Fundamentals and Philosophical Implications of an Information-Theoretic Evolutionary Model of Accelerated Cosmological Expansion

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ABSTRACT: The problem of "dark energy" is examined, and a hypothesis is proposed which holds that accelerated cosmological expansion is the result of information dynamics with a specific emphasis on the role of trans-biological intelligence. A basic discussion of quantum computing is presented, followed by a series of speculations on a possible approach to quantum gravity consistent with the information-theoretic model of accelerated expansion. Arguments in favor of considering such a possibility are presented. The basic philosophical implications of cosmological models in which trans-biological intelligence plays a key role are examined.

Dark Energy from Darwin?

In the world of physics, "dark energy" is a mysterious physical force which appears to counteract gravity, causing the expansion of the universe to accelerate rather than slow down. It was discovered in 1998 when observations revealed that a number of supernovae showed a greater than expected red shift, meaning that they were farther away from us that they should have been. Subsequent observations confirmed that the expansion of the universe is in fact accelerating, leading physicists to coin the term "dark energy" for the poorly-understood cause of the acceleration.

Although a number of potentially viable explanations for dark energy exist, none have yet been widely accepted. The current contenders include latent energy from the vacuum of space itself, a mysterious form of energy known as "quintessence," a universal slowdown in time mistaken for an acceleration in expansion, and several other speculative ideas. In this article, I will propose a rather different hypothesis. Although it may appear fanciful, it should be remember that seemingly strange notions have a remarkable history of leading to legitimate discoveries.

In short, I propose the possibility that the acceleration in the expansion of the universe is due to a continuous increase in information density due to an ongoing process of trans-biological evolution. In this view, the universe is expanding because it is becoming filled with increasing amounts of consciously-generated information over time. As biological animals evolve self-aware consciousness, they gradually develop technology which enables them to move toward a state in which they no longer rely on biological "hardware" as the medium for their cognitive processes. The end result of such technological advancement is a state in which the neural patterns of highly evolved beings are "hosted" on a non-biological medium that is as closely integrated to the fabric of space-time itself as the laws of physics will allow. Although this process occurs quite slowly from the perspective of any individual being involved in the transitionary period, the time involved is fairly brief from a cosmological perspective. Over a period of billions of years, many intelligent species might have achieved this state of existence.

The Informed Universe

Quantum theorists are increasingly drawn to models of the universe in which the basic physical properties of space-time and matter-energy are linked to information dynamics in some fundamental way, or are in fact identical with information or reducible to it. If these models are accurate, one way to describe the size of the universe might be to refer to its information content.

While many theorists contend that the physical universe is infinite in size, this does not rule out the possibility of expansion, as standard Big Bang theory shows. If the size of the universe is related to its information content, then the introduction of new information might be seen as a possible basis for accelerated expansion.

However, it is not immediately clear how information might be "created" in the absolute sense at the classical level of reality, due to the fact that from an objective viewpoint, a physical system in any state contains an amount of information equal to the sum total of the states of its constituent particles. In simpler terms, if we have a randomly generated string of ones and zeros which contains 50 integers, this string already contains 50 "units" of random information. Rearranging the ones and zeros in such a manner that they represent something meaningful to us does not add to the total information content of the system, it simply manipulates existing information in a subjectively useful way.

It may be possible to overcome this objection by making reference to the quantum level of reality, which underlies the classical one and treats the question of "objective" and "subjective" viewpoints somewhat differently. The developing field of quantum computing may provide a potential basis for an information-theoretic model of cosmological expansion.

Infinity Inside

Physicists and philosophers have developed the concept of quantum computing and the newer idea of quantum gravity computing in some detail. Although a number of questions remain unresolved and it is not yet entirely clear how to build a robust example of either device, it is widely accepted (with some dissent) that there are no fundamental barriers to the development of quantum computers, and that increasingly functional devices will be produced in the years ahead.

A quantum computer functions by using as its processing elements particles which are in a quantum mechanical superposition - that is to say, particles isolated from their environment to an extent sufficient to prevent other particles from causing them to "decohere" into a classical state. In physical terms, such particles can be said to be in multiple places at once. How this is possible depends on which interpretation of quantum mechanics one applies to the problem, but many researches in quantum computing (including its primary pioneer David Deutsch) favor the "many worlds" model, which explains quantum superposition by proposing a "multiverse" - an evolving manifold of divergent sub-universes in which every possibility of every quantum state is played out.

