In the Beginning — The Birth of a Living Universe

Evolutionary Ripples

S Krishnaswamy

In the Beginning — The Birth of a Living Universe
John Gribbin
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"Nothing can contribute more to obviate the inconveniance and difficulties attending a vacant or wandering mind than the arrangement and regular disposal of our thoughts in a well ordered and copious common place book ...." John Locke, 'Letters on Study' as quoted in the printed introduction to the common place book used by Erasmus Darwin.

The same could be said of Gribbin's book. Whether you agree with his conclusion of a 'living' universe or not, it's a book that takes you along. He takes you through the starting on early periods of the Universe to its current state, showing how the laws of physics and chemistry are 'just right' for much of what exists to happen. He ends up stating that since this Universe is a black hole that begets other black holes which in turn can be Universes in their own right, the laws of physics and chemistry have the chance of being selected over the evolution of many universes, all in all qualifying the term 'living' attached to the Universe. He draws his parallel from the concept of *Gaia* put forward by James Lovelock in 1970 which considers the entire interlocking and self-regulating ecosystem of our planet as the 'living' Earth. Even if you don't come out of it agreeing that Universes live and evolve, you do take back with you good reasoning and information on a variety of topics . The best part is the almost seamless integration of these varied (?) themes into a flowing whole. Gribbin provides beautiful analogies and explanations in nine chapters.

He starts off with showing why the sky is dark at night, a paradox pointed out by Heinrich Olbers in the 19th century, bringing in the idea of an expanding Universe and that the Universe has a definite origin in time about 15 billion years ago. The next chapter comes off with the tale of footprints of microwave background radiation and the uniform miniscule ripples seen in it in all directions which was detected by the Cosmic Background Explorer (COBE) satellite. He explains how these are evidences for the theory whereby following the Big Bang the Universe expanded steadily from infinitesimal size, but before it got very big underwent a rapid sudden expansion called inflation and then continued at a sedate pace. And being born the Universe will one day die by contraction to the singularity from which it arose.

The third chapter brings up the chemistry of life and touches on astrochemistry to end with the note that "no surprise to modern astronomy to find life like us on a planet like Earth". The next chapter then puts evolutionary process into perspective showing how the biological diversity on Earth can be traced back to the benefits of our cyanobacterial ancestors 2 billion years ago. You learn about the Evolutionary Stable Energy – games theory approach of John Maynard Smith and how given variation and selection and a long enough time span evolution can produce human beings out of single celled bacteria. Life is thus an all or none phenomenon which leads you to the Gaia hypothesis and the next chapter concludes that the answer to how we and the living planet fit into the scheme of things lies in the fact that the Universe may be a descendant of a long line of Universes. The sixth chapter then gives an overview of the Universe with all its vastness and distances involving stars, galaxies and black holes.

The next chapter is a fairy tale chapter and shows how ' Goldilocks' finds porridge, chair and bed that are just right for her, not because they were made for her, but by trying the ones available, belonging to the three bears. Here we are 'Goldilocks' and the Goldilocks effects, as Gribbin refers to them, are the flatness of the Universe; the energies of formation of Carbon atoms; the proportional strengths of the four basic forces of gravity, electromagnetism, strong and weak nuclear forces; and others. He considers might-have-been situations and shows why the production of carbon is good for the Universe. This leads us to star formation, supernovae explosions, the formation of spiral galaxies and the next chapter. There is an effort to show how the galaxies can be considered 'Gaian' maintaining stability from equilibrium and competing with one another so that only the 'fittest' survive. The Universe it turns out is extraordinarily good at turning matter into black holes. This just leaves us with how to get the black hole of the Universe which churns out black holes. The final chapter takes one through the formation of the Universe via inflation. How quantum fluctuations can produce out of singular nothingness the initial seed which by inflation and expansion bring on universe(s) which form black holes and collapse into singularity and so on add infinitum each time getting a mutated set of physical and chemical laws. One of them then being 'just right' in that we can exist and read all this. A book worth reading and buying.

The Gaian theory of Lovelock revolved around the idea that the Earth's biological and physical components interact in a way that is self-sustaining. Though his theory was not taken seriously by scientists, now *Gaia* and the notion of the superorganism are being viewed in the light of the modern mathematical theory of complexity. Similarly, it is likely that Gribbin's idea of a 'living' Universe may not find the acceptance he asks for and will probably be delegated to the outfield now. Moreover from the point of view of entropy, that decreases for organised systems and increases for the Universe as a whole, and which can be used to characterise evolution - a 'living' Universe will be hard to reconcile. Possibly, the view put forward by Gribbin will be picked up later for the 'holistic' viewpoint of the Universe and its interconnection with life.

