains of determinism and indeterminism.

At the level of theory, it would seem to be impossible to decide, for systems showing unpredictability, non-computability or randomness, between a model of the system being governed by underlying genuinely statistical, indeterminate laws of nature or by deterministic ones resulting in chaotic behavior. In the first case, apparent randomness is real randomness, in the second it isn't. As discussed below in relation to realism, one aspect of the world is the existence of reality and appearance, and I suggest a dialectical relation between them, as between other dualities.

The question of determinism was brought into focus by Bohm's proposal of a theory of quantum mechanics that postulated that all particles have at all times a definite position and velocity, whether or not one is able to determine them. The Schrödinger wave equation that describes the evolution of a physical system is taken to be perfectly deterministic. Bohm reinforced this by a guidance equation that determines, on the basis of the particles' wave function plus the positions and velocities, what their future states will be. The result is a fully deterministic theory that confirms the Copenhagen interpretation of quantum mechanics, that is, that the particle and wave descriptions of quanta are complementary, but the interpretation of complementarity as I will show in the next chapter is complex, and the simplistic Copenhagen view has been largely superseded. Hoefer states (2005) the resulting dilemma as follows: if there is ever a "Final Theory" of the quantum structure of the world, it will not only be difficult to decide whether it is deterministic or not, but there seem to be today equivalent deterministic and indeterministic theories.

The only way out of the dilemma is to assume that quantum phenomena are and are not deterministic, sometimes primarily one and sometimes primarily the other. Both theories apply in reality, and the states and relations involved in individual processes are always partly determined and partly non-determined. This view is consistent with the relational version of quantum mechanics to be discussed in the next chapter.

6.6 REALISM AND EXPERIENCE

Metaphysics is a complex construct of concepts or claims about reality and the concepts or foundations of those claims about reality. I began the analysis of the existential aspect of LIR in Chapter 3 with a discussion of what it means for

something to exist, for something to *be*, and I concluded that it is not possible to answer the question with a logic of bivalent linguistic elements.

The further question for the metaphysician is: "What does it mean for something to be real?" Science is, of course, what is supposed to tell us about reality, and in this section I will try to disentangle the various concepts of the relation between science, experience and reality that have been designated as realisms and empiricisms. Readers familiar with this field will have noted that I have already used the non-standard term 'scientific-structural' realism. This term anticipates the way in which I see that current views on scientific and structural realism can be usefully combined in LIR. I have also included a discussion of the conflict between realist and anti-realist positions in semantic realism.

Finally, is there not an infinite regress lurking as one considers the possible iterations of metaphysics of metaphysics? In my view, the origin of the concept of infinite regress, here as elsewhere, can be found in various types of challenge to a realism grounded in experience. In fact, LIR explicates the phenomenon, as indicated above, that in the reality of human experience, regresses stop as and when no further information is added, that is, after the first few iterations.[15]

6.6.1 Generic Realism

The two most general aspects of realism as a philosophical doctrine are that objects, processes, etc. exist (existence claim) and that their properties are independent (independence claim) of anyone's beliefs, linguistic practices, conceptual schemes and so on (Miller 2002).

Realists are open to challenges by anti-realists who reject the existence dimension of realism about a particular entity and either claim that such entities do not exist, or they exist but do not instantiate any of the properties ascribed to them. Examples of the first are the debates about the existence of 'Platonic' entities such as numbers, and of the second questions about the existence of moral facts and requirements. Examples of the challenges by those who reject the independence dimension of realism claim that distinctive objects exist, with distinctive properties, but none of these are instantiated independently of people's beliefs, linguistic practices, and conceptual schemes and so on. This latter is the view of classical idealism that all macroscopic objects are in some sense mental. Some of these arguments are clearly at a 'higher' level of reality or complexity in the sense of being second-order: states-of-affairs exist but do not have a causal role in *explanation* of the various aspects of our experience.

My purpose is not to comment on the merits of individual arguments – it would be another impossible task in the scope of this book. I also would remind

[15] Cf. Priest's contradictions at the iterative limits of thought (Priest 2002).

the reader of what I said in Chapter 3 regarding existence or being, namely, that it would be well if both realists and anti-realists were clear on what they mean by existence. I will return to the LIR view of being in Section 7.6 on being and becoming. What is of interest here is that arguments made on both realist and anti-realist sides appeal to more or less far-fetched examples, linguistic or otherwise, none of which appear to be totally convincing. For me, this is an example of the fundamental, inevitable conflict in existence as well as its descriptions. Realist and anti-realist positions actualize and potentialize one another, but anti-realist arguments are at another level of mental reality at which the meaning, understanding or metaphors involved are closer to the T-state of contradiction, as they are based in part on the inherent paradoxes in language, and it is difficult to 'identify' them.

In my LIR conception, all physical processes, including mental or neuro-psychic, are first of all real *qua* the energy involved in their instantiation. The logic of/in reality proposes a dialectical relation between 'reality' and its appearance to a conscious observer. It is the totality of this picture that I consider realism; reality and appearance are both real. What is *not* real then is not in the sense of lacking any character of dynamic opposition, that is, non-spatio-temporal phenomena such as abstract entities of all kinds.

My position also implies that the metaphysical issue of realism is not a semantic issue about the nature of truth. If it were, any question about anything would turn out to be 'really' a semantic issue. I discuss relevant aspects of semantic realism in Section 6.6.5 below.

6.6.2 Scientific Realism

In the discussion of LIR as a formal system in Chapter 3, I discussed two types of realism that are defined formally: logical realism and natural realism. As one moves toward science and experience, many new issues arise about the meaning of realism in science that as usual have given rise to endless debate. As with the various logics introduced in Chapter 1, all current theories of realism in science refer to on-going problems and limits of application, some of which LIR can address. The motivation of the next two sections is thus to show the utility of the logical aspects of my metaphysics in interpreting intuitions and insights available from the latest work in the philosophy of science.

In doing experimental or theoretical scientific research, scientists are involved on a daily basis in the inconsistencies and antagonisms in reality, both epistemological and ontological. Examples are the tension between their partial knowledge and ignorance, as well as the frustrating intractability of matter – the 'refusal' of a chemical compound to crystallize from solution. It is not surprising that these complex processes are perceived and conceptualized in an equally complex fashion. Faced by the diversity of the world as uncovered by science, philosophers tend to reject its metaphysical importance in the name of a perhaps

laudable but dangerous strategy of simplification, dangerous if it confers a lower ontological value or significance to diversity as such.

Scientific realism is the stance that best captures the general validity which the activity of science has acquired, but its acceptation of entities that are not directly observable has led to its refusal by some philosophers. This is in my mind another instance of the dynamic opposition that *is* observable in all phenomena, physical and mental. Realism must, in my theory, always be accompanied by anti-realism, and both will alternately predominate as more or less valid in specific cases. Structural realism describes a group of relatively recent approaches whose objective is to respond to anti-realist and other challenges to scientific realism. I will show that LIR also supports and explicates aspects of some forms of structural realism that are relevant to science at the microphysical and macrophysical levels (this chapter) and at the cosmological level (Chapter 7).

I have given below a brief description of the varieties of realism on the market most pertinent to my proposal of LIR as *logic* of and in reality. In a sense, all have been developed as attempts to answer the question "Is science reliable?" The answers given have tended to focus on the microphysical or quantum domain, in view of its 'wealth' of unobservable entities of which only the intrinsic properties (see Chapter 3) are accessible to measurement. Like Ladyman and Ross (2007), I wish to support a program of a principled unification of science, in which the special sciences (those other than fundamental physics) exemplify the principles or patterns of physics while also involving emergent ones of their own. As I will point out in Section 7.5 on quantum physics, quantum phenomena such as quantum entanglement and quantum coherence cannot be operative at the mental level, but this does not mean that the patterns of interaction at the two levels can not and do not follow a similar logic.

