

THE “ULTRAVIOLET” STRUCTURE OF RECURSIVE VALUE AND POWER

PHYSICAL STRATEGIES AND FORMAL ARCHITECTURES FOR GENERATIVE RELATIONAL BEING

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Abstract

Value and power, when examined at their foundations, exhibit a recursion without evident terminus. Every valuation appears to invoke a higher valuation that would ground it, every exercise of power a legitimation that would authorize it, and every legitimation a further legitimation in its turn, so that the attempt to fix a foundation descends through an unbounded series and the analysis grows less stable the finer its resolution becomes. This paper takes that recursion as its object. It argues that the recursion of value and power shares its formal structure with a problem long familiar in theoretical physics, the problem of ultraviolet behaviour, in which the number of relevant degrees of freedom fails to diminish as one descends toward short distances and the quantities one wishes to compute cease to converge. The paper does not claim that the two are mathematically identical. It claims that they are the same kind of formal problem, and that the discipline which has confronted such problems most directly has accumulated a repertoire of strategies worth examining. The account is built in two movements. The first is diagnostic. It reconstructs the recursion of value and power, identifies the condition under which it fails to terminate, and characterizes that condition in the borrowed and deliberately marked vocabulary of “ultraviolet” structure. The second is comparative and constructive. It sets out the four principal responses that theoretical physics has made to the ultraviolet problem, absorption in renormalization, discretization in dynamical triangulation, extension in string theory, and pre-geometric emergence in group field theory, and it examines what each would mean if carried onto the terrain of a relational and generative account of value and power. It finds that a generative relational account is most consistent with the emergence strategy, on which the recursion terminates at the level where the description in terms of contestable claims ceases to apply. On this basis the paper proposes a layered formal architecture of five offices, ontology, representation, dynamics, criteria, and observation, in which the several formal instruments each occupy a distinct office of a single relational order rather than competing for one, so that representation, generative dynamics, cyclic criteria, and multiscale observation are placed in a definite dependence. It closes, in the manner it requires of itself, on the questions that any formalization of generative value would have to confront. The paper continues a programme that has replaced the individual with generative relational being and carries that programme onto the question of formal foundations.

Keywords: recursive value and power; ultraviolet structure; generative relational being; group field theory; emergence; formal architecture.

AI usage statement: The ideas, claims, and theoretical framework of this paper originate with the author. AI tools were used as an aid in drafting, in the location and verification of sources, and in revision. The origin of each idea has been verified by the author, who takes full responsibility for the content.

1 INTRODUCTION: A RECURSION WITHOUT TERMINUS

The argument of this paper begins in a difficulty that recurs across the theory of value, the theory of power, and the theory of knowledge, and that each of these fields has met in its own vocabulary without recognizing it as one difficulty. In the theory of value the difficulty appears as follows. To judge that something is good is to judge it by a standard, and the standard invites the question of what makes it a good standard, which is a question of value in its turn, so that each valuation rests upon a higher valuation and the higher upon a higher still. In the theory of power the same difficulty appears as the problem of legitimation. An exercise of power is authorized by a rule, the rule by an authority competent to lay it down, the authority by a further rule that constitutes it, and the series that would ground the first act in a final authorization does not terminate of itself. In the theory of knowledge it appears as the regress of justification, in which each ground stands in need of a ground. These are ordinarily treated as separate puzzles belonging to separate literatures. This paper treats them as instances of a single formal structure, a recursion that descends without an evident terminus and that grows, rather than diminishes, as one attempts to resolve it more finely.

The structure has a feature that the ordinary treatments tend to pass over. The recursion does not merely fail to reach a foundation. It becomes less tractable, not more, as one descends. Each attempt to secure a value by appeal to a higher value opens the higher value to the same demand, and the demand does not weaken with depth. Each attempt to legitimate a power by appeal to a further authority raises the same question of that authority, and the question does not lose its force. The analysis becomes increasingly unstable under recursive refinement. This is the feature that gives the paper its guiding analogy. In theoretical physics there is a class of problems with exactly this shape, in which the quantities one wishes to compute receive contributions from ever shorter distances, the contributions fail to diminish as the distance shrinks, and the computation ceases to converge. These are the ultraviolet problems, so named because the divergence gathers at the high-frequency, short-distance end of the spectrum. The recursion of value and power, this paper argues, has the formal shape of an ultraviolet problem.

The word is borrowed, and the borrowing is marked throughout. When the term “ultraviolet” is applied to the recursion of value and power it is written in quotation marks, to indicate that it names a structural resemblance and not a physical fact. There is no momentum in a relational field, no integral over short-wavelength modes, no literal divergence of a computed amplitude. What there is, and what the analogy tracks, is a recursion whose relevant terms fail to diminish under refinement and whose resolution therefore does not converge. The precise sense in which the analogy is claimed, and the precise sense in which it is withheld, is set out in the methodological note that follows this introduction, and it is the load-bearing commitment of the whole paper. The reader who wishes to know at once how far the analogy is meant to reach should turn there first.

The value of the analogy is not decorative. Theoretical physics has confronted the ultraviolet problem for the better part of a century, and it has done so on repeated occasions, developing several distinct frameworks whose common origin is precisely the need to control an unbounded proliferation of short-distance degrees of freedom. Renormalization, dynamical triangulation, string theory, and group field theory are not, at bottom, competing mathematical techniques in search of application. They are different answers to one question, the question of how a theory may remain well defined when the naive account of its short-distance structure diverges. Each answer embodies a distinct attitude toward the divergence, and the four attitudes, taken together, come close to exhausting the ways in which such a recursion may be met. This is the resource the paper draws upon. If the recursion of value and power is an “ultraviolet” problem in the marked sense, then the strategies by which physics has met its own

ultraviolet problems become a structured field of options for meeting it, and the task of the theorist of value is to determine which of them the subject matter permits.

The paper may accordingly state the question it addresses in a single formulation, and it does so here so that every later section may be read as a step toward answering it.

The question of the paper. The recursion by which every value invokes a higher value and every power a further legitimation descends without terminus and destabilizes under refinement. Does this recursion possess a formal structure of a recognizable kind; if so, what strategies exist for problems of that kind; which of those strategies may a generative relational account of value and power consistently adopt; and what architecture for the formal instruments of the account follows from the strategy so chosen?

The purpose of the paper is therefore neither to import a physical model into social theory nor to assert that a relational account of value is a physical theory in disguise. Its purpose is methodological and architectural. It is to establish that the recursion of value and power is a formal problem of a recognizable kind, to survey the strategies that have been developed for problems of that kind, to determine which strategy a generative relational account of value and power can consistently adopt, and to propose, on that basis, a layered architecture in which the several formal instruments each occupy their proper level. The paper claims to have arrived at the right form of the problem and at a defensible architecture for addressing it. It does not claim to have solved it, and it marks, at its close, the questions that remain open. The distinction matters. A great part of what obstructs the formalization of value is that the problem is posed in a shape that admits no tractable answer, and to reshape the problem so that the accumulated strategies of a mature discipline bear upon it is itself a result, prior to and independent of any particular solution.

