"The physical laws and constants of our Universe are special"
Team A, Speaker 1 Against

Chris Williams
Student 1607421
HET 616

27th September 2004

Introduction

That the laws and constants of our Universe are special is a common piece of dogma. The affirmative team will contend that the position is not dogma, but is instead supported by weighty evidence and learned thinking. That position, we on the negative side know, is fundamentally flawed and easily disassembled. In order to get at the core of the argument we will address the three keys areas of the statement:

- the meaning of special,
- "constants", and
- the "laws" in which they appear.

How Special?

The affirmative team want us to believe that the Universe exists, and is the way it is, solely to support life. They might even go so far as to say that the existence of man, rather than life in general, is the defining factor in our Universe. These viewpoints are called the weak and strong anthropic principles respectively; anthropic meaning "Of or related to human beings or their period of existence on the Earth."[1] Adherents to these points of view argue that the Universe, and its workings, are special because they must be the way they are in order for us to exist. We contend that this viewpoint, as a premise for argument, is fundamentally flawed from the outset.

History is littered with the corpses of theories of the Universe that place man in a special place. Religious dogma, almost without exception, places Earth at the centre of creation, and man at the pinnacle of life. The ancient

Greeks, e.g. Ptolemy (circa 85–165), had a universal view with Earth immovably placed at the centre about which the heavens revolved on perfectly circular paths. That this model matched poorly with observation seemed of little importance in the face of the accepted "specialness"of the Earth and mankind. It took more than a thousand years before Copernicus (1473–1543), in his 1543 *De Revolutionibus Orbium Cælestium* (On the Revolutions of the Heavenly Spheres), dared to suggest that the Earth was not the centre of the Universe. Even Copernicus, a canon in the church, was afraid of retribution for opposing the received wisdom, delaying publication until he was sure that negative backlash could be minimised. Before the invention of the telescope there was little concrete evidence that Copernicus was correct, so mankind had to wait until 1609–10 when Galileo (1564–1642) turned a telescope on Jupiter and Venus, showing that bodies orbited planets other than Earth and that Venus displayed phases. Earth, and mankind, were removed from the centre of the universe through a few simple observations.

All of this was hundreds or thousands of years ago: surely the twentieth century sorted out the issues? Unfortunately, even the twentieth century has examples of the "specialness" of man clouding our view of the Universe. The 1906 "Plan of Selected Areas" survey, organised by Jacobus Kapteyn (1851–1922), arrived at a comfortable model of the Universe in which Earth was central. Serious astronomical debate about the extent of the Universe, and our place in it, was still going in the 1920s, manifest, for example, in the so-called "Great Debate" on the scale of the universe by Curtis and Shapley. Until Edwin Hubble (1889–1953) showed that "spiral nebulæ" were indeed other galaxies like ours, and Robert Trumpler (1886–1956) showed that dust was obscuring good portions of the view, the notion that Earth was central to the Universe remained.

So, the track record of treating Earth and mankind as somehow "special" is fairly poor. Time and again the uniqueness of our place in the Universe is put forward and later shown to be errant. Why then, should we expect yet another attempt to put man in a special place, to stand where all others have fallen? We shouldn't. The only viewpoint supported by history is that of the negative team: that we, and our understanding, are not "special" in the Universe.

Constant Indeed!

Science's understanding of the Universe is largely modelled with judicious use of mathematics. These models are littered with constants of proportionality needed to make the general equation match the Universe in which we live. Examples of these constants are the speed of light (c) or Planck's constant (h). The values of these constants are variable in the sense that they have units, e.g. metres per second, and that expedient selection of units can give the constant any desired absolute value. Pedantry aside, the value of c is not constant over time as we shall soon see.

Given the inconstant nature of the "constants", the affirmative team will define combinations of the constants, that result in dimensionless numbers regardless of units chosen. They will contend that these dimensionless numbers are constant and "special." One often used example is the Fine Structure Constant:

$$\begin{aligned} \alpha &= \frac{e^2}{\hbar c} \\ &= 7.297352568 \times 10^{-3} \pm 2.4 \times 10^{-8}[3] \end{aligned} \tag{1}$$

in which e is the charge on an electron, $\hbar$ is $h/(2\pi)$, and c the speed of light. We don't have to look far in order to undermine the constancy of this value over time. In 1999, Webb, Flambaum, Churchill, Drinkwater, and Barrow [4] found that α was subject to variation over time based on observations of distant quasars. Lamoreaux and Torgerson [2], using measurements of a long running natural nuclear reactor, determined that α has varied by a factor 4.5×10^{-8} over the last two billion years. To an observer a billion years ago the so-called constant α would have had a different value. How then could this value be considered special? The answer is, of course, that it cannot be considered special in the sense that it is a universal, invariant number.

What impact does variable α have in real terms? From (1) we see that in order for α to vary, one or more of the other so-called constants must vary in real terms. Any of or all of e, h, or c could be the cause of variation in α but a likely candidate is c which cannot then be held up as a universal constant. While variability of c and α is not fatal to science, it does undermine the affirmative case.