The most important contribution that I see LIR as making is to provide a *non*-mathematical element of structure to the various forms of scientific and structural realism. What I will show, in the sense of the core thesis of LIR, is that LIR and the PDO apply to both the entities described by scientific theories and the theories themselves (or more generally the epistemic and ontic aspects of theories) in primarily in the *first* and *third* of the three relevant levels or domains: the quantum level; the 'inert' macrophysical level; and the biological and mental level. It is for me rather odd to note how often examples used to illustrate philosophical positions about reality and science are taken from the *second* domain.[16]

Scientific realism is the conception that, subject to the recognition that scientific methods are fallible as suggested above and that most scientific knowledge is accordingly approximate, one is justified in accepting the findings of scientists, validated by consensus, as representations of reality, that is, that

[16] The fluttering in the wind of a crumpled thousand-dollar bill has been used to discuss issues about fundamentalism in laws of nature. Others often used are simple, reversible 'to-all-intents-and purposes' physical changes of phase. I see LIR and the PDO as making accessible for analysis, that is, to science, more dynamic and interesting cases, for example, where appearance and reality are involved as in the psychology of lying or cheating.

the unobservable entities postulated by the theories in fact exist. Constructive empiricism argues that the best current scientific theories do not require such belief, and the success of modern science can be understood without it. It is such philosophical challenges to scientific realism that convert it to a philosophical position, as well summarized in Boyd (2002). I can discuss only a few of these challenges, and the realist response to them here, but one notion stands out as clearly supported by and supporting my logic of/in reality, that of approximate truth. As we saw in Chapter 2, truth in LIR is the truth of reality, which cannot be absolute. It is accordingly *unscientific* as well as metaphysically false to require that science generate absolute truth. LIR describes, in a way that makes it appear less accidental, the relation between the actual experimental methodology used to obtain knowledge of unobservable phenomena and the theory involving prior knowledge of other unobservables upon which the methodology depends. The non-actual entity that is intended as the consequence of the experiment has a potential existence, not yet proven but present as a non-localized process in the mind of the experimenter. Entity realism (ER) is another form of scientific realism. ER consists of the thesis that science does provide knowledge of a mind-independent reality, but it does not accept the strongest scientific realist claim that science provides, or can provide, *complete* knowledge of unobservables and their properties. This is, obviously, not a claim that LIR makes either.

This characterization of science, however, opens scientific realism to the criticism that the changes in theories that *have* occurred imply that further changes *will* occur and that, accordingly, currently existing theories either cannot be considered reliable. In my view, scientific realism cannot be questioned due to the existence of predictively successful scientific theories that later turn out to be false. A theory that is false is 'true' in the sense of actual and real, and its (inevitably) approximate truth is can be carrier of a contribution to scientific methodology. In any case, the errors made tend to be about the nature of the phenomena involved rather than their relations, to which experiment provides access. Nevertheless, it is useful to show how LIR treats the responses to the challenges to scientific realism that are defined as structural realism or structuralism and talk directly to the problem of theory change. I will look now at forms of structural realism that, in my view, do and do not capture the dynamic properties of reality and structure and hence the growth of scientific knowledge as a natural process.

6.6.3 Structural Realism

Structural realism essentially states (1) that science provides knowledge of the relations that the constituents of scientific theories engage in, but does not necessarily tell us anything else about its objects of study; and (2) that those relations are constituted by the *mathematical* structures, based on set or group theory, that purport to describe the relations. SR was thus developed to compensate

perceived inadequacies of naïve scientific realism to respond to the problems of unobservables. Another way of saying this is that full-blown scientific realism has no basis for saying that the *nature* of things is described by the metaphysical and physical content of our best theories.

The epistemic form of structural realism (ESR) holds that the objects of our scientific theories (e.g., electrons) are epistemologically inaccessible. We believe what these theories tell us about the relations entered into by unobservable objects, but all we know are the structural elements (structures) of our theories. A version of ESR defended by Morganti (2004) is that there *could be* something more beyond structures rather than there *is surely* something, but we cannot know it. This requires, however, reliance on a classical, individual-based ontology and intuitive categories that I believe are *dépassées*.

The definition of structure in mathematical terms and the resulting structure/nature distinction begs the question of whether structure-as-equations captures all or most of the properties of the entities involved, since "nothing can be known of nature" whether there must be, in addition, meaning assigned to a non-mathematical nature-of-structure (McArthur 2006). Is the latter another unknowable metaphysical principle that SR correctly questions? LIR cuts the debate by establishing the role of Dynamic Opposition as defining, at least in part, a physical/metaphysical characteristic of the real structure (nature) of un-observable entities.

The ontic structural realism (OSR) of Ladyman and his colleagues is a complete current response to anti-realist challenges to scientific realism, since it insures that there are adequate metaphysical components that are lacking in epistemological versions of structural realism. The original motivation for the definition by French and Ladyman of OSR was to permit a metaphysics of quantum particles as both individuals and non-individuals. An initial version of this theory metaphysical structural realism (MSR) appeared to totally eliminate the reality of entities. As put by French, "the idea is that it is not just that all we *know* are the structures, but that all that there *is* are the structures". The latest version of OSR, which morphs to Information-Theoretic Structural Realism (ITSR) answers a number of the justified criticisms made of MSR. Thus "that relata constructed as abstractions from relations doesn't imply that there are no relata, rather the opposite. A core aspect of the claim that relations are logically prior to relata is that the relata of a given relation always turn out to be relational structures themselves on further analysis".

6.6.4 The LIR Extension: Scientific Structural Realism (SSR)

The conception of structures in LIR as real processes permits a convergence to what I define as a scientific structural realism (SSR). The ontological structure of reality of LIR established in Chapter 5 supports a non-naïve and above

all non-absolute scientific realism, so that a theory of scientific structural realism is possible that includes the best of both worlds.

The LIR view of realism in science adds the following clarifications, some of which are in OSR in other terms:

- LIR supports a causal theory of reference, according to which the relation between a term and its referent requires a chain of causal relations between uses of the term and instances of its referent. All elements stand in such chains of chains of causal relations to what constitutes them, which must be some form of definition by an opposing element. This permits moving away from so-called descriptive formal ontological conceptions of reference and provides another crucial component to a realist approach to scientific knowledge.
- By removing the total separation between internal and external, and subjective and objective viewpoints, the LIR causal conception of perceptual knowledge treats discoveries both as empirical and philosophically and epistemically relevant explanations, *without* making an external object mind- or experience-dependent.
- Some philosophical challenges raised against scientific realism rest on intuitions[17] that beg the question against empiricist anti-realism, which states that there could be no evidence that rationally distinguishes between two empirically equivalent scientific theories. Such an approach implies the existence of two such theories, and pending their appearance, inconsistent with the LIR view of identity, I consider this objection void of content. Anti-realists tend to use arguments based on counterfactuals and highly unlikely states of affairs that carry strong anti-scientific sub-texts. They are examples in themselves of dynamic opposition.
- LIR provides a basis, accordingly, for realist theories to accept a connection between natural kinds and the conceptual machinery of the sciences. Extra-linguistic and mind-independently existing natural kinds, in my view, are metaphysically fitted for explanation and induction. Any version of something like an *objective idealism* is not required. LIR, in contrast to standard naturalism and metaphysical materialism, provides the physically grounded dialectical

[17] It is essential for the understanding of the philosophical positions in this book that no concept used familiarly in an idealist program, such as intuition as usually conceived, is supported. Intuitions are real, dynamic processes, standing in a relation of dynamic opposition to 'identity'-elements of concrete knowledge. Intuitions are therefore subject to the same standard of scientific inquiry as any other phenomenon. On the other hand, nothing here should be considered an attempt to *prove* that idealist positions are impossible. To the extent that someone takes *both* positions on an issue at some time or other, as did Dummett himself, they can be seen as dynamic opposites, a realist view potentializing an anti-realist one and *vice versa*.

> basis for such a connection. LIR thus opposes and argues against anti-realism in philosophy and science. LIR accepts as reproducible, quasi-scientific evidence that people do defend one position or the other and makes the reasonable assumption that 'psychological factors' of some sort must be at work. But it thus says something further and perhaps more interesting and important about these two opposed positions: they are *inevitable*.

An area of overlap between OSR and LIR is Ladyman's definition of a "pattern" as a carrier of information about the real world. A pattern is real iff it is projectible (has an information-carrying possibility that can be, in principle, computed) and encodes information about a structure of events or entities *S* which is more efficient than the bit-map encoding of *S*. More simply: "A pattern is a relation between data." Ladyman's position is that what exist are just real patterns. There are no 'things' or hard relata, individual objects as currently understood. It is the real patterns that behave like objects, events or processes and the structures of the relations between them are to be understood as mathematical models.

But then Lupasco's question "What is a structure?" still appears, as if the only answer to it were a set of equations! The indirect answer of Ladyman and Ross is in terms of science as describing modal structures including unobservable instances of properties. What is not of serious ontological account are unobservable *types* of properties. Thus seeing phenomena not as the 'result' of the existence of things, but their (temporary) stability as part of the world's modal structure, necessity *and* contingency, is something that is acceptable in the LIR framework, provided that the dynamic relation of necessity and contingency is also accepted. There is information carried by LIR processes from one state (of actualization and potentialization) to another, describable by some sort of probability-like non-Kolmogorovian inequalities, although it may not be easily 'computable'.

