Chapter 9: conclusion

notes

Constructive comments are welcome.

"**The hierarchy that we have explored**", also see the note to section 0.1. The idea of some sort of hierarchy, sometimes called a "*scala naturae*" (Needham 1968:xii), in the physical universe has come up quite often in scientific writings. However, these proposed hierarchies have been limited to a small number of levels, and there appears to be no recognition of the unifying concept of *communities*, and how they are bound together by *exchange* processes.

Many scientists have commented on the natural hierarchy of physical systems and their levels of organisation, for example, Bronowski 1977:chapter 13, Koestler 1979:chapter 1, Holland 2000:chapter 1, Morowitz 2002, Calvin 1997:34, Laughlin 2006:chapter 1, and Feynman 1992:124.

Richard Feynman recognised "*hierarchies of ideas*", with the fundamental laws of physics at one end and "*things like evil, and beauty, and hope*" at the other end. He considered that "*what we have to look at is the whole structural interconnection of the thing; and that all the sciences, and not just the sciences but all the efforts of intellectual kinds, are an endeavour to see the connections of the hierarchies*". However, he concluded that we can't "*draw carefully a line all the way from one end of this thing to the other, because we have only just begun to see that there is this relative hierarchy*" (all quotes from Feynman 1992:124-125). In this book, I hope I've shown that our physical universe can be regarded as a single hierarchy of communities, and while I may not have drawn a line, I hope that I've managed to lay a series of stepping stones that will serve to get from one end of the thing to the other.

"**I have called this the universal hierarchy**", we need to remember that the fundamental particles of the standard model account for only ~5% of the universe's total matter-energy (section 1.2.6).

9.1 Themes and patterns in the universal hierarchy

9.1.1 a hierarchy of communities on eight levels

a community of A, bound by B, exchanging C, create and sustain D

many become one

"**It is a fundamental feature of the hierarchy**", Arthur Koestler uses the term "holon" to mean a member of a hierarchy, at whatever level. It would seem that Koestler's holon is equivalent to a community in the universal hierarchy. Koestler considers that "*'parts' and 'wholes' in an absolute sense do not exist anywhere, either in the domain of living organisms, or in social organizations, or in the universe at large*". This is because "*each member of this hierarchy, on whatever level, is a sub-whole or holon in its own right*". But, at the same time, these members "*function as quasi-autonomous wholes. They are Janus-faced. The face turned upward, towards the higher levels, is that of a dependent part; the face turned downward, towards its own constituents, is that of a whole of remarkable self-sufficiency*" (all quotes from Koestler 1979:27).

exchange processes at every level

"**There are exchange processes**", Joseph Needham saw a similarity between social ethics and molecular bonds: "*Ethics are the rules whereby man may live in social harmony … Such rules perhaps correspond to the valency bonds and other forces which hold particles together at the molecular and sub-molecular levels*" (Needham 1986:23).

the exchange process can change the receiver

interactions are specific to each level

"**In this respect, the transfer of thoughts and feelings**", this may relate to the idea of memes as the means of transfer of ideas and culture (Dawkins 2006:192 and 323, Dennett 1996, Aunger 2002).

no theory of everything

"**Because interactions in the universal hierarchy**", this leads to "level-specific" rules, so science is divided into separate disciplines, each with its own principles and understanding, from nuclear physics to psychology, as mentioned in section 0.5.

One set of laws can generate another set of laws, so, for example, "*the laws of electron motion beget the laws of thermodynamics and chemistry, which beget the laws of crystallization, which beget the laws of rigidity and plasticity, which beget the laws of engineering*". (Laughlin 2006:7). Laughlin 2000 has observed that it is generally impossible to deduce the higher organising principles from the underlying behaviour of systems at a lower level.

"**So, rather than there being a single Theory of Everything**", at the end of his book on Theories of Everything, John Barrow concludes that "*they are necessary parts of a full understanding of things but they are far from sufficient to unravel the subtleties of a Universe like ours. … There is no formula that can deliver all truth, all harmony, all simplicity. No Theory of Everything can ever provide total insight.*" (Barrow 1992:210).

"***we appear to face a hierarchy of Theories***", Laughlin 2000:30.

open and closed systems

branched and nested hierarchies

"**There are two fundamental types of hierarchy**", Koestler has considered different types of hierarchical organisation (1967:chapter 4 and 1979:chapter 1).

9.1.2 patterns of centring and extension

"**As we ascend the hierarchy**", an earlier version of the universal hierarchy was organised in 4 major levels (1–4), each with 2 minor levels (a and b), so the hierarchy had a total of 8 levels, from 1a to 4b.

In the new 8-level scheme, all the old "a" levels become the odd-numbered levels, in which there is a "centering" activity, and all the old "b" levels become the even-numbered levels, in which there is an "extending" activity.

levels 1, 3, 5, and 7 – a pattern of centering

levels 2, 4, 6, and 8 – a pattern of extension

"**The pattern continues at Level 8**", whereas biological cells can have a single fixed rôle, such as a muscle or nerve cell, individuals in a social culture have a number of rôles, which may be defined by a number of factors, such as profession, location, interest, and age.

