

## Royal Society Edge of Chaos Seminar 15/5/26 Concluding Comments

Benedict Rattigan

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### Slide 1 - Concluding comments

The topic today has been dynamic symmetry and the wider science of complexity. So what, if anything, have we learned?

Over the course of the day we've seen that central question tested in very different domains: in chaotic flows and quantum non-locality; in climate tipping points and Earth-system change; in living systems and institutional design; in the physics of matter at multiple scales; and in the philosophical framing of all of these.

At the very least, we've learned that simplicity is sometimes a highly complicated business!

Very roughly, dynamic symmetry is the claim that many systems survive and adapt by continually holding a shifting balance between excessive rigidity and unstructured disorder.

Predrag Cicovacki has put it more fully: dynamic symmetry isn't just another scientific instrument, like Bacon's induction or the Cartesian method of doubt, but a way of looking at reality itself – a worldview that sees “delicate negotiations between rigidity and chaos, between predictability and spontaneity.”

And as Denis Noble observed in his seminal 2017 Royal Society paper, nature's aim is not to eliminate stochasticity but to harness it.

Likewise, our role in nature and the environment is not to abolish conflict once and for all, but to pay attention to how opposing tendencies continually adjust to each other.

In that sense, as Gisella Marinuzzi has suggested, we're not romanticising chaos. We're dignifying it – recognising it as a partner in the work of stability-and-adaptation, rather than a mere defect to be suppressed.

The central suggestion of the dynamic symmetry paradigm is precisely this: only through tension – including the disciplined use of disorder – can two things be in genuine harmony.

### Slide 2 - Symmetry

Dynamic symmetry theory also nudges us to think differently about symmetry itself.

It starts from the recognition that ordered behaviour can emerge out of randomness or stochastic processes.

In many systems, order and disorder therefore stand in a structured relationship that is itself symmetrical.

If, in addition, symmetry and asymmetry often mirror each other in systematic ways, then the scope of symmetry is much wider than traditional treatments suggest.

Symmetry becomes not only a matter of invariance and regular repetition, but also of the patterned interplay between stability and fluctuation, order and randomness.

In that sense it is a deeply paradoxical feature of how complex systems organise themselves.

It also changes how we think about the status of symmetry.

Symmetry has a special place among the patterns of nature. Physical laws can often be expressed in terms of symmetries, but symmetry itself is unusual in that it is, in a sense, its own subject matter.

It always involves two things at once: repetition of a pattern or process, and variation in position, orientation or time.

Without some coupling between repeated elements and their differences, there is no symmetry at all.

A simple balance scale makes this concrete: its pans must be equal and opposed – matched in weight, placed on opposite sides – for the device to work as a symmetric system.

Remove either equality or opposition, and the symmetry disappears.

In that sense, symmetry is “symmetric” about itself; it does not point to a deeper, more basic principle that explains it, but is self-similar and self-grounding.

If that’s right, then we have under-stated both the structure and, dare I say, the status of symmetry.

In this light, as Professor Cicovacki has observed, dynamic symmetry is best understood not merely as a technical refinement of existing ideas, but as a candidate paradigm in its own right.

And this, I think, is where its deepest significance lies.

### Slide 3 - A new way of thinking

Dynamic symmetry theory matters not only because it offers a new way of describing certain systems, but because it asks for a different way of thinking about them.

The “modern” paradigm that shaped so much of twentieth-century thought rests on a familiar set of commitments: scepticism toward inherited authorities; the reduction of complex wholes to simpler parts; a strong individualism in which entities are conceived as sharply separable; a privileging of linear reason and bivalent logic; a strict separation of fact from value; and a belief in largely one-directional progress driven by science and technology.

That framework has delivered immense gains. It has given us analytical clarity, experimental power, and extraordinary control over many domains of nature.

Yet it also carries a characteristic picture of the world: a picture in which reality is composed of quasi-mechanical units, externally related in space and time, and in which ambiguity, paradox and tension are treated chiefly as signs of incomplete analysis rather than as potentially revealing features of reality.