The theories of mathematical structural realists like McArthur, and ontic realists like Ladyman and his colleagues might thus benefit from something like my view of structures as dynamic entities. In LIR, these are the sets of processual relations themselves rather than sets of equations semantically equal to a theory. As Ladyman points out, the structuralist faces a challenge in articulating his views to contemporary philosophers schooled in modern logic and set theory, which retains the classical framework of individual objects represented by variables subject to predication or membership respectively. "*In lieu of a more appropriate framework for structuralist metaphysics, one has to resort to treating the logical variables and constants as mere placeholders which are used for the definition and description of the relevant relations even though it is the latter that bear all the ontological weight* (emphasis mine)." This is where I see a major contribution of the LIR approach. The mutual exclusivity of the logical variables and the description of the relevant relations is lifted: the relations are the logical variables

in different states of actualization and potentialization, without the need for any kind of intermediate entity.

Concepts of partial structures, partial relations and quasi-truth were developed by the Brazilian school as the basis for their descriptions of quantum reality, given that the classic concepts of set, kind, individual and truth are inadequate. These were the basis for a definition of quantum entities as separable non-individuals. However, Bueno says at one point (Bueno 1999): "…, the partialness modeled by the partial structures approach is not understood as an intrinsic, ontological 'partialness' in the world (as an aspect about which an empiricist will be glad to remain agnostic. We are concerned here with an 'epistemic', not an 'ontological' partialness."

As I have tried to argue, LIR is about ontological partialness and approximation, without scare quotes. It confirms, as a principle, the non-absolutism of any real entity, process or theoretical, that can undergo change. If the category of Non-Separability is valid for dynamically interactive phenomena, then LIR provides an interpretation of such ontological partialness: in addition to separable non-individuals, there are also non-separable individuals and this physical individuality persists up to the highest levels of reality. The question of where the transition takes place, and individuality starts, has not been answered satisfactorily, but it may not be until the advent of *individuation* through language and memory in human beings.[18] In these terms, lower level creatures such as social insects and fish and birds that form interacting schools and flocks should be considered as consisting of non-separable non-individuals.

Like Ladyman and Ross, LIR recognizes the difference between individuality and indistinguishability for quantum particles, following Krause. Ontological verificationism (see Chapter 2) avoids reliance on the kind of non-existent pseudo-structures that are usually invoked or inserted to try to explain phenomena to which I also object. My addition to this theory is that *indistinguishability* as well as individuality is, logically, also partly present at higher levels, due to the continued instantiation of residual potentialities from the particle, molecule, etc. levels: things are and are not fully individual, are and are not the same.

Looking at entities at all levels of reality as processes and their relations is accordingly a view that is common to both LIR and OSR in the Ladyman and Ross interpretation. There is a similar pragmatic description of two domains of application of the theories, which I have referred to as those to binary logic (non-causal) and LIR (causal) respectively apply. Thus, these authors say:

> The metaphysics suggested by process views is effectively one in which the entire universe is a graph of real processes, where the edges are uninterrupted processes and the vertices the interactions between them. Thus process views, if correct, would make putatively causal claims by scientists subject to a critical test. Those that pick out real processes could be causal; those that don't can't.

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[18] Borgès talks about the "pre-eminence of the species and the almost perfect nullity of individuals". He quotes Schopenhauer as saying that the cat playing in his room is the *same* cat as the one that played in Egypt five hundred years ago (Borgès 1951).

LIR adds the critical detail of the operation of the PDO on the logical elements of the real processes, better, of the processes involving real spatio-temporal entities, which naturalizes this position, respecting the principles of both the primacy of physics constraint and naturalistic or physical closure.

I will conclude this overview with a brief reference to the neo-Kantian challenge to scientific realism in Kuhn's concept of scientific revolution. The theory dependence of scientific methods referred to above raised the possibility for Kuhn of incommensurability between competing scientific theories or paradigms. Transitions between theories, e.g. from Newtonian mechanics to relativity theory, in this view, instantiate *separability*, a form of epistemic cut (see Chapter 8), because they two theories refer to different entities despite having the same name (mass). Without going into other rebuttals of Kuhn, I will simply say that the metaphysics of LIR provides for a fundamental vagueness in nature. Any semantic conception such as that of Kuhn according to which the most basic laws in a theory or paradigm are *exactly* true is excluded as anti-realist. If my position implies that there is no epistemic cut between science and metaphysics, I have suggested some rationale for it. Based on my view of explanation in Chapter 5, I can say that LIR is a form of realism that treats experimental discovery, as for example, the components of perception indicated in Chapter 5 as empirically reliable *and* as a naturalistic philosophical explanation of why our beliefs based on perceptions represent knowledge about objects that are independent of those perceptions. Accordingly, the change to a new theory can preserve structural properties allowing a certain ontological continuity accompanying a conceptual revolution (Cao 1997). This ontological *synthesis* is a dialectical picture of growth and progress in science that reconciles essential continuity with discontinuous appearance in the history of science, a process that, again, is a logical one in LIR.

6.6.5 Semantic Realism

In semantic realism, every meaningful sentence is viewed as totally determinate, in the sense that, following the principle of bivalence, it is determinately true or false, despite the fact that there may be no method of ascertaining which. However, I feel it could just as easily be considered totally *indeterminate* or instantiating complete indeterminacy, in the sense that there is no method not to *prove*, but to *choose* between the two alternatives for the semantic case. Binary logic is adequate to describe this domain. In the dynamic process logic I propose, to the extent that real alternatives are involved, one or the other is predominantly actualized, and indeterminacy is maximized for the same reason. However, as they approach contradiction in a T-state of maximum energy and contradiction, in which each is actualized and potentialized to the same degree, that state maximizes determinacy; it is "as determined as you can get". Of course, there are many sentences that, even in a classical sense, are not true or false. It turns out,

I believe, that the semantic functions of such sentences are dependent on context in a manner that implies a dynamic relation between them.

The logic of/in reality is a realist theory, grounded in experience as well as physics, in experience *as physics*. It is logic *in* reality and it *is* experience. In other words, it is resolutely opposed to a Kantian program of seeking to transcend experience as being ultimately misleading. Let us see what the further implications are for semantic realism, and if the fundamental postulate adds value to a discussion of realism, non- or anti-realism and semantic realism. In particular, are there particular semantic challenges to realism that LIR undercuts?

A quick answer is yes. LIR provides a phenomenological sense to the idea that an object perceived as external to the perceiver is not totally 'independent', but both internal and external in that these aspects are alternately and reciprocally actualized and potentialized. Thus, there is no need to require that the 'external' physical reality, either in the sense that objects exist or their properties are instantiated, has been 'created' by anyone's linguistic practices, semantic schemes or whatever. As discussed by Miller, Dummett suggests some domains in which it may be appropriate to reject the independence dimension of realism *via* the rejection of semantic realism about them. A semantic realist, in this conception, is someone who has a notion of the truth necessary to understand a sentence that is bivalent or recognition-transcendent. It may be true or false even though we will not be able to determine which, and it is accordingly determinately *either* true or false. This is an example of the 'higher-level' T-state referred to above. His two further claims are essentially (1) that language does not give us the means to make a metaphysical characterization of realism; and (2) the literal content of realism consists in the content of semantic realism.

It should be clear that truth has nothing to do with realism *per se*. This was the problem noted in Chapter 2 in the discussion of truth-makers. Realism says nothing semantic about the world beyond making the negative point that our semantic capacities do not constitute the world. Miller quotes Devitt to the effect, also, that the literal content of realism about the external world is not given by semantic realism, since semantic realism is consistent with an *idealist* metaphysics of the external world. My scientific structural realism requires the objective independent existence of common-sense physical entities. Semantic realism concerns *statements* about physical entities but says nothing about the nature of the reality that makes these statements true or false.

There are some additional non- or anti-realist semantic challenges to realism, based on the difficulties of representation (the Representation Problem: Khlentzos 2004). One can formulate this as an aporia: if the world is resolutely mind-independent, how do we get to know about it? Wouldn't a truly mind-independent world make any representation of it in thought or language unreliable or even impossible? A mechanism is needed for any representation (mental symbol) to be reliable in the sense of providing a correlation between it and its worldly referent, the mind-independent state of affairs. This assumes, of course, that such a representative entity is required.