The argument continues a line of work with a recognizable signature. That work replaced the individual with generative relational being, treating subjects as constituted within relation rather than as prior to it, and treated value as arising within relation rather than residing in a thing or issuing from a lack. It then developed a generative relational epistemology, on which concepts and signs are expressions of relational value rather than its source, and it carried the programme onto the terrain of political economy. The present paper carries it onto the terrain of formal foundations. The recursion of value and power is where the programme meets the question of its own tractability, and the strategies of the ultraviolet problem are what allow that question to be posed in a form that can be worked.

The paper proceeds as follows. It first sets out, in a methodological note, the exact sense of the central analogy and the criterion by which a borrowed term may pass from marked metaphor to literal instrument. It then reconstructs the recursion of value and power and shows in what sense it has an “ultraviolet” structure, identifying the condition under which the recursion fails to terminate. It surveys the four historical responses of theoretical physics to the ultraviolet problem, describing each as an attitude toward the divergence rather than as a body of mathematics. It maps the four strategies onto the recursion of value and power and determines which a generative relational account can consistently adopt. It proposes a layered formal architecture in which generation, scale, and cyclic stability occupy distinct levels. It closes on the open problems, and then, in the manner it requires of itself, on the questions a generative formalization of value would have to confront.

2 METHODOLOGICAL NOTE: THE SENSE OF THE ANALOGY

Before the recursion of value and power is characterized as an “ultraviolet” problem, and before the strategies of theoretical physics are brought to bear upon it, the exact sense of the analogy must be fixed. This section fixes it. It is the shortest section of the paper and the most important, because it determines how every subsequent use of a borrowed term is to be read.

The central claim is one of shared formal structure, and it is bounded on both sides. The paper claims that the recursion of value and power and the ultraviolet behaviour of a quantum field theory are the same kind of formal problem. It does not claim that they are mathematically identical, that there exists an isomorphism between them, or that the equations of the one may be transcribed into the other. A quantum field theory has a momentum space, a measure over field configurations, an integral over short-wavelength modes, and a computed amplitude that literally diverges. A relational field of value and power has none of these. To assert an identity would be to claim resources that the subject matter does not supply, and the paper makes no such claim. What it asserts is weaker and defensible. The two problems have the same structure at the level of the problem itself, prior to any model. In each, a quantity one wishes to determine depends on a recursion; in each, the terms of the recursion fail to diminish as one descends toward finer resolution; and in each, the determination therefore does not converge. This is the shared formal problem, and it is all that the analogy asserts.

The claim of shared structure. The paper claims that the recursion of value and power and the ultraviolet behaviour of a quantum field theory constitute the same *formal problem*: a quantity determined by a recursion whose relevant terms fail to diminish under refinement, so that the determination does not converge. The paper does not claim that the two are mathematically *isomorphic*, and it does not transcribe the equations of the one onto the other.

From this bound a convention follows, and the convention governs the paper’s vocabulary throughout. When a term drawn from physics is used to describe the physics itself, in the discussion of quantum field theory, of renormalization, of quantum gravity, it is written plainly, because there it is literal. When the same term is used to describe the recursion of value and power, it is written in quotation marks, to mark that it names a structural resemblance rather than a physical fact. The reader will therefore find “ultraviolet,” “divergence,” “cutoff,” and “renormalization” quoted when they qualify the relational field and unquoted when they qualify the physics. The alternation is not a stylistic tic. It is the visible trace of the analogy’s boundary, and it allows the reader to see, at each occurrence, on which side of the boundary the argument stands.

A single principle governs when a term may cross the boundary, and the paper states it in advance so that its own restraint may be checked against it. A borrowed term passes from marked metaphor to literal instrument only when the structure that the term requires has been exhibited in the relational field itself. For the term “ultraviolet” the required structure is a genuine scale parameter together with a well-defined family of degrees of freedom that a change of scale integrates away. Until such a parameter and such a family have been exhibited, the term remains in quotation marks, and any conclusion drawn from it is a conclusion about the form of the problem and not about a mechanism in the field. The paper does not, at any point, exhibit the required structure. It therefore keeps the quotation marks throughout, and it is candid that the analogy remains, in this work, an analogy of problem-form and not a mechanism. To exhibit the structure that would retire the quotation marks is one of the open problems named at the paper’s close.

Criterion for retiring the quotation marks. A borrowed physical term becomes a literal instrument, rather than a marked metaphor, only when the structure it presupposes is exhibited in the relational field. For “ultraviolet” this is a scale parameter and a family of scale-dependent degrees of freedom. This paper does not exhibit that structure and so retains the marks throughout.

A question remains that the convention alone does not answer, and it is the question on which the whole comparative method rests. If the borrowing is licensed only at the level of shared problem-form, why should the strategies developed for the physical problem be expected to bear on the relational one at all? The strategies were devised for divergences in momentum space, and the relational field has no momentum space. The answer is that each of the four strategies is, at its core, a response to the abstract feature that the two problems share, and not to the physical particulars that they do not. What renormalization, discretization, extension, and emergence each confront is the failure of a proliferation to diminish under refinement, and each is a distinct way of rendering such a proliferation tractable: by absorbing its cost into terms that are never read off directly, by denying it a reservoir of ever-finer contributions, by dispersing the concentration that drives it, or by dissolving the very stratum on which it was posed. These are operations on the form of a divergent proliferation, and their content survives translation to any domain in which a proliferation diverges in the same formal way. The strategies are expected to bear on the recursion of value and power to exactly the extent that the recursion shares that form, and no further. Where the shared form gives out, the transfer gives out with it, and the paper claims the transfer only for the form.

Why the strategies are expected to apply. Each physical strategy is a response to the abstract failure of a proliferation to diminish under refinement, rather than to the physical particulars of momentum space. Its content transfers to any domain that shares that abstract failure, and only so far as the sharing extends. The strategies bear on the recursion of value and power because the recursion exhibits the same failure of terms to diminish, and the transfer is claimed for that formal feature alone.

The reason for placing this note before the substantive argument, rather than folding its cautions into footnotes as they arise, is that interdisciplinary borrowing fails most often through an accumulation of small unmarked overstatements, each slight on its own, that together persuade the reader a mechanism has been established where only a resemblance has been drawn. The note is a safeguard against that accumulation. It fixes, once and in advance, the weight that every borrowed term is permitted to bear, so that the comparative survey which follows may proceed without pausing at each step to renegotiate its own license.

3 RECURSIVE VALUE AND POWER AS AN “ULTRAVIOLET” PROBLEM

This section reconstructs the recursion of value and power without recourse to any formalism, and shows in what precise sense it has the structure of an “ultraviolet” problem. The reconstruction has three parts. It sets out the recursion as it appears in the theory of value and in the theory of power. It identifies the feature that makes the recursion resemble an ultraviolet divergence rather than a benign infinite series. And it names the condition on which the recursion depends, the condition whose presence sustains it and whose absence would terminate it.