9.1.3 novel emergent properties

"**The universal hierarchy emerges level by level**", see also the note to section 0.5.

Peter Hoffmann asks if it is possible to predict a cow from particle physics. "*Is it just too complicated to predict the existence of cows from particle physics, or is it fundamentally impossible to predict a cow from the properties of quarks and electrons? … Thus, we could say that a cow can be explained by particle physics, since quarks and electrons (and the forces acting between them) make atoms with different properties, which in turn make molecules, which in turn make cells, which in turn make cows*" (Hoffmann 2012: 241). He concludes that "*there is no formula for "cow" based on the laws of particle physics. Particle physics may be necessary to make a cow (because we need atoms and molecules), but it is clearly not sufficient*" (Hoffmann 2012: 242).

Thus, understanding the parts at level *n* is crucial, but then complex interactions between these parts "*create new processes, structures and principle that, while based materially on the underlying parts, are conceptually independent of them*", and so a new level, *n*+1, comes into being, with totally new principles and rules (Hoffmann 2012:238). Peter Hoffmann concludes that there is "*no meaningful conceptual connection between a highly complex entity and the most fundamental levels of matter and energy*" (Hoffmann 2012:240).

The only way we can understand the generic entity that we call "cow" is to follow the universe as it evolves, level by level up the universal hierarchy. Even then, we can only describe the sequence of events that have led to cows at Level 6, and we can't, in principle, predict their existence from fundamental particles at Level 1, and certainly not from the formless energy at Level 0.

And we can go further, to consider individual cows, which are now recognised as having their own distinct personalities and range of complex emotions (Marino 2017). To be able to "explain" an individual cow, we would have to start at the Big bang and follow the interactions of a selected group of fundamental particles, as they come together, level by level, finally to become the ensemble of molecules that constitute this particular individual organism. This select group comprises just four types of particles – *up* and *down* quarks, electrons, and neutrinos (section 1.5.1).

This is the basis of the argument in section 0.5, which considers a unique human brain. Carl Sagan considered apple pies, and wrote, "*If you wish to create an apple pie from scratch, you must first invent the universe*" (Sagan 1981:218).

"**Electrons belong to the family of fermions**", see section 1.2.1, figure 1.5 and section 3.7.1.

"***it is impossible***", Lincoln 2012:80.

"**Consequently, when electrons are clustered**", the atomic orbitals that electrons can occupy are specified by 4 quantum numbers (see note to section 3.6.2). Pauli's exclusion principle (Atkins 1995:chapter 9 and 2006:337) states that "*no two electrons in an atom can have the same set of four quantum numbers*" (Atkins 2002:36). Quantum numbers only apply to electrons when they come together in atomic orbitals around a nucleus.

"**The exclusion principle is the key**", Atkins 1995, 1998:362.

"***moves matter at a specific place***", Davies 2006:39.

"**Instead, it is a fundamental principle**", Bertulani 2007:section 12.11.

"***new causative relation***", Davies 2006:39.

9.2 a progressive pattern

9.3 a self-assembling universe

"**There seem to be four principles**", basically, these are the first two laws of thermodynamics (section 4.3.6), the standard model of fundamental particles (section 1.2), and evolution by natural selection (section 5.7.5). The nature and evolution of our physical universe rests on these fundamental principles of chemistry, physics, and biology.

"**The existence of a sequence of stable levels**", see the section on Darwin ("**From this viewpoint**") in the notes on section 5.7.1.

9.4 the universe within ourselves

"**Each of us is a universe in microcosm**", Albert Einstein is commonly quoted as saying, "*The most incomprehensible thing about the universe is that it is comprehensible*", which is catchy, but a misquotation (Andrew Robinson, at https://primemind.com/we-just-cant-stop-misquoting-einstein-19ad4efab26e). For example, one version of this, with "*world*" instead of "*universe*", is on the title page of "The Comprehensible Cosmos", by Victor Stenger. What Einstein actually said was, "*the eternal mystery of the world is its comprehensibility. … The world of our sense experiences is comprehensible. The fact that it is comprehensible is a miracle*" (Einstein 1936:351).

Anthony Zee sees the realisation that the world is comprehensible as one of humanity's most profound insights, and points out that there have been many sophisticated civilisations that never took this view (Zee 2007:293).

However, if the material universe was created in a single event, and has evolved continuously from that time and place, then it must be comprehensible. What is perhaps more significant is the idea that the universe came into existence with certain intrinsic features and "rules", and then found its own way forward through the evolution of matter, life, and mind (for an outline of these "rules", see Stenger 2006). The universal hierarchy embodies that evolution, from a state of extreme simplicity, just after the Big Bang, to a state of extreme complexity, with the existence of human brains and societies.

After nearly 14 billion years, with the existence – on at least one planet – of material entities capable of empathy and abstract thought, the universe has evolved to a state where it is beginning to understand itself. There is a nice symmetry here; a comprehensible universe is beginning to be comprehended by the products of its own evolution. Is it a "miracle" that the universe is comprehensible? … or that a species has evolved to comprehend it? Maybe there is not one miracle here, but two.

End-matter

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