S Krishnaswamy , School of Biotechnology, Madurai Kamaraj University, Madurai 625 021, India

Addendum to the article *Some Unsolved Problems in Number Theory* by K Ramachandra in *Resonance* Vol.2, No.5, May 1997, pp.77–80

1. S S Pillai – The omission of the name S S Pillai (Siva Sankaranarayana Pillai) in connection with Waring's problem is very serious. In a series of papers, Pillai proved that if $k \geq 6$ and further if $(3^k + 1)/(2^k - 1) \leq [1.5^k] + 1$ then Waring's Conjecture is correct for that k. Around the same time (but a little later) L E Dickson proved this with $k \geq 7$ and $(3^k + 1)/(2^k - 1) \leq [1.5^k] + 1$. The inequality $(3^k + 1)/(2^k - 1) \leq [1.5^k] + 1$ was proved for all integers exceeding a certain constant C (same as in para on Waring's problem) by K Mahler. The history of this discovery is very well explained in G H Hardy and E M Wright, *Introduction to the Theory of Numbers* (see notes at the end of the chapter XXI). For another treasure house of information regarding priority of Pillai's work see K Chandrasekharan, S S Pillai (obituary), *J. Indian Math. Soc.*, Vol.15, pp.1–10, 1951. Regarding Pillai's achievements I mention the following: when I was in the Institute for Advanced Studies, Princeton, USA, during 1970-71, I noticed in the Institute Library a book by G H Hardy where he places Pillai as the greatest Indian mathematician after Srinivasa Ramanujan. Waring's Conjecture was proved for $k=5$ by Chen-Jing-Run (around 1970) and for $k=4$ by R Balasubramanian, J-M Deshouillers and F Dress in 1989. Cases $k=2$ and 3 were disposed off (by simpler methods) by Lagrange and Wieferich respectively. About Pillai I have the following comment: Once I was talking to a responsible Indian specialist dealing with History of Mathematics. I was very surprised when I came to know that he had not heard of Pillai at all. I can account for it as follows. Pillai was very unassuming; he was a member of the Indian Mathematical Society alright; but he was not a fellow of any of the academies and he had no publicity whatsoever amongst mathematicians who had not looked at the book by G H Hardy and E M Wright mentioned earlier.

2. Last line in the text on page 78 should read $\left| \sum_{1 \leq n \leq x} \mu(an+b) \right| \leq x^h$

3. A comment on *The Circle Method* in the box on page 78.

The function $f(z)$ is analytic in $|z| < 1$ and it does not exist anywhere in $|z| \geq 1$. (So the terminology *poles of* $f(z)$ is not correct). We have to make r a suitable function of n but still less than 1. Then decompose this circle into small bits in a particular way and obtain asymptotics of each bit. The cumulative effect of adding all these asymptotics will give the Hardy–Ramanujan formula for partitions. Actually Ramanujan in his first letter (this letter was written from Madras Port Trust) to Hardy mentions (see equation 1.14 of *Twelve Lectures*), that the integer $q(n)$ defined by

$$\left(\sum_{n=-\infty}^{\infty} (-x)^{n^2}\right)^{-1} = \sum_{n=0}^{\infty} q(n)\, x^n$$

(note that LHS is the product $\Pi_{h=1}^{\infty}\{(1-x^h)(1-x^{2h-1})\}^{-1}$) is the integer nearest to

$$\frac{1}{2}\frac{d}{dn}\left(\frac{\sinh(\pi\sqrt{n})}{\pi\sqrt{n}}\right)$$

When questioned about this he wrote in a letter that it is "not the integer nearest to but this main term plus ... (Compare this main term with the first term of the Hardy–Ramanujan–Rademacher formula for $p(n)$).

K Ramachandra

Errata

Resonance, Vol.2, No.3, March 1997

Page 88: Line 8, first paragraph in the text

...which began a thousand years...

should read ...which began a million years...

Resonance, Vol.2, No.5, May 1997

Page 76: Line 6 in the text

...in these *m* trials.

should read ...in these *n* trials.

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