3.1 THE RECURSION

Consider first the recursion of value. A judgment that something has value is made against a standard, and the standard is itself a bearer of value, since to adopt it is to hold that judging by it is better than judging by another. The standard therefore stands in need of the same warrant it confers, and the warrant, if it is supplied, is supplied by a further standard of the same kind. The series does not close of itself. No standard in the series is the standard by which the series as a whole is good, for any candidate for that office is itself a member of the series and subject to its demand. This is the familiar regress of justification in the particular form it takes for value. That it fails to terminate is an old observation and carries little interest here. How it fails is the concern of the next part.

Consider next the recursion of power. An exercise of power counts as more than the mere application of force when it is authorized, and the authorization is conferred by a norm that the exercise satisfies. The norm in its turn is not self-standing. It is valid because it was laid down by an authority competent to lay it down, and the competence of that authority is itself constituted by a further norm, which raises the same question of its own validity. The chain of authorization that would ground a present exercise of power in a final and self-sufficient source runs backward without arriving. Attempts to arrest it have been made by positing a basic norm presupposed rather than derived, or a sovereign whose will requires no authorization, and the recurrence of such devices is itself evidence that the recursion is felt as a difficulty in need of a stopping device, rather than as a series that halts on its own.

The two recursions are one recursion in two materials. In each, a term of the relevant kind, a value or an authorization, is sustained only by a further term of the same kind, and the demand that opened the series reopens at every stage. What is sought at each stage is a ground, and what is found is another term that itself requires grounding. The recursion is the movement of that demand as it descends.

3.2 WHY THE RECURSION RESEMBLES A DIVERGENCE

Not every infinite series is an “ultraviolet” problem. A series may descend without terminus and yet be harmless, if its terms diminish quickly enough that the whole converges, so that the absence of a last term costs nothing and the sum is well defined despite the infinity. The regress of value and power is not of this benign kind, and the difference is exactly the difference that makes the physical ultraviolet problem hard.

In the physical case the divergence is a divergence because the contributions from shorter and shorter distances do not fall off. Were the short-distance contributions to diminish rapidly, the integral over them would converge and there would be no ultraviolet problem; it is precisely their failure to diminish that makes the sum ill defined. The analogous feature in the recursion of value and power is that the demand for a ground does not weaken with depth. The tenth-order value standard is exactly as much in need of warrant as the first-order valuation, and the hundredth authorization is exactly as questionable as the act it was summoned to authorize. The recursion does not approach a limit at which the demand exhausts itself. It reproduces the demand undiminished at every level, and it is this undiminished reproduction, and not the mere fact of infinity, that gives the recursion its “ultraviolet” character in the marked sense. The analysis becomes increasingly unstable under recursive refinement, because each refinement, far from settling the question, restates it at full strength one level down.

The correspondence should be stated with care, since the two cases differ in what the failure consists of. In the physical case the ill-definition is additive, a sum over contributions of non-vanishing size that fails to converge to a finite value. In the recursion of value and power there is no summation, and the failure is one of termination, a series of grounds, each requiring a

ground, that fails to arrive at a member which would close it. What the two cases share is the feature that drives both failures, the refusal of the relevant terms to diminish under refinement, so that no finite truncation is adequate and the descent must be continued without end. The analogy is claimed for this shared feature, the non-vanishing of terms under refinement, and it is claimed neither for the additive form of the physical divergence nor for any summation on the side of value. It is in this exact and restricted sense that the recursion has an “ultraviolet” character.

The “ultraviolet” character. The recursion of value and power resembles an ultraviolet divergence, rather than a convergent infinite series, because the demand for a ground fails to diminish with depth. Each level reproduces the demand of the level above at undiminished strength, so that finer resolution destabilizes the analysis rather than settling it.

3.3 THE FUEL OF THE RECURSION

If the recursion is sustained by the undiminished reproduction of a demand, then the recursion depends on whatever it is that reproduces the demand, and to name that is to name the condition on which the whole structure rests. The condition may be stated as follows. What drives the recursion is that each term in it is posed as a *contestable claim*. A value standard, offered as a ground, is offered as something that could be otherwise, that draws a boundary and excludes alternatives, and that therefore presents to any challenger a surface against which a counter-claim may be pressed. An authorization, likewise, is a claim that could be denied, a drawing of a line that another may contest. It is because each term is a contestable claim that each term invites the counter-claim which reopens the demand, and it is the endless availability of the counter-claim that keeps the recursion in motion. The fuel of the recursion is the contestability of the claim.

This identification has a consequence that governs the constructive half of the paper. A recursion sustained by contestability will continue for as long as its terms retain the form of contestable claims, and it will continue no longer. Should the descent reach a level at which what is found no longer has the form of a contestable claim, at which there is no boundary to press against and no line to deny, the counter-claim would find no surface, the demand would not be reproduced, and the recursion would lose its fuel. Whether such a level exists, and what would be found there, is not a question the diagnostic reconstruction can answer, for it is a question about the deep structure of the relational field rather than about the surface form of the recursion. It is the question that the comparison with physical strategies is designed to sharpen, since the several strategies differ precisely in what they suppose to lie at the bottom of the descent, and it is to that comparison that the argument now turns.

4 LAYERS OF FORMALIZATION

The comparison of physical strategies presupposes a prior question that the paper has so far left implicit, and this section makes it explicit, because the answer to it governs which strategies are even eligible for the recursion of value and power. The question is what determines the choice of a formal strategy in the first place. The position taken here is that the choice depends on the ontology of the object under study. A formal strategy is answerable to what it is a strategy for, and the strategies developed in one domain transfer to another only when the two domains share the relevant features of their objects. The recursion of value and power belongs to the study of social facts, and the eligibility of any formal strategy for it is settled by what social

facts are taken to be.

4.1 THE ONTOLOGY OF THE OBJECT

The object of social inquiry is the social fact, and social facts are of several kinds. Following a standard account, they include events, entities, relations, attributes, and states, and the discipline of international politics, among others, takes these as the units through which its subject matter is analyzed [7]. A theory of value and power operates upon social facts of exactly these kinds, upon the event of a judgment, the entity that judges, the relation within which the judgment falls, the attribute it ascribes, and the state it institutes or disturbs.

The programme this paper continues does not deny the reality of these social facts. Its single modification of the received ontology is to raise relation to a position of relative priority, so that entities, attributes, states, and events are taken to be generated and stabilized within relation rather than given prior to it. The priority is relative and not exclusive. The claim is not that relation alone exists and the other social facts are illusions, which would leave the theory unable to speak of the very events and entities that social inquiry concerns. The claim is that the other social facts have their being within relation, that an entity is constituted as the entity it is by the relations that place it, and that the analysis therefore begins from relation and reaches the other facts through it. With this the ontology of the object is fixed, and the question of representation may be posed.

The relative priority of relation. Social facts comprise events, entities, relations, attributes, and states. The programme takes relation to have relative ontological priority, so that entities, attributes, states, and events are generated and stabilized within relation. The priority is relative rather than exclusive: the other social facts are real, and they have their being within relation.