Dynamic symmetry cuts across that picture at several points.

It begins from the thought that many of the systems we most care about – living bodies, nervous systems, ecosystems, institutions, cultures, even individual biographies – don’t behave like Lego constructions assembled from inert bricks.

They’re self-organising ensembles whose identity depends on ongoing negotiations between stability and disruption, between what holds and what yields.

In such systems there is rarely a uniquely correct decomposition into basic parts; relations, feedback loops and flows are as fundamental as any putative building blocks.

What counts as the “same” system over time is not a static inventory, but a pattern of responses to disturbance: a distinctive way of riding the edge between too much order and too much chaos.

Seen from this angle, dynamic symmetry matters not only because it describes such systems well, but because it asks for a different intellectual posture toward them.

It asks us to move, at least at times, beyond the reflex that treats every tension as something to be dissolved and every apparent contradiction as something to be eliminated.

It asks whether some of the deepest structures in reality are not best understood as neat either-or alternatives, but as patterned negotiations between mutually conditioning opposites.

### Slide 4 - Paradox and logic

This gives logic itself a slightly different flavour.

The modern habit of mind trains us to seek clean disjunctions and to regard contradiction as a failure of thought.

Dynamic symmetry doesn’t license incoherence; it doesn’t ask us to celebrate confusion or to abandon standards of rigour.

What it does ask is subtler and, in some ways, more demanding.

It asks us to distinguish between genuine inconsistency and the appearance of contradiction that arises when complementary aspects of a process are forced into a single flattened description. Wave-particle duality is the obvious scientific example. Yang and yin provide a more traditional one. In each case, the tension isn't simply a defect to be removed. It may instead be a sign that different descriptions are picking out different, interdependent aspects of one underlying process.

A dynamically symmetric mindset is therefore comfortable with “both/and” structures, with nested scales, and with patterns that repeat across levels while changing their local expression.

At this point one has to say something stronger.

The worldview that emerges from dynamic symmetry theory is not merely tolerant of paradox; at times it seems positively to require it.

That's not because the theory is confused, nor because it secretly invites us to lower our standards of thought.

It's because reality itself – especially in its more complex and living forms – often presents us with structures that cannot be adequately understood if we insist that every truth must appear as a clean, one-directional proposition.

Logic remains indispensable. Without it there is no discipline, no testability, no distinction between insight and verbal fog.

But logic, at least in its stricter and more classical forms, can only carry us so far.

It is extraordinarily powerful at identifying contradiction, clarifying implication, and testing consistency within a framework.

It is much less powerful when the problem is that the framework itself is too narrow to contain the phenomenon.

#### Slide 5 - Life and contradiction

This matters because many of the most significant features of life appear precisely where neat conceptual separations begin to break down.

An organism, for example, is never simply identical with itself in the inert sense that a stone is identical with itself. It persists only by changing.

It remains itself only by replacing its parts, exchanging energy with its surroundings, adapting to disturbance, and renegotiating its internal order.

Likewise, a mind is stable only because it is plastic; a culture endures only because it changes; an institution remains legitimate only if it can preserve continuity whilst revising itself in response to pressure.

In each of these cases, the thing in question is what-it-is only by being, in some real sense, other than what it was.

Classical logic can describe this after the fact, but it does so awkwardly, because the phenomenon itself is constituted by a tension between opposed predicates: identity and change, persistence and revision, order and fluctuation.

To think adequately about such systems, one must learn not simply to avoid contradiction, but to dwell with it long enough to discover what kind of structured reality is generating its appearance.

This is why contradiction may sometimes have a positive epistemic role.

Not every contradiction is illuminating; many are merely mistakes.

But some apparent contradictions are signals that we've reached a level of reality at which mutually necessary opposites are in play.

They tell us that our inherited concepts have become too blunt, too linear, or too static for what we are trying to understand.