In this view, reality is fundamentally a sea of potentiality out of which an infinite number of individual but spatio-temporally co-substantial "objective realities" condense in every possible physical configuation. An observer, such as a self-aware conscious being, experiences only one such reality due to the fact that other elements in the environment interact with with each other and the observer, causing the quantum state of superposed potentiality to "decohere" into a definite physical state. However, each time a quantum event occurs anywhere in this individual universe, the entire physical state "branches off" into a new universe with a divergent history, starting from the original quantum event.

A quantum computer, then, functions by accessing the fundamental superposed quantum state underlying all individual divergent universes. In therory, it is able to access the information processing power of every universe simultaneously. In practice, the processing power is limited depending on the number of processing elements ("qubits") available to the processor, although this still results in exponentially greater processing power than that of classical computers.

Alien Beings and Black Holes

If advanced intelligent beings develop quantum computing, as we are beginning to do, it should eventually be possible for them to transfer their neural patterns to a phsyical substrate capable of quantum computation, or at least to one with access to such processing ability. Such beings would then have the capability to construct their own "virtual universes" which would be in some

sense "parallel" to our own - originating from within our space-time structure but functioning at the level of quatum superposition, where all possibilities are accessible. In effect, such beings would be at liberty to "create their own reality" in a concrete sense that has nothing to do with magic or mysticism.

Supposing for a moment that the universe is in fact home to a number of such highly evolved beings or civilizations who have achieved such technology, our universe would then be the foundation for any number of derivative "virtual" universes, which would be subjectively independent from the embedded perspective of their inhabitants, but integrally linked from an outside perspective such as our own. To draw an analogy, the distinction would be similar to that involving a black hole - from within, where not even light can escape, the black hole appears to be a self-contained system. However, from the outside perspective, we can observe that the black hole is integrally linked to the surrounding space-time environment.

Although the issue of whether black holes effectively remove or isolate existing information from the surrounding universe in the classical sense remains unresolved, it seems clear that they at least have the capacity to isolate regions of new information from the environment. A number of physicists now believe that black holes generate new space-time domains, resulting in new and classically separate "Big Bang" events. However, understanding the implications of this for an information-theoretic model of cosmological acceleration requires at least some discussion of quantum gravity.

Quantum Gravity and Shrunken Space

Quantum gravity is one of the most fiercely debated topics in modern physics. It stems from an attempt to arrive at a mathematically-sensible unification of Einstein's theory of relativity with quantum mechanics, a goal which has eluded physicists for over half a century. While mathematical formalisms are outside the scope of this paper and are the territory of qualified theoretical physicists, I would like to propose some unorthodox ideas regarding quantum gravity and how it might relate to a model of cosmological expansion based on information dynamics. While I have no fanciful ambitions of solving quantum gravity in a speculative conceptual paper, perhaps these ideas will be useful to someone more qualified than myself who takes seriously the oft-repeated maxim that progress in quantum gravity will require radically unexpected departures in thought.

If, as I proposed above, the physical (spatio-temporal) "size" of the universe is in some sense related to its information content, then it might make sense to view any phenomena which removes or isolates information from the spatio-temporal environment as one which "shrinks the universe," so to speak. In this view, gravity could be understood as a shrinking of space which tends to "pull" objects toward the mathematical center of shrinkage.

Several objections to this view of gravity come to mind. Firstly, while it is fairly apparent how a black hole might serve to "shrink space" in this sense by removing or isolating information from the surrounding space-time environment, it is not clear how ordinary matter might do so. For the purposes of this paper, we will ignore objections to the black hole analogy which are concerned with the Hawking radiation and similar factors. Although these objections are potentially substantial and will need to be thoroughly addressed in any derivative work expanding on the concepts introduced here, they are simply outside the scope of this paper.

The Fall of Matter

In order to establish a universal basis for the "shrinking space" model of gravity, we need to propose a mechanism by which ordinary baryonic matter might alter the information content of space-time in some relevant sense. One possible avenue has already been suggested - the nature of information at the quantum mechanical level. As discussed earlier, reality at the basic level is a "sea of superposition" which decoheres into all possible classical universes. In this view, it is possible to suggest that the information content of the vacuum, in which "virtual particles" randomly boil out of the "superpositional sea," is in some sense greater than that of any given

decoherent classical state. In effect, this view re-envisions classical matter not as the "highest" state of being, but as the "lowest." Reality flows from a "potentialized" quantum state of all possible information to an "actualized" classical state of divergently-individualized information, which could be treated as a functional decrease in net information content.