4.2 THE REPRESENTATION OF RELATIONAL STRUCTURE

Once the object is fixed as a field of social facts with relation at their base, the next question is not how the field evolves, which is a question of dynamics, but how its structure is to be represented. This step is easily passed over, and passing over it is a frequent source of confusion, because a theory that has not fixed its representation will smuggle one in unnoticed. A relational ontology requires a formal language able to express several things at once: relations among many terms rather than only two, changes in the pattern of connection, the local structure of what connects to what, and the generation of new structure from the combination of old.

Among the available candidates, a combinatorial structure of a particular kind meets these requirements more fully than its rivals, the structure that in the physics of quantum geometry is called a spin foam. A spin foam answers to the four requirements in turn. Its vertices encode interactions among several terms at once, meeting the requirement of many-term relations. Its reconnections encode changes in which terms are joined, meeting the requirement of changes in the pattern of connection. Its combinatorial and local character exhibits the actual pattern of what connects to what, meeting the requirement of local structure. And its edges, gluing interactions into an extended complex that a dynamics can then act upon, meet the requirement that new structure be generated from the combination of old. Its advantage over a graph is that a graph carries only relations between pairs, while the social relations at issue are characteristically relations among many, a coalition, a market, a household, none of which reduces to a set of pairwise ties. Its advantage over a purely categorical representation is that a spin foam is combinatorial and local, exhibiting the actual pattern of connection rather than only the ab-

struct relations among structures. And its decisive advantage for the present programme is that it stands at the meeting point of the discrete and the continuous, serving at once as a combinatorial object and as the object on which a field-theoretic and a dynamical-systems description can both be defined.

The role assigned to the spin foam must be stated with care, and it is the role of a representation and nothing more. A spin foam is an intermediate representation, a layer of formal structure interposed between the relational ontology and the dynamics that will act upon it. It is a candidate for the office of representing relational structure, chosen for the reasons just given, and it is offered as the most adequate candidate rather than as the only one. Nothing in the argument requires that a spin foam be a picture of social reality, and the claim is expressly withheld. What is claimed is that a relational ontology needs a representation with the four features named, and that the spin foam supplies them.

4.3 THE DYNAMICS OF STRUCTURE

A representation is static, and structure is not. The spin foam represents a relational structure; it does not account for how such a structure comes to be, how it dissolves, or how it recombines. For that a dynamics is required, and the dynamics is what a group field theory, together with the resources of dynamical systems theory, is fitted to supply. A group field theory takes the combinatorial structures that the spin foam represents and gives them a generative dynamics, a law by which structures form, interact, and give way to others. In the layering proposed here the spin foam and the group field theory occupy adjacent offices, the one representing structure and the other setting it in motion, and together they constitute the representation and the dynamics of the relational field.

It is at the level of dynamics, and specifically in the transition by which determinate structure precipitates from a state that carried none, that the recursion of value and power reaches its terminus, for the reasons given in the mapping. The generative level from which structure emerges is the level below which the description in terms of contestable claims ceases to apply, and it is therefore the dynamics, and not the representation or the layers above it, that carries the resolution of the recursion.

4.4 THE CRITERIA OF HISTORY AND CYCLE

Above the dynamics, and dependent upon it, stand two further offices that are often mistaken for parts of the dynamics itself but are properly distinct from it. The first is the office of criteria. Once structures have formed and entered into cycles, a question arises that the dynamics alone does not answer, the question of what a cycle accumulates over its course. A relational cycle may return to its point of departure having generated a surplus within itself, or having drawn one down, or having depended throughout on a supply from without, and to distinguish these is to apply a criterion to what the dynamics has produced. The instrument of this office is the holonomy, together with the geometric phase to which it belongs, and its work is to characterize the history-dependence and the cyclic quality of an evolved structure. A holonomy, in the sense borrowed from the geometry of transport around closed paths, is the quantity by which a system fails to return to its exact starting condition after being carried once around a loop, so that a cycle may close in its parameters while leaving a residue that records the path taken.

The criterion is dependent on the dynamics in a strict sense, and the dependence is worth stating because it prevents a common error. A holonomy is defined only where there is a space of configurations around which a cycle may be carried, and such a space is itself a product of the dynamics, appearing only once structure has emerged. The criterion therefore has no ap-

plication below the level of emergence, and it says nothing about the generative level. It is a characterization of what the dynamics has already produced, and it presupposes that production. The criterion does not ground the dynamics; it reads a property off the dynamics' output.

4.5 THE STRATEGIES OF OBSERVATION

The second office above the dynamics is that of observation across scales. A relational structure exists at many scales at once, from the relation between two persons, through the household, the community, the organization, and the state, to the international system, and the same structure observed at different scales presents different features. The office of observation is to say, as the scale of description changes, which features are to be retained, which are to be set aside, and how the effective description transforms. This office is filled by two complementary strategies, and their complementarity is important enough to state with precision, because they are easily conflated.

The first strategy addresses the hierarchy of spatial scales. It is the strategy of the renormalization group, which describes how an effective description flows as the scale of observation changes, which features remain relevant as one ascends from the smaller scale to the larger, and which become irrelevant and are washed out. Carried onto the relational field, it is the account of how a description adequate to the dyad transforms into a description adequate to the institution or the society, and of what survives that transformation.

The second strategy addresses the hierarchy of temporal scales, and it is distinct from the first. It is the strategy of fast and slow dynamics, the decomposition of a system into variables that change quickly and variables that change slowly, so that the fast variables may be treated as reaching their local equilibrium while the slow variables carry the long-term evolution. Many relational forms have exactly this temporal layering. The event, the passing emotion, and the momentary fluctuation are fast, while the institution, the custom, the ethical disposition, and the settled trust are slow, and the fast-slow decomposition says which processes may be treated as quickly equilibrating, which are to be held slowly varying, and which slow variables govern the long-term attractors of the relational system.

The two strategies of observation share a common logic, the elimination of what is finer in favour of an effective account of what is coarser, and they differ in what the fineness is. The renormalization group eliminates short-scale degrees of freedom and flows a theory along the axis of spatial scale. The fast-slow decomposition eliminates fast degrees of freedom and reduces a trajectory along the axis of time. One flows a description across scales of size, the other reduces a description across scales of duration, and a relational field that is layered in both size and duration requires both. The renormalization group answers to the hierarchy of spatial scale; the fast-slow decomposition answers to the hierarchy of temporal scale.

4.6 THE ARCHITECTURE ASSEMBLED

The five offices may now be set out together, and the dependence among them made explicit, for the dependence is what distinguishes this architecture from a mere list of formalisms each borrowed for its own sake.

Five layers of formalization.

LAYER	QUESTION	CANDIDATE FORMALISM
Ontology	What is studied	Social facts, relation with relative priority
Representation	How structure is expressed	Spin foam, or other combinatorial structure
Dynamics	How structure forms and evolves	Group field theory, dynamical systems
Criteria	How history and cycle are characterized	Holonomy, geometric phase
Observation	How multiscale behaviour is read	Renormalization group, fast-slow dynamics

The five layers do not stand side by side as equals. Ontology, representation, and dynamics form a chain of generation, in which each office presupposes the one before it: representation presupposes a fixed ontology, and dynamics presupposes a representation to act upon. The remaining two offices, criteria and observation, do not lie further down this chain. They stand upon the output of the dynamics, as two kinds of characterization applied to structures that the dynamics has already generated. The holonomy characterizes what an evolved cycle has accumulated; the observation strategies characterize how an evolved structure appears across scales of size and duration. Neither is foundational, and neither can be carried beneath the dynamics, for each presupposes the emergent configurations that the dynamics alone produces.