Consider the most obvious cases: wave and particle, stability and adaptability, freedom and constraint, autonomy and dependence, self and environment.

These are not always choices between rival descriptions, one of which must finally eliminate the other.

Often they're interlocking aspects of a deeper process that can only be grasped if one resists the urge to collapse one pole into the other.

Dynamic symmetry theory, at its best, encourages exactly that resistance.

It asks us to hold opposites together, not in a spirit of obscurity, but in order to see more clearly the patterned negotiation by which each side conditions the other.

#### Slide 6 - Intellectual bilingualism

That requires a shift in intellectual temperament.

Much modern thought has trained us to assume that maturity consists in dissolving paradox, eliminating ambiguity, and forcing phenomena into cleanly articulated schemas.

But there's another kind of maturity: the capacity to recognise that deeper forms of order may initially appear as contradiction because they exceed the categories with which we first approach them.

To think in terms of contradiction, in this richer sense, is not to celebrate nonsense. It is to cultivate a disciplined tolerance for unresolved tension while searching for a more adequate description.

That's why dynamic symmetry theory represents not just a new framework, but an entirely new way of thinking. Or rather: a new way of thinking that is also, in some respects, very old.

It asks us to recover forms of intelligence that modern habits have often marginalised: sensitivity to reciprocal dependence, to circular causation, to the way wholes condition parts and parts reconfigure wholes, to the possibility that reality may be organised not by inert simplicity alone but by balance-in-motion.

For that reason, a deeper understanding of life may depend on our willingness to become intellectually bilingual: to retain the precision of analytic reasoning whilst also developing a more supple, process-sensitive mode of thought capable of tracking feedback, emergence, reciprocity and dynamically-maintained form.

Life is full of situations in which one thing becomes its opposite, or in which a system survives only by incorporating what seems to threaten it.

Immune systems need exposure as well as defence. Creativity requires discipline as well as disruption. Love itself depends on both attachment and freedom.

Once one notices this, contradiction begins to look less like a scandal, and more like a clue: a sign that reality may be organised through dynamic tensions rather than through inert simplicities.

#### Slide 7 - Method and value

The same shift appears in our treatment of evidence and method.

Dynamic symmetry does not reject empiricism or rigorous modelling; on the contrary, much of its motivation comes from close attention to neural networks, climate dynamics, flocking, schooling, market fluctuations, and so on.

But it's wary of treating controlled experiment and linear extrapolation as the sole arbiters of sense. In many complex systems, the most revealing signals lie in pattern, correlation and resonance rather than in isolated causal chains.

A dynamically-symmetric approach therefore treats quantitative measures and qualitative insight, theory and narrative, model and case-study, not as rival claimants to authority but as different modes of access to an underlying structure that is itself relational and evolving.

Crucially, it also carries a different attitude to value and normativity. Where the modern stance tends to compartmentalise “being” and “ought”, treating ethics, meaning and purpose as secondary overlays on an otherwise indifferent substrate, dynamic symmetry takes seriously the extent to which evaluative tensions saturate the systems we study.

Questions about resilience, adaptability, overload, burnout, senescence, failure and repair are not external add-ons. They’re internal to the way living and social systems navigate their state spaces. A framework that foregrounds negotiated balance between stabilising and exploratory tendencies is therefore naturally hospitable to ethical and axiological questions.

It expects that talk of “too rigid”, “too volatile”, “over-constrained” or “under-protected” will have real traction, and that our descriptions of systems will unavoidably carry a normative charge.

All of this adds up to a way of thinking that is more holistic and, in a strict sense, more paradox-friendly. It asks us to track wholes without denying parts, to honour individuality without erasing inter-dependence, and to respect reason without banishing intuition, imagination and feeling. It is suspicious of single-axis metrics, single-master variables and single-master narratives.

Instead, it looks for families of coupled processes and for the narrow, shifting bands in which their tensions are held in workable alignment. That, I think, is what gives the dynamic symmetry paradigm its real depth.

