

JOHN POLKINGHORNE A Note on Chaotic Dynamics

*The insights of **chaotic dynamics** are held to encourage a supple view of **physical reality** which is capable of accommodating **human freedom** within its world view. It is suggested that such a metaphysical scheme encourages a move beyond the God of **deism** to the God of **theism**, interacting with his creation and known through personal encounter.*

John Houghton¹ has given a clear account of the modern theory of dynamical chaos. Even quite simple non-linear systems are found to possess such exquisite sensitivity to circumstance that they prove to be intrinsically unpredictable, despite the deterministic character of their defining equations. The name universally given to this recognition is not particularly apt, since 'chaotic' systems are not completely random in their behaviour but exhibit a degree of structure represented, for example, by convergence on to 'attractors'. In fact, one of the most interesting aspects of dynamical chaos is the way in which similar patterns are found occurring in the behaviours of very different physical systems.

These developments have been hailed in some quarters as representing a third revolution in physics, to be set alongside the Newtonian and quantum mechanical revolutions of the past. Houghton took a cautious view about any broader implications to be read out of this development. In particular, he argued that the recognition of the existence of chaotic systems had 'no fundamental theological implications'.² I too want to be careful but I would suggest that a somewhat warmer appraisal might be in order. Two issues need to be discussed.

The first is whether our view of physical reality is affected to any greater degree than the simple recognition in practical terms of an unexpectedly severe limitation on our ability to predict. A more than minimal answer could be justified in two ways. The first is to acknowledge the fact that predictive power (measured by the length

1 J. T. Houghton, 'New Ideas of Chaos in Physics', *Science and Christian Belief*, (1989) 1, pp. 41–51.

2 *Ibid.* p. 50.

of time over which our calculations are in tolerable agreement with behaviour) depends exponentially upon the accuracy of knowledge of initial circumstances, implies that quantum effects rapidly become of significance. As Houghton notes, this means that 'We then come up against an inability, not only in practice but in principle, to specify with perfect precision the state of the system at any given time'.³ In other words, chaotic systems imply a greatly heightened degree of interlocking between the worlds of macroscopic and microscopic physics, with the consequence that the former inescapably partakes of the cloudy fitfulness of the latter.⁴ Random quantum triggers can produce large-scale consequences; an extreme case of 'the Butterfly Effect—the notion that a butterfly stirring the air today in Peking can transform storm systems next month in New York'.⁵

Even without the invocation of quantum theory, I would want to argue that chaotic dynamics suggests a more supple and subtle view of the nature of physical systems than that to which we have been accustomed. Herein is the second type of answer one might make. It recognises that in strict logic the intrinsic unpredictability of systems which purport, nevertheless, to be described by strictly deterministic equations, is an epistemological property. It simply tells us what we can know about their behaviour, not about what they are in themselves. Yet, almost all scientists (whether they know it or not) are philosophically critical realists. They believe themselves to be investigating a physical reality whose character controls the results of their experiments. For those who take this view, there is always a close link between epistemology and ontology, what we can know and what is the case. For example, Heisenberg's original formulation of his uncertainty principle was epistemological in character; it was concerned with the limits on possible measurement. The instinct of the vast majority of quantum physicists has been to extend this to an ontological statement. They embrace an interpretation of quantum theory which asserts microscopic physics to be truly indeterminate. In an exactly analogous way, it seems to me that chaotic dynamics leads naturally to our taking a more flexible view of physical reality, even at the (classical) macroscopic level, than that which would correspond to a merely mechanical account.

If so, what do we then make of the admittedly deterministic

3 *Ibid.* p. 49.

4 See, for example, J. Polkinghorne, *The Quantum World*, Longman, Harlow (1984).

5 J. Gleick, *Chaos*, Heinemann, London (1988), p. 8.

classical equations from which we started? Houghton notes that chaotic dynamics offers 'An additional challenge to a reductionist's view that a system can be understood by breaking it down into its component parts'.⁶ However holistic we may strive to be in our thinking, it is extremely hard not to retain a reductionist residue, treating fundamental physics as having a privileged position. Thus one speaks of 'emergent properties' as one goes in a direction of increasing complexity. It seems to me possible that 'emergence' takes place in both directions and that the apparently deterministic equations of the classical physics of simple systems are themselves approximations to a more supple and subtle reality. In other words, the clockwork regularity of Newton's planets in their orbits is as much an emergent deterministic simplicity as the biology of animals is an emergent flexible complexity.