The answers provided by LIR revolve around the word independent. I suggest in effect that antagonistic aspects of reality are 'imported' in perception and are subject to similar interactions in the brain, including the semantic ones that will be involved in communication and other activity. But is the mere existence of such dynamic correlations a guarantee of their reliability? As usual in LIR, the answer can only be "Not completely".

A direct realist response to this anti-realist challenge points to the prevalence in our linguistic practices of realist-inspired beliefs to which we give expression in what we say and do. The anti-realists' counterargument is that reality is fundamentally indeterminate and reasoning follows a correspondingly intuitionist logic. Khlentzos suggests, in terms that are directly relevant to the thesis of this book, that "the overwhelming acceptance of classical logic by mathematicians and scientists and their rejection of intuitionist logic for the purposes of mainstream science provides very good evidence for the coherence and usefulness of a distinctively realist understanding of truth." Wait a minute. There are important domains of science and mathematics for which intuitionist logic, despite its limitations as discussed, is highly useful. Classical logic *has* been useful and still is for many objectives of science, despite its incapacity to resolve certain problems. Third, the citation places the emphasis, incorrectly in my opinion, on 'truth' as opposed to the reality that grounds it, as discussed in Chapter 2. This choice may be a disservice to physical/metaphysical realism.

In my view, that the considerations of LIR support a naturalistic story against semantic externalism to describe "how creatures like us came to develop the linguistic dispositions we did" so that a link can be made between, for example, the use of a name "Big Bang" and the event of that name that, in some theories, occurred some time ago. The correspondences for semantic and non-semantic mental operations are a consequence of a contradictorial reading of internal and external, and suggest that many of the semantic challenges to realism can be met accordingly.

The metaphysics and ontology of LIR are very general, and the question may be asked as to whether its key principle, the PDO, is scientific or constitutes some form of a natural law. In the next section, I provide an answer to this question, as well as comments on the on-going debate on the nature of laws of nature themselves. This will again illustrate some of the key aspects of the application of LIR to philosophical problems.

6.7 THE PRINCIPLE OF DYNAMIC OPPOSITION AND LAWS OF NATURE

LIR is a theory that is strongly realist, as I have shown, while providing an epistemological interpretation of a contradictory anti-realism. It includes as a fundamental structural feature the dualities of nature and the inherent antagonism of the terms of those dualities. I have referred to this feature as a PDO, but this

leaves open the questions of whether this represents simply a coherent phenomenological observation, a law of nature, or a more authoritative scientific principle, a fundamental physical theory, on a par, say, with symmetry. There are several candidates for an appropriate description, none of which, I am afraid, exactly fit the principle of LIR. Another closely related question show the term constitutive is to be understood, in view of its Kantian and neo-Kantian background. In Chapter 4, I defined a constitutive principle simply as one that establishes the relation to an object of experience.

6.7.1 Dynamic Opposition: Constitutive and Regulative

At this stage of development of the theory, let me first say what the PDO is not:

- It is not constitutive in Reichenbach's sense of coordinating a pre-existing mathematical (or logical) formalism with the physical part of a scientific theory.
- It is not constitutive in the sense of involving a Kantian *a priori* that is isolated from experimental evidence, something prior to experience that is a condition of the possibility of the existence of that experience.

Dynamic opposition is constitutive in LIR in the sense of establishing the critical relation of interactive coordination inherent in phenomena. Lupasco introduced dynamic opposition as a logical rule on: (1) phenomenological grounds, intuition and introspection; and (2) within the increasing body of quantum mechanical knowledge, increasing its nomological scope in the process. In fact, it developed in parallel with the evolution of the Pauli Exclusion Principle from phenomenological rule to scientific principle (Massimi 2005). This principle is the scientific justification for the LIR position that the movement toward diversity, heterogenization, is as fundamental as that toward identity, governed by the 2nd Law of Thermodynamics, to which there are no known exceptions.[19] In this, however, the PDO accomplishes what might be considered a open-ended Kantian *regulative* function, giving a kind of systematic unity to knowledge in general, not only quantum mechanical.

My conclusion is that it is best to consider the PDO as *sui generis*, constitutive and regulative. In looking for models of dynamic opposition, it is essential not to refer to systems that involve the principles of standard logics that *a priori* exclude interaction between terms. I have already claimed, in the previous

[19] There are, of course, imaginable exceptions, but they constitute an alternative description of non-existent, fictional entities.

chapter, that the PDO is a metaphysical structural principle. However, is PDO a scientific principle and, accordingly, one that should not be ignored either in the philosophy or practice of science?

6.7.2 Dynamic Opposition as a Scientific Principle: Linking Physics and Statistics

I referred in my discussion of probabilistic causation to the difficulty of combining statistical and non-statistical considerations into a world which nevertheless seems to be grounded by the physical constants, indicated in Chapter 4, for both of them. Sklar calls it the "curious interworking of full laws (i.e., those of the dynamics of quantum entities) and statistical generalizations in the explanatory scheme."

If this distinction is maintained, however, then again the problem is displaced to decide what grounds the additional statistical assumptions other than the fundamental dynamics and/or whether additional fundamental postulates are necessary to include *them* into physics. I note in passing that if such a concept would hold, it could mean the end of accident and contingency as valid metaphysical terms (except for the famous unresolved question of the indeterminacy of radioactive decay).

The LIR position is that the PDO is just such a postulate. The locus of the intervention of statistical fluctuations (which in my view still follow, at a micro-scale, deterministic rules) at both microscopic and macroscopic levels is the transition from potentiality to actuality and *vice versa* that is involved in all change, but the formalization of this linkage as a scientific principle in its own right remains to be made. This will require a directed, appropriately designed experimental effort to test its assumptions without, as in this book, relying on data developed for other purposes. But the concept of a scientific principle is also open to interpretation. If causation can be viewed as a physical process, as in LIR, then it belongs as in Cassirer's conception to a new type of physical statement in which both measurements and laws or principles are interwoven (Laudisa 2006).[20]

Massimi proposed that a scientific principle is best understood in the context of Cassirer's reinterpretations of the Kantian *a priori* and principle of systematicity in regulative terms. A scientific principle fulfills a regulative task of systematizing and conferring order on empirical knowledge, *while being an integral part of that knowledge* (emphasis mine). This could serve as an alternate definition of Logic in Reality!

In my view, it is otiose to try to argue whether entities bearing properties and in relation with other entities are ontologically prior to laws of nature or not,

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[20] As quoted by Laudisa, Cassirer talked about an "ultimate common element of all possible forms of scientific knowledge, never perfectly achieved." That the PDO might be such an element I leave as an open-ended possibility in the spirit of Cassirer's inquiry.

that is, whether objective reality is attained because there is conformity to law, and not *vice versa*. On the other hand, my categorial definition of different domains of reality according to whether the PDO is functionally instantiated in them or not suggests something fundamental about dynamic opposition that might deserve the *appellation controlée* of a law of nature.

6.7.3 Dynamic Opposition as a Law of Nature

A law of nature is defined as a general relation that holds between properties of physical entities or systems or between the physical quantities that result from measurements made on those entities. Laws are supposed to have universal validity and a high degree of accuracy and consistency, thus providing a description that aids in conceptual understanding of phenomena. Implicit in the notion of a law of nature is that such laws govern the behavior of all the entities in the universe.

The position of Hume and his followers is that there are no necessary relations or connections in nature – connections, powers or dispositions (see Section 6.3.4) – that could collectively be called modal properties. Accordingly, there are no laws of nature. In contrast, the metaphysics of the logic of/in reality are fundamentally anti-Humean: in LIR, necessary connections, including those of cause and effect are such that there are no such things as distinct existences of events linked only by contiguity.

Most realists believe that laws of nature and real modal features *do* exist, but they are divided on their content and role in explanation. For example, does the concept of a law of nature add explanatory value beyond that of the modal properties themselves? The debate about the laws of nature is whether the description of an aspect of the universe as a law implies that it is more than the equations and/or descriptions of properties of certain natural kinds that it contains. If so, it should be possible to state in what that consists. If there is 'nothing more to it', then one can ask if there is still some value in describing some phenomenon as law-like as opposed to those that is not, generally designated as accidents.

Another form of this division is that between fundamental and less fundamental laws, in other words, should the designation change of something as a law or not according to level of reality? Realists are also divided on other issues, in particular whether laws are necessary and contingent, and what the meaning of a contingent law might be. There is the related question of what should be the proper domain of application of a certain non-fundamental laws, given that there are domains in which they clearly fail or are incomplete. Finally, is there any cognitive and heuristic advantage in defining something, such as the PDO of LIR, as a law of nature?