If it proves fruitful, it won’t be because it offers an all-purpose slogan, but because it teaches us to recognise a pattern that’s been present all along: a pattern of balance-in-motion that may underlie phenomena as diverse as phase transitions, development and ageing, creative work, institutional reform, and the everyday labour of remaining a person over time.

#### Slide 8 - Critique and testability

Today’s talks have both strengthened and disciplined these intuitions.

In some domains the edge-of-chaos picture already has real explanatory force; in others, it remains suggestive rather than conclusive.

That is not a defect. It’s exactly what one would expect of a framework that is still being tested in the only way that matters.

New scientific and philosophical ideas often enter mainstream thought through informed opposition. Paradoxically, it’s by exposing the flaws in an argument and identifying its weak spots that the argument is either improved or rightly discarded.

At the outset I suggested that, at this stage, the only reasonable demand is for serious attention: neither indulgence nor reflex dismissal, but the kind of scrutiny owed to any proposal that claims both to connect phenomena across disciplines and to offer tools for understanding and design.

The worst fate for a framework of this kind is not rejection but indifference – being allowed to drift along without ever being clearly tested.

Robustness depends on challenge.

And here, too, the deeper claim returns.

The testing of dynamic symmetry theory is itself an exercise in dynamically-symmetric thought.

Good critical thinking has two complementary aspects. On one side there is outward-facing observation; on the other, inward-facing evaluation and reflection.

Each of us is prone to projection and observer bias.

To approach objectivity, we have to find a middle position between suppressing inconvenient features of what we see and over-emphasising those that fit our expectations.

Inward reflection reverses that pattern: it asks us to hold together two apparently opposed attitudes at once.

There must be rigorous—even ruthless—scrutiny of any hypothesis; but there must also be genuine openness to new ideas, because relentless scepticism leaves no room for learning.

Critical analysis itself, in other words, depends on an elegant symbiosis between complementary opposites. In testing dynamic symmetry theory, we find dynamic symmetry at work.

#### Slide 9 - Quantum gravity

So where might this framework actually help?

Let me end by sketching, very briefly, two domains where dynamic symmetry theory may have genuine explanatory potential. These are not claims that the theory has already solved the problems in question. They're invitations to think about them in a more structured way.

The first is the long-standing tension between quantum theory and general relativity.

Quantum mechanics gives us a world of amplitudes, superpositions and fluctuations; general relativity gives us a world of smooth geometries and curvature.

One lives naturally in Hilbert spaces and operators, the other on differentiable manifolds and metrics.

For nearly a century, physicists have sought a consistent framework that can contain both.

Dynamic symmetry theory doesn't pretend to be a theory of quantum gravity. What it offers is a way of thinking about the relationship between these apparently incompatible descriptions.

Very roughly, quantum field theory provides a catalogue of “disorder-like” quantities – fluctuation, entanglement, decoherence, variance – whilst general relativity provides “order-like” quantities – curvature, geometric regularity, and global constraint.

Instead of asking which of these is more fundamental, a dynamic-symmetry perspective asks: in which regimes do gravitational order and quantum disorder form a viable, dynamically symmetric pair?

Where does the system occupy a band in which geometric coherence is strong enough to behave classically, yet quantum fluctuations are still rich enough to matter? Conversely, where does that balance break down – near singularities, at the Planck scale, at black-hole horizons?

One can imagine, at least schematically, defining an “order” metric for spacetime – tracking the smoothness or coherence of the metric – and a complementary “disorder” metric for quantum fields – tracking, say, fluctuations in stress-energy or entanglement across regions.

A DSI-like index would then not search for a single magic value of a coupling constant, but for regions where scaled geometric order and quantum variability are in balance.

Those might be the regions where semi-classical behaviour is most robust: spacetime well-defined enough to curve, but noisy enough to allow non-trivial quantum dynamics.