One might even detect here a reinterpreting echo of David Bohm's ideas on implicate and explicate orders intertwined⁷ but I do not want to become too speculative. A suitably restrained position would be the belief that chaotic dynamics gives us unforced encouragement to seek a world-view sufficiently realistic and accommodating so as to encompass both the orderliness of elementary particle physics and our own undeniable experiences of embodied freedom. I am not for a moment suggesting anything so extravagant as a claim that the age-old problems of biology and physics, mind and brain, are solved. I am simply encouraged by the glimpse of how a world of both being and becoming⁸ might be described.

The second issue concerns what relevance, if any, these ideas have to theology. Houghton clearly thinks Not much. 'We need to believe that God is both big enough and clever enough to ensure both scientific consistency and at the same time providential significance. The Christian will therefore be looking for a double consistency—scientific and providential . . . there are no fundamental theological implications which arise from recent findings regarding chaotic systems'.⁹ Now it is true that science and theology both have their basic realms of experience and neither is able to dictate to the other what that experience shall be. Yet I am a passionate believer in the unity of knowledge, a belief theologically undergirded by the recognition that the one true God is the ground of all that is. One may well

6 *Op. cit.* (1), p. 50.

7 D. Bohm, *Wholeness and the Implicate Order*, Routledge and Kegan Paul, London (1980).

8 See I. Prigogine and I. Stengers, *Order out of Chaos*, Heinemann, London (1984).

9 *Op. cit.* (1) pp. 49–50.

believe that God is 'big enough and clever enough' to create a world capable with perfect consistency of being interpreted by insights both scientific and providential, but it scarcely seems impious to try to understand, as far as we can, how He has managed to do it. It is simply not enough to read the Book of Scripture on Sunday and the Book of Nature on Monday. A merely mechanical world of clock-work regularity would be consistent with the God of deism but not with the Christian God who interacts with his creation and who allows that creation a measure of creaturely freedom. The flexibility-within-regularity which chaotic dynamics suggests, does appear appropriate to a world held in being by the God of love and faithfulness, whose twin gifts to his creation will be openness and reliability. Houghton refers to Donald MacKay¹⁰ but, much as I admired him, I was never convinced by his exploratory attempts to see if a physical determinism could be reconciled with some notion of personal freedom. It seemed to me that this essay at squaring-the-circle was encouraged by a Calvinist desire for too tight a control by divine sovereignty. Instead, I believe that we are able to take a view of physical reality which is not purely deterministic but which is open enough to accommodate not only human experience of choice but also the interaction of a God neither deistically detached nor (in Whitehead's phrase) a cosmic tyrant.

This is not the place to attempt the discussion of a metaphysical understanding accomodating both divine interaction and creaturely freedom within its compass. I think that a world-view suggested by an ontological extrapolation from chaotic dynamics could be modestly helpful in that respect and I have tried elsewhere to develop that theme.¹¹ For the moment let me remark that if there is indeed value in such an approach it will not only be so for internal theological discussion within the believing community, but also for external apologetic address to those who are exploring the possibility of belief. A striking feature of recent years has been the spontaneous growth of a kind of natural theology within the physics community which recognises that the rational beauty and delicate balance of the universe calls for an explanation lying beyond science, which theism can give with economy and persuasiveness. Such an approach to God is necessarily limited (it takes account of only a restricted aspect of reality) and it has often led to nothing more than a deistic Cosmic Architect or Great Mathematician. A

10 See D. M. MacKay, *The Open Mind*, IVP, Leicester (1989).

11 J. Polkinghorne, *Science and Creation*, SPCK, London (1988); *Science and Providence*, SPCK, London (1989).

Chaotic Dynamica

notion of physical reality more open to notions of becoming and suppleness might well encourage exploration of those personal aspects of experience to which scripture and the testimony of the church point as the meeting place with the God and Father of Our Lord Jesus Christ.

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