6.7.4 Metaphysical Positions

The problem of the *metaphysical* character of laws of nature can be approached by reference to the LIR treatment of identity and diversity as non-separable categorial features, based on the discussion in Section 4.4.1.2. Standard logic is a logic of identities, and laws of nature express those identities as being dependent on necessary connections between distinct states. The opposite, antagonistic position, as noted, is the one of Hume that no such connections exist or need to be postulated to explain the observed regularities in nature. Mumford (2005) describes this position as 'Humean lawlessness'.

Currently, it is nomological realists who think that there are metaphysically real laws of nature, and that these laws correspond to the relations between entities. This approach displaces the problem, however, to whether these relations are necessary or contingent. The further argument is over whether the necessity is metaphysical, grounded in the real features of the world; analytical necessity, grounded in meaning of propositions; or classical logical necessity, grounded in form (syntax).

Roberts (2005) differentiates between two forms of laws of nature, as follows:

(1) P is a law relative to a theory T iff P is implied by T and plays a role R within T.
(2) P is a law of nature iff it is a law relative to some true theory.

In this metatheoretic account, the definition (2) of a law of nature is tautological, unless there is a theory-independent understanding of the operator "It is a law that _". Roberts says that there is a better way to define a fundamental physical law than as a law posited by a fundamental physical theory: (1) certain theories contain propositions that play a special role within those theories that are, or can be designated as the *fundamental laws* of that theory; and (2) a theory all (or most?) of whose propositions are laws of it is a *fundamental physical theory*.

Roberts suggests a new form that a philosophical theory of fundamental laws of nature defined by (1) might take. He states that correlations on which measurability depends are guaranteed not by meaning-constitutive principles, but by laws of nature. This in turn depends, however, on the proposal that what it is to be a law of a theory is to play an indispensable role in showing that the theoretical quantities posited by that theory are indeed measurable. But such laws, in turn, seem to be difficult to differentiate from principles, since if laws can be principles from which one can derive systems of differential equations, they are "well equipped" to guarantee the measurability of theoretical quantities.

My two-level approach permits the application here of the between-level epistemic dynamics that I have proposed. Elements are part of laws, and laws are

parts of theories, and *vice versa*. It is not necessary to take a dogmatic position on whether LIR is law or theory from a specific point of view. Mumford refers to three general stances taken about the existence of laws: *primitivism*, that states that they correspond to a distinct non-reducible category; *eliminativism* that rejects laws as a separate category entirely; and *reductionism*, that says that there are laws but they, or the phenomena they describe, can be accounted for by other things that are not laws. My view is that something that is expressed by the phrase 'natural law' exists, and exists within the sub-category of Non-Separability, and is accordingly reducible to the underlying dualistic interactions of the universe. As a general stance, LIR is *both* reductionist and eliminativist. The modal, nomological connections of the world are inherent in the properties connected and these features are really in the world without it being laws that ground them. The job left for laws is to function as a heuristic device to *call attention* to the interaction between theories and their elements.

I thus have a further approach to the current debate on whether the laws of nature that obtain in "our universe", the one which we are able to exist according to the weak anthropic principle (Chapter 1), are a selection from an (infinite) set of laws that permit many different universes (the multiverse). LIR supports the view expressed by Davies (2007) that it is not necessary to appeal to "something" outside our universe to explain the "fine tuning" of the laws of physics. The PDO inherent in what there is "inside" provides some of the missing explanations of the operations of those laws, without going outside of *them*.

If the above line of reasoning is accepted, then it makes little difference whether the PDO and its related logic and ontology do or do not constitute a corpus of natural laws. For example, what anomic constraints[21] have in common is the extent to which they replace laws as sources of understanding or provide other epistemic or pragmatic outputs, but the benefits are not linked to generality, the formal unifying and explanatory property expected from laws. The notions of LIR are more substantial, realist and causal, as well as general, and the simplest conclusion is that they can be seen as both law-like and not.

I believe this discussion of laws of nature from the LIR standpoint constitutes an example of the second objective of this study: it is to show how theories themselves can benefit from the contradictorial approach by the explicit reference to the presence in them of the interaction between their constitutive concepts and their contradictions.

6.7.5 Laws of Nature in Use

Much effort has been made to give substance to the notion of laws of nature by using behavior under counterfactual suppositions or conditionals to

[21] *Non*-lawlike aspects of real processes (see below Cat 2005).

make a sharp distinction between laws and accidental truths. The concept of an accident has a long history in philosophy, but it is best defined for my purposes as a phenomenon whose causes appear to be essentially indeterminate. The argument, roughly, states that laws of nature hold under any counterfactual supposition that is logically consistent with every logical consequence of the laws. Laws can be defined as a stable set of truths; truths have a kind of necessity; and an accidental truth (the truth of an accident) has no such sense of necessity (Lange 2005).

However, once this definition is made, it should be clear that one is in the domain of binary logic.[22] The notion of propositional truth that is used is incompatible with the LIR description of reality. Counterfactual suppositions are epistemological devices without direct implications for physical processes, and the discussion of whether counterfactuals or laws are ontologically prior is a question within classical ontology. From the point of view of real phenomena, there are no accidents defined as undetermined events; arguments that depend on a definition of laws of nature as totally distinguished from accidental regularities cannot be maintained.

From the LIR standpoint, laws can be interpreted as governing or characterizing both A – models of real systems, equivalent to a semantic view of theories; and B – the real systems themselves. I thus have a two-level framework A and B to analyze in the sense of Section 5.2. If inconsistency in nature is constitutive, a relation must be established between such inconsistency and the basic concept that laws should not have exceptions. For this discussion, the definition of a model is a conceptual structure that mediates the application of abstract theory to phenomena or data, or simply provides their understanding by way of representation or explanation. There is no absolute requirement that that any theory cannot be *lawful* and restricted, consistent and inconsistent, since it does not have be fully both at the same time. The structure of the LIR approach accommodates the idea that laws can apply more or less completely to models, given that the models, in their similarity to the underlying phenomena, will also instantiate the categorial features of LIR (Cat 2005).[23]

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[22] As a consequence, the concept that there are laws of *logic* as logic is generally understood is trivially true: the 'law of the excluded middle' guarantees the truth of propositions of the form *either* p *or* not-p.

[23] Where, for example, Hooke's law of elasticity describes a deformation accurately, the material is in a region in which internal structural properties of the atoms or molecules have determined the elastic constant, but the macroscopic behavior is governed by the law and its simple, non-antagonistic dynamics. The 'language' of energy and dynamic opposition of LIR is thus well adapted to discussions, for example, of the strength of materials as a measure of resistance to fracture, resistance being, in this view, a potentiality dependent on the microstructure of the material, that is, on the integral of its residual potentialities at the interface between molecules. A crack is not a boundary condition, but the structural site at which macroscopic mechanical potential energy Um is transformed into crack surface energy Us. The crack as a site of physical activity is best described as an *opposition* (Cat's word) between Um and Us; as Um decreases, Us increases.

It is also clear from this discussion that for valid analysis, some distinction must be made *within* the general category of laws of nature. The issues are not the same for a 'law of gravity' or 'law of thermodynamics' which have no known exceptions, and a law such as Hooke's Law governing the elastic deformation of solids where there exists a very specific event domain, namely fracture, at and in which it no longer applies. The domain of application of some laws of nature, and the corresponding understanding of phenomena, that is, the explanatory power of the relevant theories, can be illuminated by looking at the ensemble of representational elements and processes that lie outside the content of the law proper. Cat (2005) calls these elements anomic and they include boundary conditions, state descriptions, structures, constraints, limits and mechanisms. This 'law-eccentric' knowledge is central, in his view, to both modeling the world and intervening in it.

With such content for the anomic elements, one may well wonder what role is left for the laws of nature themselves, as in the metaphysical viewpoint. As it turns out, it is exactly in this intermediate or boundary domain, the 'join' of the lawful and so-called extra-lawful, that the conflicts and dichotomies have been looked at exclusively from the point of view of classical logic. Most if not all of the issues raised in Chapter 5 and the present one seem to be involved, including continuity, the domain of application of differential calculus and the discontinuity of the boundary.