At the extremes one would find regimes where geometry is frozen and quantum structure negligible, or where geometry itself dissolves into something like a foam of fluctuations.

Instead of a sharp line between “quantum” and “gravitational”, one gets a structured map of how their stabilising and exploratory tendencies are coupled across scales.

Even if this doesn't yet yield equations, it offers a common language for comparing candidate theories, and for asking of each: what is its dynamic symmetry?

#### Slide 10 - Arrow of time

My second example concerns the arrow of time.

In text-books, time's direction is explained by entropy: the universe moves from improbable ordered states to overwhelmingly probable dis-ordered ones.

Yet many of the systems we've looked at today – organisms, eco-systems, brains, cultures – locally do the opposite. They build and maintain structure, even as they contribute to the global increase in entropy.

Dynamic symmetry theory invites us to think about temporal direction in terms of the coupling between stabilising and exploratory processes.

In any domain, we can identify processes that preserve structure – homeostasis, error-correction, memory, or institutional rules – as well as processes that introduce variation – mutation, exploration, innovation, or random search.

The arrows of time that matter in biology, cognition and culture arise when those two classes of process are coupled in particular ways: when stabilising mechanisms don't simply freeze the system, and exploratory mechanisms don't simply dissolve it, but together they trace out viable paths through state space.

From this point of view, one can ask how the balance between order-like state space and disorder-like dynamics changes as systems evolve.

A very young universe, almost entirely homogeneous, may have few stabilising structures; fluctuations dominate, but have little to organise.

As structure emerges – galaxies, stars, planets, chemistries – stabilising mechanisms proliferate: gravity wells, chemical cycles, and feedback loops.

With life and mind, more intricate forms of dynamic symmetry appear: organisms that maintain themselves by continually breaking and re-making their own order; nervous systems that stabilise some patterns of activity while exploring others; social systems with institutions robust enough to survive shocks yet flexible enough to adapt.

Time's direction then looks less like a simple march from order to disorder and more like a directional change in the structure of dynamic symmetry itself: the direction in which, for many systems, stabilising and exploratory processes are coupled in increasingly sophisticated ways, and in which that coupling can also break down.

That is a research programme, not a slogan: it suggests that thermo-dynamic, biological, cognitive and institutional arrows of time might correspond to the typical paths traced by a DSI-like index, and that breakdowns of those arrows – collapse, senescence, extinction, or institutional failure – occur where the balance between stabilisation and exploration is lost.

## Slide 11 - Final challenge

These sketches are deliberately speculative.

Their purpose is to show that dynamic symmetry theory isn't just a poetic way of saying that "things are complicated", but a candidate framework for posing some of our hardest questions more sharply. What has been attempted today is not to present dynamic symmetry theory as a finished doctrine, but to expose it to scrutiny.

If this framework has any value, it'll be because it proves capable of illuminating real systems – and of surviving criticism from people who have no reason to indulge it.

What has encouraged me most is the range of fields brought into conversation: physics, climate science, biology, philosophy, governance.

Even where there has been disagreement, there has also been a shared recognition that questions of order, fluctuation, resilience and breakdown recur across many scales and disciplines.

The next step is clear.

Dynamic symmetry theory cannot remain a metaphor or a mood.

It has to become more precise, more measurable and more vulnerable to disproof.

That is the purpose of work on the Dynamic Symmetry Index and related tools: to ask whether this

language can generate genuinely useful forms of diagnosis and comparison – in the sciences, in institutions, and perhaps beyond.

So I hope you leave today not with a doctrine to defend, but with a double task: to test this framework in your own field, and to ask whether some of the realities you study require not only new measurements, but also a new intellectual stance equal to their complexity.

Where are the edges in your systems, and what would count as evidence that this framework helps us to see them more clearly?

For my part, after thirty-six years of working on dynamic symmetry – most of it in relative isolation – I can say that these questions have been a very long time in the making.

Thank you.

Slide 12 - [www.oxq.org.uk](http://www.oxq.org.uk)