This arrangement dissolves a question that has recurred throughout the programme, the question of which formalism is the more fundamental, the group field theory or the renormalization group, the holonomy or the emergence. The question is malformed, because the formalisms answer different questions and occupy different offices. What exists is a matter for the ontology; how it is represented, for the spin foam; how it evolves, for the group field theory; how its cycles are judged, for the holonomy; how it is observed across scale and across time, for the renormalization group and the fast-slow decomposition. The formalisms do not compete for a single office. They fill an ordered set of distinct offices, and the recursion of value and power is resolved at the office of dynamics, where the description that generated the recursion gives out, while the offices above supply the characterizations of what the dynamics produces.

A word is owed on the double appearance of two of these formalisms, since it might otherwise read as an inconsistency. Group field theory and the renormalization group each appear twice in the paper, once as a response to the ultraviolet problem, surveyed among the historical responses below, and once as the candidate formalism for a layer of the architecture, group field theory at the office of dynamics and the renormalization group at the office of observation. The two appearances are consistent, and the one grounds the other. What qualifies a framework to fill a layer is the attitude it takes toward the recursion. Group field theory is fitted to the office of dynamics because its response to the ultraviolet problem is the strategy of emergence, the strategy that resolves the recursion of value and power; the renormalization group is fitted to the office of observation because its response is the account of how an effective description runs across scales. The survey of responses that follows is therefore a justification of the architecture rather than a digression from it, the place where it is shown why each formalism belongs to the office it has been assigned.

It is this architecture, and the strategy of emergence that sits at its generative core, that the survey of physical responses in the following section is meant to inform.

5 HISTORICAL RESPONSES TO THE ULTRAVIOLET PROBLEM

Theoretical physics has met the ultraviolet problem more than once, and the several frameworks it has built to meet it share a common origin in that problem, whatever their later divergences. This section describes four of them. It describes them as attitudes toward the divergence rather than as bodies of mathematics, because what the paper requires of them is their strategy and not their machinery, and because the strategy is what can be carried across to a domain that has no momentum integrals to transcribe. Throughout this section the physical terms are written plainly, without quotation marks, because here they are used of the physics itself, where they are literal. The quotation marks return in the following section, where the strategies are carried onto the relational field.

The problem common to all four may be stated in a sentence. When a quantity in a field theory is computed by summing contributions from all distance scales, the contributions from the shortest distances fail to diminish, and the sum diverges. Each of the four frameworks is a way of ensuring that the theory remains well defined in the face of this failure, and each embodies a distinct conception of what the short-distance structure of the world must be for the divergence to be controlled.

5.1 RENORMALIZATION: ABSORPTION

The first and most conservative response leaves the divergence in place and absorbs it. Its insight is that the parameters written into the theory at the outset, the bare mass and the bare charge, are not the quantities anyone measures. What is measured is always the effective quantity, the parameter as it appears after the short-distance contributions have been included, and this effective quantity is finite even when the bare one is not. Renormalization allows the bare parameters to carry the divergence, absorbing the infinite short-distance contribution into quantities that were never observable, so that everything that is observable comes out finite. It further reveals that the effective parameters run with the scale of observation rather than holding constant, taking different values as the distance at which one probes the theory changes, and the law of that running is the renormalization group. The attitude here is one of coexistence with the infinite. The divergence is not defeated; it is relocated into the unobservable and thereby rendered harmless, and the physics that remains is the physics of quantities that vary with scale.

5.2 DYNAMICAL TRIANGULATION: DISCRETIZATION

The second response denies the divergence its source. The divergence gathers at the shortest distances only because the theory permits distances to become arbitrarily short, and it permits this because it takes space and time to be a continuum, indefinitely divisible. Dynamical triangulation refuses the continuum at the smallest scale. It builds spacetime from elementary simplices of fixed size, a smallest triangle or tetrahedron below which there is no further division, and it assembles geometry by gluing these building blocks according to rules that respect the causal order. Because there is no distance shorter than the edge of the simplex, there is no reservoir of ever-shorter contributions for the divergence to draw upon, and the sum that diverged in the continuum becomes finite on the discretized structure. The attitude here is one of a floor. The recursion toward shorter distances is stopped by a smallest element, the common edge length of the simplices. A qualification belongs here, and it will matter when the strategy is carried across. In the standard practice of the approach the edge length serves as a regulator, a shortest distance introduced to render the sum finite and then sent toward zero in

a continuum limit, so that the discreteness is a device of calculation rather than a claim about the constitution of space. A stronger reading is available, on which the smallest element is a genuine feature of the world and space is grainy at bottom, and the two readings are distinct. What the strategy contributes to the present argument is the form common to both, the arrest of the descent by a smallest element, whether that element is a regulator to be removed or a floor to be affirmed.

5.3 STRING THEORY: EXTENSION

The third response dissolves the divergence by refusing the point. In a theory of point particles, an interaction occurs at a single location, a sharp vertex at which the whole energy of the process is concentrated into a region of vanishing size, and it is this concentration into a point that produces the worst of the short-distance divergences. String theory replaces the point particle with an extended object, a one-dimensional string, and with this replacement the sharp vertex of interaction is smeared into a smooth surface traced by the string as it moves and joins and parts. The energy that was concentrated at a point is distributed along the extended object and among its many modes of vibration, and the short-distance behaviour that diverged for points is softened for strings. The attitude here is one of extension. The divergence is relieved by giving the fundamental entities an internal extension and internal degrees of freedom, so that no interaction is ever truly point-like and the concentration that caused the divergence never occurs.

5.4 GROUP FIELD THEORY: PRE-GEOMETRIC EMERGENCE

The fourth response removes the background against which the divergence was defined. The ultraviolet problem presupposes a spacetime continuum in which short distances exist to be summed over, and the three responses so far each take that continuum as given and treat the divergence within it, whether by absorbing it, flooring it, or softening it. Group field theory does not take the continuum as given. Its fundamental degrees of freedom are fields on an abstract group manifold, carrying no spatial or geometric interpretation of their own, and continuous spacetime, rather than being assumed, is expected to emerge from the collective behaviour of these pre-geometric quanta through a phase transition, a condensation in which a great number of the fundamental elements enter a common state and a smooth geometry appears as their collective description. On this account the short-distance continuum, within which the ultraviolet problem was posed, is itself a derived and emergent thing, and the question of what lies at distances shorter than any that the emergent geometry supports does not arise, because below the emergent level there is no geometry and no distance at all. The attitude here is one of emergence. The divergence is dissolved together with the background, by locating the background itself as the product of a more fundamental level that has no short-distance problem because it has no distances.

5.5 THE FOUR STRATEGIES COMPARED

The four responses may be set beside one another as four attitudes toward one divergence, and the comparison is the hinge on which the paper turns from physics to its own subject.

