POSSIBLE IMPLICATIONS OF THE QUANTUM THEORY OF GRAVITY

An Introduction to the Meduso-Anthropic Principle

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In his excellent book “Life and Light” (still in press as of this writing) Lee Smolin has proposed that if the quantum theory of gravity has two special features the universe would fine tune itself.

Specifically, he proposes [1] that the quantum theory softens the singularity which forms in a Kerr-Newmann black hole, for example, if we perturb it, so that the new universe on the other side of it will really form. He then proposes [2] that the constants of nature might fluctuate in such a process, so that the new universe would have slightly different physics in it. In the absence of a quantum theory of gravity, of course, both of these suggestions are speculative.

Nevertheless, it is interesting to see what would result from such a process. Universes with peculiar fine tuned values of the coupling constants would have many more “daughter” universes, so that fine tuning, instead of an improbable accident, would be highly probable.

Professor Smolin proposes this as an explanation of the fine tuning evident in our universe, which leads to the possibility of life. In this view, life and intelligence are biproducts of the very special physics necessary to provide surface chemistry and radiating stars in order to produce many generations of black holes.

Philosophically, then, life and even intelligent life are accidents.

I do not intend to repeat Professor Smolin’s argument in this note. Rather, I wish to propose a modification of his reasoning which seems practically necessary in the framework of his conjectures, but which changes their philosophical implications immensely.

I have called this modified version the meduso-anthropic principle, after a stage in the life cycle of the jellyfish. The reason for this metaphor will be explained in time.

In addition, I want to point out in this note that within the approach to quantizing gravity which I proposed in my paper “Topological Quantum Field Theory as The Key to Quantum Gravity” the second conjecture which Professor Smolin makes, ie that coupling constants might fluctuate when the topology of spacetime changes, becomes much more plausible. This is because I propose a quantum theory in which the coupling constant is part of the state of the universe. If this approach were extended to gravity coupled to matter, the coupling constants of the matter fields would have a similar role. One could try to compute topology changing amplitudes from them via the state sum methods in my paper. I do not yet see how to do this, but there are some suggestive possibilities in the underlying
algebraic picture.

The question whether the real quantum theory of gravity has the right features to make this picture work will no doubt remain open for a considerable time. Nevertheless, let us explore the implications.

MAN IN THE LOOP

The conjecture which I believe modifies Professor Smolin’s conclusions is the following:

SUCCESSFUL INDUSTRIAL CIVILIZATIONS WILL EVENTUALLY CREATE BLACK HOLES.

The synthesis of this with Smolin’s two conjectures is what I call the meduso-anthropic principle. Before exploring the implications, let us consider the plausibility of this conjecture.

SUBCONJECTURE 1: SUCCESSFUL INDUSTRIAL CIVILIZATIONS WILL EVENTUALLY WANT TO MAKE BLACK HOLES

and

SUBCONJECTURE 2: SUCCESSFUL INDUSTRIAL CIVILIZATIONS WILL EVENTUALLY BE ABLE TO PRODUCE BLACK HOLES.

It is fairly clear, at least, that the conjecture follows from the two subconjectures. (This paper is not on the mathematical level of rigor).

Let us first consider subconjecture 1. There are two reasons to want to make black holes. One might want to make a few for scientific purposes. Indeed, barring major surprises in physics they are the ultimate high energy phenomenon. If it came within the reach of a technological civilization to build them, certainly the scientists in it would want to do so.

The second motivation for creating black holes is much more compelling. The hydrogen supply of the universe is slowly being exhausted. At some point in the future, any civilization will face the possibility of perishing from a lack of free energy. In principle, black holes could provide a permanent solution to this problem, since they can convert matter into energy via the Hawking radiation forever and with perfect efficiency. (They are also the perfect waste disposal for similar reasons). In order to make this practical, it would be necessary to have very small and very hot black holes, and to be able to “feed” and manage them very carefully. However difficult this problem finally is, our descendants in a few hundred billion years will have no alternative if they want to go on living.
Now let us consider the second subconjecture. The main difficulty in creating a black hole is cramming a lot of mass-energy in a small space.

Nature solves this problem by cramming a lot of nuclear matter into the center of a large star. This is completely inadequate for our purposes, since the resulting black holes are much too big, and hence much too cold to be of use. Also, it is hard to imagine a civilization doing such a thing.

Fortunately, there are two approaches which could produce much higher densities, and hence much smaller holes.

In one approach, one simply creates a huge sphere of converging lasers and fires them simultaneously at a central point. Since light is composed of bosons, there is no Pauli exclusion principle to overcome, and the bursts of photons could all occupy a very small space simultaneously, creating a black hole of a temperature corresponding to the frequency of the light. (The term “successful” in the conjecture has to be taken on such a scale. Still, a hundred billion years is a long time).