Laws: Made to be Broken

The third element that our learned colleagues will attempt to colour as "special" are the laws of our Universe. However, before we can address that topic we need to get an understanding of what a scientific law is.

In addressing the constants of our Universe we briefly mentioned mathematical models. Scientific method uses candidate models to predict the behaviour of the Universe and will discard or adapt models that cannot match reality. The models we know as laws are those that withstand scrutiny and approximate reality sufficiently well for a given purpose. Think of this process, and the resultant laws, as Darwin's evolution applied to ideas and models: the weak die out, the fittest survive by adapting to changing conditions, and occasionally a dead-end is pursued. From this description it is clear that laws have a number of key traits: they are constructs of an intelligence, they change over time, and at best they are approximations in a limited domain.

At first glance, laws as intelligent constructs seem to make a concession to our opponents. Without humankind laws would not exist, therefore these laws are special and must lead to our existence. However, by considering a hypothetical, contemporary intelligence elsewhere in the Universe we discount this line of reasoning. Our hypothetical beings develop the concept of science and maths and try to apply that to describe the Universe. The iterative, evolutionary process of science will mean that the path of their progress is different to ours. At any given moment the collection of alien laws will differ from ours. They will make different approximations and reflect different areas of emphasis, e.g they may see in UV frequencies. Their set of laws will, to the best of their knowledge, apply to the Universe. We now have two self-consistent sets of laws, both describing the same Universe, but nonetheless different. Which should we consider special? The answer is clearly neither, they are both only part of a picture.

The laws as we currently know them are neither immutable nor perfectly accurate. To take an example we have the laws as they pertain to motion and gravitation. Before Galileo the commonly held belief was that a objects of different weights fell at different rates; i.e. the law governing motion was weight dependent. Galileo's experiments rolling objects down inclined planes invalidated the law of the time. Isaac Newton (1643–1727) later put forward a mathematical formulation of the laws of motion and gravitation that very closely approximated the world as it was known in the 17th century. In the 20th century, puzzling discrepancies between observations of Mercury's orbit and Newton's predictions were resolved by Albert Einstein (1879–1955) with the General Theory of Relativity (GR). Einstein banished the notion of absolute space and time so fundamental to Newton's laws and provided a remarkably successful alternative that is with us today. Unfortunately, Einstein's model of gravitation has a limited domain. In the world of the very small, at the size of atoms, gravitation and GR take a back seat to the weird world of quantum mechanics, where everything is uncertain, and behaviour is discrete rather than continuous. GR predicts the existence of infinitely dense masses, black holes, but the mathematics cannot cope with the end results of falling in to one. In general, any theory that predicts infinities, as GR does, is problematic mathematically and will typically evolve to remove or explain the offending singularity. As with the "special" discussion, history tells us that laws change by their very nature and that we should expect that this will continue. In effect, laws are made to be broken. We cannot, therefore, hold the laws at any given time as special.

As we see from the preceding discussion, the state of play in dynamics is a patchwork of laws each of which is only applicable, and sufficiently accurate, within their own domain. If we only have a patchwork of laws with grey areas between their domains then we cannot call our understanding of the

Universe complete. Proponents of the anthropic view will counter with the notion of a Grand Unified Theory (GUT) that will pull these patches into a cohesive whole. While this is a laudable aim, and much effort is being expended toward it, the GUT is yet to materialise in any complete form. Without a complete understanding we really do not have a concrete basis to declare our laws "special."

Even if a comprehensive GUT is developed soon it will only serve to bolster the negative case. This curious situation arises because the most likely candidate theories, M-Theory etc., predict or require the existence of other universes. The existence of a multi-verse, as it has been dubbed, with many universes of differing make up, would immediately deny the anthropic viewpoint because we are not part of those universes, yet they exist.

Conclusion

History tells us that elevating humankind to some special status in the Universe is unlikely to remain unchallenged. The affirmative case is doomed to repeat history, with any special status being revoked in the fullness of time. The constants in our models of the Universe are not special in that they vary over time. Even supposedly invariant, dimensionless combinations that the anthropic crowd use to bolster their case are seen to vary over time, and would therefore be considered different by different observers. Therefore, we cannot consider such a "constant" as special. Finally, laws are the product of intelligences, change over time, and are approximations suitable for the task at hand. Each of these factors makes calling the laws "special" a grave mistake. Clearly the physical laws and constants of our Universe are not special.

References

[1] Merriam-Webster Dictionary Online. Internet `http://www.m-w.com`, September 2004.

[2] S. K. Lamoreaux and J. R. Torgerson. Neutron moderation in the Oklo natural reactor and the time variation of alpha. *Physical Review D (Particles, Fields, Gravitation, and Cosmology)*, 69(12):121701, 2004.

[3] National Institute of Standards and Technology (NIST) (US). CODATA Internationally recommended values of the Fundamental Physical Constants. Internet `http://physics.nist.gov/cuu/Constants/index.html`, September 2004.

[4] J. K. Webb, V. V. Flambaum, C. W. Churchill, M. J. Drinkwater, and J. D. Barrow. Search for Time Variation of the Fine Structure Constant. *Physical Review Letters*, 82:884–887, February 1999.