Four responses to the ultraviolet problem.

Renormalization absorbs the divergence into unobservable parameters and lets the observable ones run with scale. Attitude: coexistence.

Dynamical triangulation discretizes spacetime into smallest simplices below which no division exists. Attitude: a floor.

String theory extends the point into a one-dimensional object and distributes the interaction across its modes. Attitude: extension.

Group field theory makes geometry emerge from a pre-geometric level, so that the short-distance continuum is derived rather than given. Attitude: emergence.

Two of the four propose that the descent toward shorter distances is stopped, and two that it is not. Dynamical triangulation stops it against a floor of indivisible elements. Group field theory stops it in a different manner, at the level below which the very notion of distance ceases to apply, since geometry itself is emergent and there is nothing geometric beneath it. These two ways of stopping the descent are distinct, and the distinction between a floor and a limit of applicability will prove to be the decisive one when the strategies are carried across, for it is the difference between a smallest thing and the ceasing of a kind of description. Renormalization and string theory, by contrast, do not stop the descent at all. Renormalization lets it run and absorbs its cost; string theory lets it run and softens its effect by extension. With these four attitudes in hand, the paper turns to the recursion of value and power and asks, of each, what it would mean there.

6 MAPPING THE STRATEGIES ONTO GENERATIVE RELATIONAL BEING

The four strategies are now carried onto the recursion of value and power. The quotation marks return, because from this point the physical terms qualify the relational field and name resemblances rather than facts. The question asked of each strategy is the same. If the recursion of value and power is met in the manner this strategy proposes, what does the strategy assert about the nature of value and power at the bottom of the descent, and is the assertion one that a generative relational account can consistently make? The four answers differ, and the difference is instructive, for each strategy, transposed, becomes a distinct thesis about what a value or an authorization ultimately is.

6.1 ABSORPTION: THE DRESSED CLAIM

Carried onto the recursion, the strategy of absorption yields the following thesis. The recursion of justifications is acknowledged as endless rather than halted, and what is asserted in any actual valuation is the effective value, the valuation as it stands after the whole recursion of grounds has been folded into it, in place of the bare value that would carry the infinite series of higher grounds explicitly. On this reading a value in use is always a “renormalized” value, one that wears the entire series of its higher justifications as a garment rather than deferring to them as an external ladder, and the counter-claim that would reopen the recursion is reconceived as a correction already absorbed into the effective term. Power admits the same reading. An authorization in force is a “dressed” authorization, carrying its infinite regress of legitimations within itself as an effective legitimacy that functions while the regress stays untraversed.

The thesis is coherent and has a genuine attraction, since it accounts for the plain fact that valuations and authorizations do function, in practice, while the infinite series they would seem to require goes untraversed. Its limitation, for a generative account, is that it purchases this at

the cost of leaving the recursion intact and merely unobserved. The infinite series remains, still undiminished, and the effective value is well defined only if the folding-in of the series is itself well defined, which requires something answering to the physical scale parameter along which the running is organized. The recursion of value and power exhibits no evident parameter of this kind, and lacking one, the absorption remains a metaphor stripped of its mechanism. Absorption describes how effective values function; on its own it leaves the recursion in place, and a generative account that seeks a genuine terminus will find in it a description of the symptom in place of a treatment of the cause.

6.2 DISCRETIZATION: THE SMALLEST RELATION

Carried onto the recursion, the strategy of discretization yields the thesis that the descent of justifications reaches a floor, a smallest relational element below which the demand for a further ground has no application. There would be, on this thesis, an atom of value or of authorization, an indivisible relational unit that is not itself valued or authorized by anything more basic, and against which the recursion halts as the physical descent halts against the smallest simplex. The thesis has the merit of supplying a definite terminus, and it corresponds to a familiar move in foundational thought, the positing of a basic norm or a self-evident value that grounds without needing to be grounded.

Its difficulty for a generative account is that a floor of this kind reintroduces exactly what the programme was built to refuse, a foundational element prior to relation, an atom whose value or authority is intrinsic to it and not constituted within the relational field. To halt the recursion against a smallest valued thing is to concede that value has, at bottom, a bearer that possesses it independently of relation, and this concession is incompatible with the claim that value arises within relation rather than residing in a thing. The strategy of discretization, taken by itself, therefore sits poorly with a generative relational ontology. It will reappear, transformed, when it is seen to converge with the strategy of emergence, but as a bare floor of intrinsically valued atoms it is not a thesis the programme can adopt.

6.3 EXTENSION: THE NON-POINT CLAIM

Carried onto the recursion, the strategy of extension yields a thesis of unusual interest. The worst of the recursion, on the analogy, is produced by treating a value or an authorization as a point, a sharp and isolated claim concentrated at a single position within the order of justification, against which the counter-claim may be pressed with full force. Extension proposes that the claim is never in fact point-like. A value, on this reading, is an extended relational object with internal structure and internal degrees of freedom, and what presents itself as a single contestable claim is the outer aspect of a distributed relational form whose content is spread across its internal relations rather than concentrated at a contestable point. The counter-claim, meeting an extended object rather than a point, is dispersed among the object's internal degrees of freedom rather than concentrated against a single surface, and the sharp opposition that fuelled the recursion is softened.

This thesis is congenial to a generative account, and more so than the first two, because it locates the content of a value in a distributed relational structure rather than in an isolated bearer, which is close to what the programme has maintained from the start. Its limitation is that softening is not termination. An extended claim is harder to contest at a point, but it remains, in the end, a claim, and a sufficiently distributed counter-claim could still meet it. Extension relieves the recursion without ending it, and it does so by a supposition, that values are internally extended relational objects, which a generative account can accept but which

does not by itself reach the level at which the recursion would lose its fuel. Extension, then, is a partial and welcome measure, and it will be retained below as a supplement to the strategy that does reach that level, rather than as the primary response.

6.4 EMERGENCE: THE CEASING OF THE CONTESTABLE CLAIM

Carried onto the recursion, the strategy of emergence yields the thesis that the descent of justifications terminates at the level below which the description of the relational field in terms of contestable claims ceases to apply. The recursion, as the diagnostic reconstruction showed, is fuelled by the contestability of the claim, and it continues for exactly as long as its terms retain the form of contestable claims. The strategy of emergence proposes that beneath the level of contestable claims there lies a more fundamental relational level, a generative level of pure difference and relation prior to the constitution of any bounded claim, at which there is no boundary to press against and no line to deny. At that level the counter-claim finds no surface, the demand for a ground is not reproduced, and the recursion loses its fuel. The descent does not strike a smallest valued thing. It passes below the level at which “value,” in the sense that supports a contestable claim, is the right description at all, into a generative level from which bounded claims of value and authority themselves emerge.

On the emergence strategy the recursion of value and power reaches its terminus at the level where the description in terms of contestable claims ceases to hold. The terminus is a limit of applicability and not a floor of foundational things. The fuel of the recursion is the contestability of the claim; beneath the level of claims there is no contestability, and so no fuel, and so no recursion.