An additional problem is the difference in forms of symmetry breaking, explicit and spontaneous. Explicit symmetry breaking involves a clearly 'external' factor meaning in LIR terms one free of any prior interaction. As mentioned, spontaneous symmetry breaking (SSB) involves asymmetries in the states of systems that are not present in the prior equations of state. They, and the resulting emergence of new properties, can be described as a change in the order of a system due to instability under small internal statistical perturbations. Phenomena exhibiting such behavior at the macroscopic level include turbulence, phase changes of all kinds, superconductivity and onset of ferromagnetism. Are such changes captured by a law, or by a structural description of the state of the system? If one defines laws as applying before symmetry breaking, with a unifying character, and some other model as that from which asymmetrical states derive, then it is obvious that the latter is what bears the explanatory role.

In LIR terms, for any process to go forward, some form of symmetry breaking is required to get out of the state of a 'frozen' dialectic at a temporary limit of non-contradiction (of identity or diversity) but it is misleading to call it spontaneous. The LIR category of Process implies the dynamic interaction between actual and potential states that captures the phenomenon, 'before and after'. LIR thus has a law-like content that provides a causal interpretation of the critical value of a property. It is a mechanism in the sense that it describes the interaction of the different entities involved with their respective cause (and effect) aspects that increase the explanatory power of the concept of symmetry breaking. It is not the laws alone that are bearers of scientific knowledge, but structures and mechanisms also, as shown in the discussion of scientific-structural realism.

The difference between boundary conditions and constraints is that the former are time dependent and the second not, a property that will reappear in connection with my analysis of the basis for evolution.[24] In LIR, time is not fundamental in the first place, and the relation between a regime of boundary conditions and one of constraints can be explained in terms of the ternary/binary distinction. This is my basis for saying that a simple physical change of phase, with no internal representation, belongs in the category of Separability. Each case of boundaries and physical limits raises its own conceptual considerations, but LIR adds the generalization that no such limits can be considered absolute over an appropriately long time scale. LIR essentially fits a definition of bridge principles or correspondence rules that connect or coordinate abstract theoretical terms to or with more concrete terms to which the abstract theory is to be applied. LIR provides the basis for a incorporating an appropriate function for laws, models and the kind of philosophical Gestaltic switch that must be made depending on which level of description is the center of attention. What might be considered as *just* an epistemological shift between, say, two levels of explanation, cannot be properly interpreted unless the shift or switch is seen as a dynamic process, in the category of Process, in that the levels or elements are connected following the axioms of LIR.

I will now turn from the various theoretical aspects of the logic of and in reality developed above to their applications in some selected areas of philosophy and science. Before this, however, I will make one reference to a philosopher that I and others consider a major precursor of Lupasco, namely Hegel.

6.8 FRIEDRICH HEGEL: IDEALISM AND/OR CONTRADICTION?

I have not sought in this book to refer, except in passing, to the major precursors of the logic of/in reality. Nevertheless, because of the parallels to Hegel's dialectics, logic and ontology that may suggest themselves to the reader, it is useful to show in some detail how LIR should be differentiated from Hegel's system. Lupasco considered that his system included and extended that of Hegel. However, one cannot consider Lupasco a Hegelian or neo-Hegelian without specifying the fundamental difference between Hegel's idealism and Lupasco's realism. I share this realism and have tried to support it in previous sections in this chapter.

Both Hegel and Lupasco started from a vision of the contradictorial or antagonistic nature of reality; developed elaborate logical systems that dealt with contradiction and went far beyond formal propositional logic; and applied these

[24] At the cosmological level, the difference between a central law and an auxiliary constraint vanishes since in the effective quantum field representation of the universe, the wave function of the universe is described by the Wheeler-DeWitt equation in which time is absent.

notions to the individual and society, consciousness, art, history, ethics, and politics.

To give a rough idea of the complex relationship between Hegel and LIR, I will look at the logic; the source and locus; and the consequences of contradiction in the two systems. Hegel incorporated contradiction in logic and rejected the idea of a classical 'formal' logic that claimed to be a study of the form of thought in abstraction from content.[25] This is similar to the LIR view, also in the sense that thoughts and concepts reflect the universe in some way, but the dynamics involved are very different. Hegel proposed three axioms to describe reality that differ from our first reformulation of the classic axioms: A is A; A is non-A; non-A is A after all, or else they are all together. They imply a primarily diachronic sequence of A, non-A, and A as thesis, anti-thesis, and synthesis, whereas I have suggested both a synchronic and diachronic existence of A, non-A and T-state as an included third term, with the understanding that 'inclusion' refers to its location between the first two terms but at another level of reality or complexity.

Hegel's contradictions had their origin in the manifestations of Spirit as Idea or Concept, and, governed by Absolute Necessity as their Internal Teleology, they struggle to return to it in an ascending dialectic *via* the vehicle of human-consciousness-in-history being finally in a position to understand the process. At first sight, Hegel seems to have accepted contradiction as fundamental, until one realizes that, although the most ontologically significant relation is one of opposition between two things that mutually define each other, what is essential is their inner identity. In fact, if an element is in contradiction with itself as its negation, it disappears. This argument suits only Hegel's ontological conclusion that finite things disappear or die because they are failed attempts to 'embody the infinite' and makes it clear that Hegel lacked a physical/metaphysical basis for life, form and diversity of equal ontological value.

Hegel's logic is still Aristotelian in my view, integrated into a "metaphysical dialectic" (Lupasco 1986), in which the contradictory duality he introduced was continually abolished by successively purer and broader syntheses of antithetical terms, finally reaching the *Aufhebung*. Priest translates this as sublation, a dialectical transition in which a lower stage is both annulled and preserved in a higher one, and *Versöhnung*, reconciliation, because the new unity does not abolish the distinction. Here, one can see Hegel's picture as both synchronic and diachronic, in that the three terms are, at least sometimes, present at the same time. Nevertheless, contradiction is inherent even in the supreme identity of absolute spirit (*Geist*), since it is both embodied and opposed to its embodiment. This is nothing more than the philosophical expression of macrophysical becoming, governed by the 2nd Law of Thermodynamics. The subsequent dialectics of Marx and Engels simply transposes, to the social level of reality, the same Hegelian drive toward a synthesis involving the suppression of, in contrast to Hegel, *all*

[25] In a paper for publication, "What is formal logic?", Jean-Yves Béziau shows, from the standpoint of contemporary logic, that the notion of 'formal' is neither essential nor useful to characterize it.

contradiction. One may, rather, take Hegel's idea that every phenomenon is a 'fragment' of *Geist* that reflects the latter's properties to foreshadow the contradictorial, dynamic view of energy, provided the difference in their role and behavior is not overlooked. For example, Hegel's description of the part-whole relation is close to that of LIR:

> …parts and whole are not identical, each only exists in opposition to the other and in order for each to exist for itself, each must as it were reduce the other to satellite status, dependent on itself. They are related essentially: each is only itself in relation to another that is its negation. … the contradictions in it (reality) that we see by looking at part and whole show that it is in movement, that it is constantly going over from unity to multiplicity and back again. But this relation of exteriorization is that of force (energy) and its manifestation. It is the whole seen dynamically as inner force that produces external reality as its manifestation.

It is easy to see "satellite status" as the result of potentialization. All this picture would require further to fit the logic of reality is the more complete picture of energy as the 'inner force' that grounds the contradiction.

Lupasco's system, however, involves *two* dialectics, ascending and descending (*diverging*) toward the non-contradictions of identity and diversity and a *third* dialectics *converging* toward contradiction. As above, the source of contradiction is inherent in energy and is the only existent reality. To say that material-energetic reality was the result or emanation of some other necessity as the foundation of the real amounts to tautology or mysticism, and Hegel's "obscure logical descriptions remained without a future for logic and science". As Lupasco expressed it, Hegel's system was "only half of a dialectics" (Lupasco 1947). The affirmative value of identification always transcends the negative value of diversification. In LIR, contradiction is established at the basic physical level.

As pointed out by Taylor (1975), Hegel's thesis depends on a premise of ontological necessity that in turn depends on the contradiction of the finite. Hegel established or expounded his ontological structure at 'high' levels, but his project required demonstration of his ontology at the lowest level of simply determinate beings, and his attempted proof of contradiction failed. I suggest that the realism of LIR successfully answers this major objection to the coherence of Hegel's system, without requiring a commitment to his basic thesis, the idealist part of his doctrine.

The Hegelian picture of the world has on-going relevance as the basis of a relevant philosophical vision of "embodied subjectivity, of thought and freedom emerging from the stream of life, finding expression in the forms of social existence, and discovering themselves in relation to nature and history." In my view, as exemplified throughout this book, Lupasco's view of contradiction founded a dynamics, whereas Hegel's did not, precisely because his system is *not* metaphysically and physically grounded at the "lowest level of simply determinate beings" that is, microphysical entities. Lupasco (1987b) showed that there is no *deductive* necessity in Hegel for thesis generating anti-thesis, let alone any

subsequent fusion.[26] My view is that LIR can be considered as Hegel *naturalized*, since a physical basis in reality for Hegelian change has been defined.