The critical length in such an apparatus is the wavelength of the light used. If our descendents can build nuclear lasers which lase in hard gamma, then a spherical converging laser the size of a small asteroid would suffice to produce very small hot black holes. Of course, gamma interferometry would be necessary to keep it focussed. None of this is beyond what could plausibly be done in a few centuries.

Another approach involves ordinary fermionic matter. One creates very long thin cylinders and accelerates them towards one another at high relativistic velocity. This gets around the density problem for two reasons: first, the cylinders would be lorentz contracted, and second, their rest masses would increase by a gamma factor. The combination of these two effects would produce a very large effective compression if ultrarelativistic velocities could be reached.

Both of these approaches pose subtle relativity questions, as well as extremely obvious engineering ones. Nonetheless, I believe that they demonstrate some degree of plausibility for my second subconjecture.

The notion of a successful civilization here is considerably beyond contemporary standards. The picture I am imagining is of a civilization which has reached a galactic center or some other stellar cluster, and is able to rework the resources of an entire solar system into a single huge machine. The energy output of the entire star could be diverted to powering the machine. This is not so outlandish as it first appears, given robotic factories.

**IMPLICATIONS OF THE CONJECTURES**
If both Smolin’s two conjectures and mine are true, then the fine
tuning of physical constants would not stop with physics which pro-
duced stars and gas clouds which cool. Rather, the selection would
continue until physics evolved which resulted in successful civiliza-
ations, with a very exacting definition of success. In the limit as the
number of generations of daughter universes increases, this would
be true even if we only make the weaker assumption that successful
civilizations make a few black holes as experiments. This would in-
crease the average number of daughter universes in universes with
successful civilizations, even if by a small fraction. Each such uni-
verse would have more daughters, until, after many generations, in-
telligences would be present in almost all universes. The effect would
be much more rapid if black holes as energy sources turn out to be
practical.

The philosophical implications of such a process are very deep.
Although it has been generally believed by people with a scientific
frame of mind that human life and history take place within the rule
of physical law, it has generally been assumed that the relationship
between the specific laws of physics and human events was complex
and accidental. This has, in fact placed science in conflict with the
otherwise dominant currents of Western (and by no means only West-
ern) thought.

Indeed, it has been the belief of most philosophers, and a surpriz-
ing number of important scientists, that humanity had some funda-
mental role in the universe, and that mind was more than an acci-
dental attribute of organized matter.

If the combination of hypotheses described above is correct, a
richer connection between mind and matter appears in a surprizing
way. Almost all universes would produce successful intelligence, be-
cause their detailed structure would be fine tuned by a long process in
which intelligences had reproduced universes over and over; a process
with the closest analogy with the passage of millions of generations
which has honed life forms to an almost unimaginable perfection.

If the combination of hypotheses which I am giving the name of
meduso-anthropic is correct, the relationship of civilization to envi-
ronment would entail a thousand improbable coincidences with favor-
able outcomes. Historical events would skirt innumerable disasters
and find an improbable path to success. The relationship of humanity
to the universe would have an organic quality.

It is now possible to explain the metaphor I have chosen in the
title meduso-anthropic. It refers to a stage in the development of the
animals in the phylum which includes the jellyfish and coral. These
animals have two phases of life, medusid and polyp. Medusids pro-
duce polyps, which produce medusids. It is sometimes even difficult
to recognize that the two stages represent a single species. Analogically, intelligences are the medusids, and black holes/universes are the polyps of a single evolutionary process.

The idea of an organic fine tuning of the relationship of life to nature seems improbable as long as one listens to the voice of scientific common sense. The minute one examines any part of natural history as our understanding of it is growing, experience begins to drown out common sense. How did we really end up with a repeating series of extinctions, frequent enough to drive on evolution, yet rare enough to permit it? Why is there so much fossil fuel on the earth? For that matter, why didn’t we discover the atom bomb a few years earlier, or fight world war 2 a few years later?

It is not hard to see that if these ideas are true, they will be the victims of abuse to dwarf quantum healing and even quantum golf. That is not sufficient reason to ignore them.

A SUMMATION

It is certainly impossible to claim that the quantum theory of gravity has reached a stage where these ideas can be validated. On the other hand, it could reach such a stage in fairly short order, if we are lucky.

Nevertheless this much seems clear. The laws of Physics which only operate at very high energies can nevertheless have profound implications for what we see around us. They have the possibility of changing our understanding of ourselves and our world in ways we cannot yet imagine. The fact that machines at Planck scale energies are not yet in the cards does not mean that quantum gravity is of no concern to us.

For myself, I intend to return to my four dimensional state sums with greatly increased ardor, in the hope that something like the meduso-anthropic principle might emerge from them.