This thesis is the one a generative relational account can consistently adopt, and it should be seen clearly why. It terminates the recursion, which absorption and extension do not. It terminates it without positing a foundational element prior to relation, which discretization cannot avoid. And it terminates it in a manner that the programme has, in another domain, already worked out, for the account of how bounded linguistic and symbolic structures emerge from a pre-structural generative level, through a breaking of symmetry and a condensation, parallels the account of how contestable structure arises from a level at which no contestable structure yet exists. The termination of the recursion of value and power at the generative level follows the same form, in the register of value, that the emergence of structure from the generative field follows in the register of form.

It is at this point that the strategy of discretization returns, transformed. The emergent, pre-geometric account has a discrete aspect as well as a continuous one, for the same fundamental level that gives rise, in one limit, to a smooth emergent structure is built, in its combinatorial description, from elementary relational simplices. The floor that discretization posited in isolation, and that a generative account could not accept as a floor of intrinsically valued atoms, reappears here in a changed office, as the combinatorial grain of the generative level itself, below the emergence of any valued structure. The smallest element, so understood, is a smallest relational element prior to value rather than a smallest valued thing, and in this transformed sense the discretization strategy is absorbed into the emergence strategy rather than standing against it. The distinction that discharges the earlier objection should be made explicit, since a grain and a floor may appear the same. What the generative account refused, in refusing discretization, was a foundational element standing prior to relation, an atom whose value or authority belongs to it in itself and not through the relations that place it. What the transformed strategy admits is a smallest element of the relational fabric, a grain internal to relation and

possessing no value or authority of its own, valued structure appearing only above it through emergence. The first is an element outside relation from which relation would be built; the second is a minimal articulation within relation from which no value yet follows. The grain is relational through and through, and it is for this reason that admitting it does not restore the foundational atom that the programme set aside. This convergence parallels the one that the underlying physics exhibits, in which the emergent and the discrete are two aspects of a single pre-geometric account rather than two competing proposals.

6.5 THE RESULT OF THE MAPPING

The mapping yields a determinate result, and it is important to state it in the exact form the programme requires, neither weaker nor stronger. A generative relational account of value and power is most consistent with the emergence strategy, supplemented by the extension strategy and incorporating the discretization strategy in its transformed, pre-value sense. This is a claim of consistency and of best fit. It is not the claim that a generative account of value *is* a group field theory, or that the recursion of value and power *is* an ultraviolet divergence. The physical framework supplies the *form* of a strategy, the attitude of dissolving a problem together with the background that posed it, and the generative account adopts that form because the form matches its own prior commitments. What the generative account must supply for itself, and what no physical framework can supply for it, is the *content*: what the generative level is, in the register of value; what emerges from it, and by what relational process; and what distinguishes the bounded structures that emerge as bearing one value rather than another. The physical strategy tells the account where to look for the terminus of the recursion. It does not tell the account what it will find there. That is the burden of the architecture set out above, whose generative office is where the resolution falls, and of the open problems that follow.

7 THE STANDING OF THE PAPER AND ITS REACH

An argument built by analogy owes its reader a plain statement of what it is, of what it hopes to make knowable, of how it might one day touch the empirical domain, and of where its limits fall. This section supplies that statement. It is placed before the open problems because the open problems are its consequence, and it gathers into one place the claims about the paper's own standing that the earlier sections made in passing.

7.1 THE STANDING OF THE ARGUMENT

The paper is a methodological and architectural study, and it is neither a physical model of value nor a completed formalization of it. Its work is done at the level of the problem and of the arrangement of instruments, one remove above any particular mechanism. It takes a recursion that several fields have met separately, shows that the recursion has a recognizable formal shape, surveys the strategies a mature discipline has developed for problems of that shape, determines which strategy a generative relational account can consistently adopt, and proposes an architecture in which the account's formal instruments occupy distinct and ordered levels. Each of these is a contribution of form and not of content. The paper claims to have found the right shape for a problem and a defensible order for the tools that would address it, and it claims no more. In the vocabulary of the discipline it borrows from, the paper offers a strategy and a scheme of organization, and it leaves the construction of any specific model to the work its architecture is meant to guide.

7.2 THE OBJECTS OF KNOWLEDGE

The paper hopes to make three things knowable, and they correspond to its three contributions. The first is that the unbounded regress of value and of power, which has been treated as a defeat for the theory of foundations, has instead the structure of a problem that admits of principled response, so that the regress becomes a thing to be worked rather than a wall at which work stops. The second is that the several strategies of the ultraviolet problem, when set beside the recursion of value and power, sort themselves into those a generative account can adopt and those it cannot, and that the sorting is determined by the account's prior commitments rather than by preference, so that the choice of strategy is shown to be constrained and not free. The third is that the formal instruments the programme has gathered, which have appeared to compete for a single explanatory office, in fact belong to distinct levels of a single order, so that their apparent rivalry dissolves into a dependence. To make these three things knowable is to convert a cluster of difficulties into a structured field of questions, and that conversion is what the paper offers as knowledge.

7.3 THE PATH TO THE EMPIRICAL DOMAIN

The paper is formal throughout, and its reach into the empirical domain is therefore indirect and mediated, and it is worth saying by what path such a reach might one day be made, if only to mark that the path exists and that the paper does not now walk it. The architecture proposed here assigns definite offices to definite levels, and each office, once a concrete model realized it, would carry empirical commitments of its own.

At the level of emergence, a realized model would predict that bounded structures of value and authority form through something answering to a transition, a relatively sudden precipitation of determinate structure from a state that carried none, rather than through gradual accretion alone. Where the formation of a norm, an institution, or a shared valuation can be observed over time, the architecture directs attention to whether that formation exhibits the marks of a transition, a threshold, a rapid ordering, a sensitivity to conditions near the threshold, and this is a matter on which historical and developmental evidence could in principle speak.

At the level of effective structures, the cyclic criterion distinguishes relational cycles that return bearing an internally generated surplus from those that return depleted or are sustained from without. A realized model would make this distinction operable, and it would direct empirical attention to whether a given institution or relation regenerates the conditions of its own continuation or draws them down, a question that the study of commons, of organizations, and of relationships already asks in other terms and could ask in these.

At the level of scale, the architecture holds that a description adequate to one scale reappears transformed at another, and that the transformation is lawful rather than arbitrary. A realized model would predict specific relations between the description of a relational form at the scale of the dyad and its description at the scale of the institution or the society, and comparative and multiscale social evidence could in principle test whether such relations hold.

These are directions of possible contact and not results. Each of them presupposes a concrete model that the paper does not supply, and each would acquire empirical content only once the value question, deferred to the open problems, had been answered in some determinate way. The paper's relation to the empirical is therefore the relation of a frame to the pictures it may one day hold. It specifies where empirical commitments would enter and what offices they would serve, and it leaves their supply to the constructive work that a settled architecture is meant to make possible.