Some comments about dialectical logic may be appropriate here. As discussed also by Priest (1989), Hegel distinguished between dialectics and formal logic – which was for him the Aristotelian logic of his day. The law of non-contradiction holds in formal logic, but it is applicable without modification only in the limited domain of the static and changeless. In what is generally understood as a dialectical logic, which LIR superficially resembles, the law of non-contradiction fails. The subsequent developments of formal logic, starting with Frege and Russell, have forced Hegel's conception of contradiction to be rejected or interpreted non-literally. Neo-Hegelians have attempted to conserve *this* principle of contradiction by emphasizing the factor of time: A is not identical to A, because time has passed in which changes have occurred; contradictions take place one after the other, etc. Articles purporting to describe dialectical logics still appear. In one example, a relation is proposed with non-linear dynamics in which dialectical logic is enhanced by mathematical logic. These and other moves, however, do not address, any more than Hegel did, the question of what drives the change from thesis to antithesis to synthesis, that is, how any term cannot 'stand on its own' but 'goes over' into its opposite or contradiction. Russell demonstrated, before Lupasco, that Hegel's logic could be deconstructed because it still presupposed traditional Aristotelian logic, but not for this more important reason.

Piaget, also, did not go beyond the standard Hegelian form of Marxist dialectical materialism. This correctly accords a central role to conflict and contradiction in the transformation of social realities. However (Priest 1989), Marxist dialectics fail to give an adequate account of the true contradictions involved in society: an inconsistent or paraconsistent logic is necessary for such an account, albeit in my view not sufficient. A logic of the LIR form seems required to characterize the emergence of new structures from real contradictions.

6.9 THE LIR APPROACH TO PHILOSOPHY

At several points in the previous discussion, I have referred to the difficulties associated with philosophical arguments of various kinds and suggested that LIR could make specific contributions to resolving them. The purpose of this

[26] Lupasco rejected Hegel's dynamic relation between being and becoming, since he wanted to limit contradiction to the domain of becoming, which drastically limits the value of Lupasco's thesis. In fact, Lupasco's universe consists of almost nothing but Becoming as functional contradiction, the alternation of the actualization of a phenomenon, with the potentialization of its contradiction, and the actualization of the former, plus emergent T-states. Contradiction is absent only in affect or affectivity, which has no energetic aspects and is the only constituent of being. This metaphysical position is incompatible with the non-naïve realism of LIR.

section is to provide a characterization of some general aspects of philosophy and philosophical structures and what the application of the principles of LIR might accomplish. My criticism of philosophical arguments is that they often depend on some form of absolute separability of opposing or dichotomous terms. This takes place *via* the importation as noted, explicit or implicit, of principles of binary logic exemplified in the standard notions of time, space and causality.

My catch-all definition of philosophy is that of a set of disciplines – logic, ontology, metaphysics, epistemology – and their use *via* reasoning and analysis to arrive at a viewpoint about what it is for human beings to be alive and think. This definition has the following consequences:

1. The relations between the disciplines are themselves extremely complex, but, again pragmatically, domains can be identified in which one or the other is the preferred form of description. In turn, this can assist the characterization of the additional key relation, namely, between philosophy and science as differently constituted modes of inquiry.
2. Philosophical statements must be assumed to say *something* meaningful about the underlying reality, physical or mental, and it is accordingly legitimate to ask if they do so successfully or not.
3. If, on the other hand, the statements are claimed to be (nothing but) metaphors, it is legitimate to ask what the reality is like to which the metaphors refer.

The key terms of my (very limited) analysis of philosophy in the LIR system are *experience*, *separability*, and *immanence and transcendence.*

- **Experience**

The logic of/in reality is a logic of experience, as well as of physics, that gives equivalent ontological value to both physical and mental phenomena. It is a philosophical position that places experience within philosophy without, however, equating it with Humean empiricism. Lupasco said that "experience is logic and logic is experience", and logic, experience and method were synonyms (Lupasco 1947). This position conflicts with the statement attributed to Wittgenstein (Ambrose 2001) to the effect that

> I am going to exclude from our discussion questions which are answered by experience. Philosophical problems are not solved by experience, for what we talk about in philosophy are not facts but things for which facts are useful.

In addition to Heidegger and Sartre, a few lesser-known, European philosophers accepted the philosophical relevance of experience, e.g., Piaget, Bachelard and Gonseth. The system of Gonseth, for example, has the advantage of providing a smooth connection to science (Pouget 2004) through mutual reinforcement of theoretical (logical in the standard sense), experimental and intuitive perspectives. Its 'open methodology' refers to openness to experience.

The interactions implied in Gonseth's approach can be well described in Lupascian terms, and contrast with the Deleuzian view below.

Wittgenstein claims in the *Tractatus* that logic does not deal with the world, but with the possible. But such a dualism is now untenable (Peruzzi 1994). The development of the categorial approach to modalities clarifies how the possible pervades or intertwines with the real. LIR theory emphasizes the role of potentialities, starting at the level of basic physics, and provides an interpretation of 'intertwining'.

- **Separability**

As I have shown, most philosophical arguments seem to depend on some form of absolute separability of dichotomous terms. This takes place *via* the importation, explicit or implicit, of principles of binary logic exemplified in the use of standard notions of time, space and causality.

Derrida's philosophical concept of '*différance*'[27] is one that rather supports the principles of LIR. He questions the structure of binary oppositions (in the LIR view, the lack of recognition of how they interact), and says that *différance* "invites us to undo the need for balanced equations, to see if each term in an opposition is not after all an accomplice of the other. At the point where the concept of *différance* intervenes, all of the conceptual oppositions of metaphysics, to the extent that they have for ultimate reference the presence of a present …(signifier/signified; diachrony/synchrony; space/time; passivity/activity, etc.) become non-pertinent. A new definition for dialectics is necessary" (Derrida 1974).[28] LIR takes this intuition and provides a new 'structure' of the oppositions in question and what it might mean to "be an accomplice".[29]

Deleuze is a contemporary philosopher, on the other hand, who considered philosophy as a constructivism (Deleuze and Guattari 1991), implying an intuitionist logic that depends on the maintenance of the law of absolute non-contradiction. Accordingly, all the concepts he uses are to be placed in the subcategory of Separability.

My claim is thus that despite, or rather because of the fact that the various philosophical disciplines (disciplines within philosophy) overlap, the application of the PDO and its consequent ontology defines domains in philosophy that are characterized by whether binary logic or the ternary logic of/in reality primarily apply. Thus, aspects of LIR may still be considered within the multiple traditions of analytical philosophy, as a logical system into which physical processes, as well as propositional ones, may be translated.

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[27] The neologism *différance*, with an 'a' in the third syllable, differs from the word for difference in French which is spelled *différence*. *Différance* is a kind of dynamism in the LIR sense.

[28] Derrida's concept of 'supplementarity' can be seen as a kind of emergent third term.

[29] Priest (2002) also shows that the notion of *différance* instantiates both the inexpressibility of all linguistic expressions and its own expression and that this real contradiction is inherent in Derrida's system.

Philosophers may also wish to note that the paradox of analysis does not arise in LIR, since by Axiom **LIR1**, *analysandum* A and *analysans* C in the form 'A is C' can not have exactly the same meaning due to identity. A is and is not C, and this gives substance to the concept that the statement can be informative if C has a "different or more richly articulated sense than A". Finally, LIR opposes what Dummett has proposed as the fundamental axiom of analytical philosophy, namely, that "the only route to the analysis of thought goes through the analysis of language". The LIR analysis of 'thought' goes through the analysis of the energetic processes at hand.

- **Immanence and Transcendence**

I discussed immanence and transcendence earlier in this chapter in relation to causation and determinism and proposed a contradictorial relation between them. The absence of such a relation in the work of Deleuze further illustrates my thesis.

