

## Critique of the Cosmic Coincidences

Last Update: 30 March 2008

### Prologue

As I write, the world appears to be heading towards a deepening conflict between religious fundamentalism and secular liberal values, including scientific atheism. In the USA the old conflict between the Creationists and the scientific mainstream, in this case Darwinism, has re-ignited under a new banner, Intelligent Design. In the east, radical Islamists are motivated as much by distaste for liberal western society as by the positive precepts of the Koran. Whether one looks to the east or the west, the conflict is between dogmatic, intolerant religious fundamentalism on the one hand, and rational liberalism on the other. What a relief it is that physical scientists, as opposed to biological scientists, can remain aloof from the matter! Unfortunately, that is not so.

The conflict between science and religious orthodoxy has a far older history than 19<sup>th</sup> century Darwinism, as Galileo knew to his cost. Thankfully, there is no suggestion at present that any of the Christian churches wish to re-instate the Ptolemaic system, still less the Inquisition. However, the anthropocentric view in cosmology has also re-emerged in a different form. It has been claimed that the physical properties of the universe are peculiarly well suited to the emergence of life. More specifically, the claim is that the basic parameters of physics take numerical values which could not be varied greatly without catastrophically impairing the fitness of the universe for life. The disconcerting, and intriguing, thing about these claims is that, on cursory inspection, they appear to be true. But then, on cursory inspection, the Sun appears to go around the Earth.

There are those who have been eager to interpret this peculiar fitness of the universe for life, if such it be, as evidence for the existence of God. The claim is that the universal constants of physics and cosmology are fine-tuned to permit the emergence of life. A universal constant is said to be 'fine tuned' if a small change in its magnitude would render the universe sterile. A brief search on the Internet will reveal more postings on the topic of cosmic coincidences by members of the Christian community than by the scientific community (although they are not mutually exclusive). The New Creationists have a *prima facie* case. It appears that Science is in the dock to defend its ability to explain these 'coincidences' or 'fine tunings' of the fundamental constants. So far, the hypotheses put forward by the defence council seem rather extravagant, even contrived. But before we expend too much effort on the reasons for these 'fine tunings', are we sure that they are real? Has any crime actually been committed?

Many popular books have been written on the subject of the cosmic coincidences, for example Davies (1982), Barrow & Tipler (1986), Gribbin & Rees (1989), Rees (1999), Barrow (2003), Davies (2006). Excellent though these books are, it is difficult to decide just how impressed to be with the 'coincidences' claimed.

Without being versed in the details of the subject, the reader is in the position of having to take the authors' word for it. It is as if the trial consisted only of expert witness testimony, with no first-hand witness accounts nor any physical evidence. In such cases, as in physics generally, there is no substitute for rolling up your sleeves and carrying out for yourself the detailed mathematical derivations that underpin the claims. To strain my analogy further, it is as if we abandon the court room in favour

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of the forensic scientists' laboratory so that we can look down the microscopes for ourselves. This web site is a record of the author's attempt to do just that.

The outcome, I hope, is an unbiased assessment of whether the claimed instances of fine tuning are real. The attempt is made, wherever possible, to quantify the degree of fine tuning involved so as to gauge how coincidental it seems. This undertaking is more perilous than its laudable objectives would suggest. Feelings run high on this issue within the scientific community. To some it is indisputably clear that the coincidences are really there, and any contrary opinion meets with the accusation of "being in denial". The opposing camp, however, appears to regard the whole subject as profoundly unscientific. If the property of being 'fine-tuned' is to have any meaning, it is necessary to accept that it makes some sort of sense to contemplate a universe in which the universal constants are different. But some people regard this exercise as intrinsically meaningless. Disconcertingly, adherents of this philosophical position may regard an exercise to refute a claimed anthropic selection as being just as objectionable as one aimed at demonstrating anthropic selection. The distaste is associated with the procedure itself, i.e. the willingness to contemplate changes in the universal constants, rather than the outcome.

They may have a point. If the universal constants are actually uniquely determined by pure mathematics, as physicists have long dreamed, then it is indeed nonsense to consider them taking different values. As a fanciful example, suppose the fine structure constant could be derived as a sum of roots of Bessel functions, perhaps due to some finiteness requirement in field theory. It would then make no sense to pretend to be able to vary the fine structure constant, since the same logic would presumably hold in any alternative universe. Adoption of the anthropic viewpoint therefore entails abandonment of the dream that the universal constants are mathematically prescribed. The position of string theory is of interest in this respect. At one time string theory held out the promise of being just such a theory that would mathematically constrain, perhaps uniquely, many of the universal constants. This hope has faded, and talk of the "string landscape", i.e. the space of possible parameters, is more in vogue. As this transformation has taken place, string theorists have become naturally more anthropic in outlook.

However, I cannot emphasise too strongly that an examination of the anthropic principle(s), or anthropic reasoning, is not the purpose of this book. Nor is any consideration of the relative merits of God versus the Multiverse. Attention is confined to whether the fine-tunings appear to be real. Only if they are indeed real is there any need for explanation. This is, as it were, merely the committal proceedings to determine if there is a case to answer.

Most of the detailed arguments follow standard astrophysical approaches to a greater or lesser degree. However, some results I believe to be original and these are given in greater detail. Examples include the demonstration that the diproton disaster is mythical and the derivation of the sensitivity of the Hoyle resonance states to changes in the strong force.

The approach taken in the derivations is sometimes rather idiosyncratic. I can only hope that more expert physicists have forbearance with my shortcomings. My motivation was to understand the subject myself, not to find the neatest method or the

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most accurate solution. The result might sometimes be fine tuned to my own rather baroque thought processes.

Any comments, including errata, will be gratefully received.

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