7.4 THE LIMITS OF THE ARGUMENT

The limits are as definite as the contributions, and honesty requires that they be stated with equal plainness. The paper's central instrument is an analogy, and the analogy is one of problem-form and not of mechanism; the quotation marks that mark this have not been retired, and until the relational field is shown to possess a genuine scale and genuine scale-dependent degrees of freedom they cannot be. The paper does not formalize value; it locates where a formalization would have to begin and declines to fix the form that value takes, resisting in particular the assumption that value must be an observable on the physical model. The paper does not commit the generative level to a definite mathematical form, holding it open among an action, an evolution rule, a categorical dynamics, and other possibilities, and it therefore does not deliver the base on which a full construction would stand. The paper surveys the strategies of one discipline for one problem, and its survey is complete only as that history is complete, so that a further strategy, within physics or beyond it, might alter the field of options. These limits are not failures of execution. They are the exact boundaries of a study that has chosen to establish the form of a problem rather than to force a premature solution, and to mark them precisely is part of what the study offers.

8 OPEN PROBLEMS

The paper has claimed to arrive at the right form of a problem and at a defensible architecture for addressing it, and it has been careful to claim only that. Its omissions are as important to state as its claims, and this section states them, because an architecture is honest only when the vacancies within it are marked as plainly as the parts that are filled.

The first open problem is the one the methodological note anticipated. The analogy on which the paper turns remains an analogy of problem-form and not of mechanism. The quotation marks around "ultraviolet" have not been retired, because the structure that would retire them, a genuine scale parameter and a family of scale-dependent degrees of freedom in the relational field itself, has not been exhibited. Whether such a structure can be exhibited, and whether the relational field possesses anything answering to the physical scale along which effective descriptions run, is unsettled. Until it is settled the transposed strategies remain strategies borrowed in their form, and the paper's use of them is the use of a form and not the operation of a mechanism.

The second open problem concerns the content of value at the generative level, and it is the problem that the mapping deferred and the architecture inherited. The emergence strategy locates the terminus of the recursion at a generative level from which bounded values emerge, but it does not say what value is at that level, nor by what relational process bounded values precipitate from it, nor what distinguishes the structures that emerge as bearing one value rather than another. The programme has reason to resist the first form in which this question presents itself, the form that would demand a value observable on the model of a physical measurement, for there is no evident ground for supposing that value in the relational field takes the form of an observable at all. It may take the form of a constraint that the generative dynamics must satisfy, or of a selection principle that governs which structures emerge, or of an order parameter that distinguishes phases of the relational field, or of something for which the physical vocabulary has no ready name. Which of these, if any, is the right form for value is not decided here, and to decide it prematurely, by fixing on the observable because the analogy makes it available, would be to let the borrowed vocabulary settle a question that belongs to the subject matter.

The third open problem concerns the base of the architecture. The generative level has been

named neutrally, as a relational generative dynamics, and the paper has declined to commit it to a specific mathematical form, and in particular to an action. This restraint leaves open the question of what form the generative dynamics takes. Whether it admits a variational formulation, or is better rendered as an evolution rule, a categorical dynamics, or a generative process of another kind, is not established, and the choice among these is not a matter of notation but of what the generative level is claimed to be. The programme's own group-field-theoretic work supplies one candidate realization, but the architecture proposed here is not bound to that candidate and would survive its replacement by another. The form of the base is open, and the architecture is deliberately built so as not to prejudice it.

The fourth open problem is whether the emergence strategy, having been shown to be the one a generative account can consistently adopt, is the one it *must* adopt. The paper has argued for best fit and for consistency, and it has shown that the alternatives either fail to terminate the recursion or terminate it by positing a foundation prior to relation. It has not shown that no fifth strategy, outside the four that the physics of the ultraviolet problem has so far produced, could terminate the recursion in some further way. The survey of strategies is a survey of the responses a particular discipline has made to a particular problem, and its completeness is the completeness of that history and not a completeness in principle. That a better strategy may yet be found, in physics or outside it, is a possibility the paper does not foreclose.

These four vacancies are not incidental gaps to be filled by further labour of the same kind that produced the architecture. They are the points at which the architecture meets what it does not yet contain, and each of them is a direction of inquiry rather than a defect of the present one. The paper's contribution is to have built the frame within which these are the right questions to ask, and to have shown that they are questions about the content of a generative theory of value rather than about the form of the problem, which is settled, or about the arrangement of the instruments, which is proposed.

9 CONCLUSION

The argument set out from a recursion that the theory of value, the theory of power, and the theory of knowledge have each met in their own vocabularies without recognizing it as one thing, the recursion in which every ground stands in need of a ground and the demand for a foundation descends without terminus. It has tried to show that this recursion has a definite form, and that the form is one a mature discipline has confronted repeatedly. The recursion does not merely fail to terminate. It grows less tractable as it descends, reproducing at every level, undiminished, the demand that opened it, and this undiminished reproduction gives it the structure of what physics calls an ultraviolet problem, in the marked and bounded sense that the paper has been at pains to keep in view. Named so, the recursion ceased to be a private puzzle of the theory of value and became an instance of a problem for which strategies exist.

The strategies are four, and the paper has read them as four attitudes toward one divergence, absorption, discretization, extension, and emergence. Carried onto the recursion of value and power, each became a thesis about what a value or an authorization is at the bottom of the descent, and the four theses were not of equal worth to a generative account. Absorption described how effective values function without terminating the recursion. Discretization terminated it only by positing a foundation prior to relation, which the programme was built to refuse. Extension relieved the recursion without ending it, and was retained as a supplement. Emergence terminated the recursion in the one manner a generative account can consistently adopt, at a limit of applicability rather than against a floor, at the level where the description in terms of contestable claims gives out, and it did so in the very movement by which, in another register,

bounded structure emerges from a generative field. Upon this the paper raised an architecture of five layers, ontology, representation, dynamics, criteria, and observation, in which the offices of generation stand in a chain and the offices of criterion and of observation stand upon what the dynamics produces, so that the instruments the programme had gathered were seen to stack rather than to compete, and the cyclic criterion and the strategies of scale were placed where they belong, as properties of what has emerged and not as grounds of emergence.

The account does not close on a doctrine, and the form of its close is required by its content. A frame that locates the terminus of recursion at a generative level prior to every bounded claim cannot end by installing a new bounded claim as its own foundation, a master strategy from which all else is to be derived. It ends, instead, on the questions a generative formalization of value would have to take up, and it offers them as openings rather than as a programme to be executed. There is the question of the analogy itself, of whether the relational field possesses a genuine scale and genuine scale-dependent degrees of freedom, which alone would let the borrowed terms be spoken without their quotation marks. There is the question of the content of value at the generative level, of whether value there is a constraint, a selection principle, an order parameter, or something for which no borrowed word yet answers, a question the paper has been careful not to let the convenience of the analogy decide. There is the question of the form of the generative dynamics itself, of whether it is an action, an evolution rule, a categorical dynamics, or a generative process of another kind, a question the architecture was built so as not to prejudge. And there is the question that stands behind the others, of whether the four strategies a single discipline has so far produced exhaust the ways in which such a recursion may be met, or whether a fifth remains to be found.

The recursion of value and power is not a wall against which thought must stop, and it is not a void into which thought must fall. It is a descent that ends where the description that generated it gives out, at the generative level from which bounded value and bounded power themselves emerge, and the task of a generative theory is to say what is found there.

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