Deleuze has probed deeply into the relation between real events and philosophical concepts and 'events', especially, immanence, transcendence, life and meaning. His work is significant for this study because of the *way* in which he rejected dialectics (Lardreau 2006), although he accepted a reciprocal relation between his most important terms – Immanence and Life.[30]

The best way of summarizing his system is to see it as a structure of abstract relations between terms which define two domains – 'philosophy' and 'science'. Deleuze's philosophy includes transcendental structures of several kinds: two levels of idealized structures: a pre-philosophic chaos and a plane of immanence (in which language games operate), which 'cuts' through the chaos (Bento Prado 2003); the transcendental field; the metaphysical surface and the plane of immanence. Examples of separability in 'philosophy' are to be found in Deleuze's construction of meaning as a metaphysical surface, or a 'line', a middle between extremes (Badiou 2006), that are the loci of the separation of different aspects of phenomena, propositions and things (Deleuze 1969).

The plane of immanence provides a field in which concepts and meanings are produced, circulate collide, etc. Life is transcendental, but the plane of immanence is *a* life; "it is not immanence *in* life, but immanence which is not *in* anything." If it were immanence in life it would lose its character as being which possesses in itself the reason for its being, as opposed to a being whose existence depends on that of another. A critical task for this philosophy is to retain

[30] Life is simply a more affirmative and better-specified concept than Immanence. Life rather than Immanence opposes Transcendence not only as a general concept, but as the form in which (or by which) Transcendence is specified, namely Dialectics. Term-to-term oppositions remain an essential part of philosophy – Negation-Transcendence *vs*. Affirmation – Immanence, and Dialectics, placed in opposition to Life, in opposition to an integral 'immanentism'. Transcendence is thus specified by Dialectics, but its relation to Immanence is not Dialectics. These are not dynamic relations in the LIR sense, in which the relations between non-absolute elements constitute the 'dialectics', and there is no difference between opposition and dialectics.

a property – the infinite – that is allegedly 'lost' in science.[31] The objective of philosophy is not to recognize objects; it is the task of science to convert the objects of the plane of immanence into determined states-of-affairs.

The philosophy of Deleuze illustrates the results of an application of the concepts of immanence and transcendence that does not define or include any dynamic dialectical relation between them. The domain of Deleuze's philosophy is a realm, governed by binary logic, of undetermined, idealized entities, Humean in its lack of effective interactions. In the domain of reality to which LIR applies, the existence of all beings depends and is defined by that of others. Infinities and infinitesimals do not exist, but are replaced by transfinite values, and immanent and transcendent aspects of phenomena are alternately actualized and potentialized.

My interim conclusion, that will be valid for my use of the term 'philosophical' in the remainder of this book, is that LIR can discuss philosophical problems in physical, dynamical terms that do not require recourse to any imaginary, abstract structures to separate or define aspects of reality. Any such aspects that are considered 'virtual' or 'possible' in Deleuze are so 'in philosophy' but 'in reality' are instantiated as potentialities.

The practice of philosophy as an activity that is 'chaotic', not subject to formal rules (Wittgenstein) brings it close to a form of artistic creation; its language-games are from this point of view exactly that, games, *Glasperlenspiele*, and do not necessarily have anything to tell us about reality or real behavior. Games as they are usually understood are binary phenomena, with winners and losers. Only infinite or transfinite games, in which the objective is to keep the game going, seem to me to involve dynamic real relationships, to which the rules of LIR might be applicable.

The example of Deleuze should not be taken to mean that I believe all philosophical characterizations involve imaginary structures or processes. As a counterexample, I suggest Jankélévitch's view of irony as being capable of transforming apparently conformist attitudes into a 'higher synthesis', that is, something with additional real meaning. This is a real emergent process in LIR terms. The opposite of this 'ironic conformism' is 'conformist extremism' that moves back, 'through superficial and mechanical anti-theses' toward the non-contradictory thesis from which it started out (Jankélévitch 1964).

The LIR view of philosophy expressed here ultimately combines, as in the conception of D. W. Smith (2004), phenomenological and ontological standpoints, in particular in relation to the most complex philosophical questions of life and mind. It differs from that of Smith in its picture of ontology, as I have shown above, but it is also a systematic approach to the structures of all real phenomena, including mind.

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[31] I discussed the concepts of infinity *vs*. transfinity in Section 2.3.1. As stated by the Argentine poet Jorge Luis Borgès: "Infinity is the concept that corrupts and alters all others".

6.9.1 The Philosophy of Mind

The existence of a phenomenon in the universe capable of reflecting on its own existence and referring to it symbolically is only one of the innumerable ways in which the human mind has been described. The philosophy of mind can be considered as the sum of all theories that attempt to explain both its physical or quasi-physical aspects – biological, neural, causal, computational – and its psychological components – intellectual, emotional, social, and the relations between mind and the objects, internal and external, physical and linguistic, that are processed by it. Dealing with the concept of mind also requires dealing with the related concepts of consciousness and intentionality, the unique character of mental phenomena, considered by some as parallel and by others as equivalent to that of mind. Consciousness in turn is accompanied by, or may be equivalent to, its self-referential properties, self-consciousness. The problem is thus enormous, and only this start on an LIR theory of consciousness and mind will be made in this book.

The central problem for a philosophy of mind is to show how physical tokens, the neuro-physiological processes occurring in the brain, can give rise to mental tokens that retain the properties of intentionality, "aboutness", individuality and some level of causal powers or functionality. The weak point in some current views (Esfeld 2006) is that physical and mental tokens must be identical (identity theories of mind (ITM)). The LIR principle of opposition at all levels of perception, mental processing and action gives the logical and scientific basis for saying that something is the same *and* different, here physical and mental tokens, in dynamic opposition at the same time. It has now been shown that the energy required for the brain's responses to controlled stimuli is extremely small compared to the on-going amount of energy that the brain normally and continually expends. LIR thus supports the idea that a "balance of opposing forces" (Raichle 2006) that has a high energy cost is a necessary element of brain function.

At this stage, I thus simply state as a postulate that *no* theory of mind, philosophical or metaphysical, that is based on entities, physical and mental in the category of Separability, can provide adequate explanations of mental phenomena. Philosophers of mind may, however, already see that a revision is possible of Brentano's basic thesis of intentionality as involving a *separation* of mental and physical. If there is a philosophical attitude endorsed by LIR, it is, certainly, one of looking for what links, rather than what separates, aspects of phenomena.

My additional claim, which should be obvious, is that the complexity of mental phenomena and their relations of partial self-reference exclude the application of the principles of classical logic except to the most reductionist, mechanistic models of brain function. That the principle of bivalence continues to be used or implied in discussions of intentionality is simply a measure, for me, of the extent of the problem.

6.9.2 The Naturalization of Phenomenology

I have claimed that the PDO and the categorial features of the logic of/in reality are instantiated, also, at the mental level. The dualism of LIR does not involve 'flirting' with a classical, indefensible dualism of body and mind, one neurological and the other mental. However, why should the sole presence of a dynamic, interactive dualism, a non-reductive physics involving potentialities as well as actualities, insure preservation of the specific qualities of human thought, that is, provide an adequate explanation for its operation? A successful scientific theory of human cognition should account for its phenomenality, the fact that things have appearances, but appearances can, also, be shared. The ultimate objective is to bridge the explanatory gap between a phenomenological mind (consciousness) and brain and to naturalize phenomenology, bringing subjective conscious experience within the purview of natural science. The following remarks indicate some of the directions the LIR discussion might take.

Any view of consciousness and mind must account for both external events as they are cognized – phenomenological data – and their internal processing. However, phenomenology cannot be taken into cognitive science as such without substantial modification. To be scientific, phenomenology thus requires some form of 'naturalization', but there are some inherent limitations in both cognitive science and other current approaches. Most of these theories involve a kind of realism and objectivism that either eliminates all subjective, 'irrational' dimensions of the phenomena under study as 'unscientific' or assign them to a second-rate logical category.

As one example, Smith's strategy for the naturalization of phenomenology is to extend the concept of the natural world to the processes of intentionality, viewed as a physical phenomenon. However, his 'Unionism' is subject to the condition that the unity of the mental and physical is to be understood as the product of a categorical constitution and not as a factual reality. Naturalization in this way is alleged to avoid "reduction to causal or computational processes along the lines envisioned by current cognitive science," but it is difficult to see how intentionality defined in this way would not be epiphenomenal.

LIR challenges the structure of both cognitive science and Smith's critique of it as embodying classical concepts of cause and separability, e.g., between internal and external. Like standard cognitive science, LIR can propose a "close and explicit relationship between brain mechanisms, their existence within an organism, and a surrounding world with which there is an unceasing coupling" (Petitot et al. 1999), but the basis for such coupling, as in my critique of Maturana in Chapter 8, needs to be spelled out.

In the next chapter, I return to issues in physical science, with the recognition, however, that these very much include the structure of the phenomenological world.

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