If this is the case, it predicts that the expansion of the universe will not necessarily be uniform, but will be greater in regions where less matter is concentrated and inhibited in regions where there are large accumulations of matter. In fact, in this view, gravity and cosmological expansion could be described as complementarily opposed facets of the same phenomena - shrinking or expanding space - with the degree of expansion or contraction depending on how fully the underlying "potentialized" superposed quantum state has decoherently "devolved" into ordinary "actualized" classical matter. However, this does not explain why the overall rate of expansion should accelerate uniformly, which is where the main thrust of this paper is focused.

It is not my intention to egregiously overstep my bounds in this regard by proposing a rudimentary theory of quantum gravity, and it is hoped the reader will forgive me for doing so. The subject has been approached because it is necessary to establish some basis for the idea that introducing large quantities of "new" information into the universe from a functionally isolated source might lead to accelerated cosmological expansion.

Noetic Inflation

If I have succeeded thus far in convincing you to at least consider the idea that the expansion of space might be in some sense related to its information content, it only remains to discuss how the "parallel virtual realities" created by the proposed advanced beings might in fact add information to the larger spatio-temporal environment from which their subjectively self-contained reality is derived.

One possible answer involves the previously discussed idea that such advanced beings embed their neural patterns on a medium identical to or capable of accessing the quantum substrate. By doing so, they may create regions of non-random activity in the vacuum, which might tend to "leak" into our space-time domain, so to speak. While a precise mechanism through which this might occur remains unclear, it is well-understood that "virtual particles" capable of having physical effects in our universe arise from the vacuum through random quantum fluctuations. If the activities of advanced beings in a "virtual reality" physically linked to our universe could somehow affect the behavior or frequency of virtual particle creation originating from the superposed quantum state they inhabit or access, then a possible source of a net functional gain in information content within our space-time manifold may exist.

I freely admit that my argument in this regard is tenuous at best, and much more sensible alternative mechanisms may occur to others. However, my purpose here is not to propose any particular mechanism by which information-based cosmological expansion might occur, but only to suggest through example that it might at least be a thinkable concept. Serious objections relating to information-theoretic models of energy (which this paper does not address) and the first law of thermodynamics might be raised, in addition to other possible objections. I will not deal with these issues here, although I remain hopeful that if this or a similar line of thought is pursued by others, sensible rebuttals might emerge.

Finally, it is particularly interesting to note that observations indicate that the expansion of the universe has not always been accelerating. Rather, it began to accelerate approximately 6 billion years ago. In fact, this is what prompted me to begin speculating along these lines. Why did the state of the universe apparently begin to change 6 billion years ago? While some ideas have been proposed to explain this seemingly unprecipitated change in the nature of space-time, none are particularly satisfying yet. My proposal, although highly unusual and in need of significant further development, does have the advantage of providing a rather attractive explanation for this conundrum. Expansion began to accelerate roughly six billion years ago because that is likely to be the earliest possible time advanced life forms could begin to emerge. Previously, it is unlikely that the elements necessary for complex biological life existed (although it is possible that strange

forms of non-organic or semi-organic life might have been evolving previously - and may still be evolving unknown to us).

Philosophical Implications

What would it mean to live in a universe driven to expand faster and faster by the evolution of advanced intelligence? Most immediately, it would obviously mean that we are far from alone, at least in principle. However, we might still reasonably expect to find very few biological civilizations elsewhere in the universe, with most of them having evolved to the trans-biological state at any given time we might choose to look. If the window between the first emergence of tool use and the achievement of full-fledged trans-biological existence is no more than a few million years, as our own development suggests that it might be, then the vast majority of life in the universe we might find at any given time is either of animal-level or lower intelligence or is essentially invisible to us due to effective isolation from our reality. Thus, even though we may in effect be surrounded by advanced consciousness, the outlook for those who hope to recieve "signals from space" or encounter an "alien invasion" may remain unpromising.

Secondly, it would imply that the development of life and intelligence is fundamental to the nature of physical existence, and that those models and interpretations of the universe which are in accordance with this conclusion are to be given greater weight than those which are not. In practice, this has two primary consequences - one political and one metaphysical.

Politically, a view which supports the idea that progressive advancement in the qualitative nature of consciousness would tend to bolster the more general "progressive" viewpoint - the approach which welcomes and values change intended to uplift human conditions. Not only would such progressive change simply be "good for us" in the usual sense, it would also be in harmony with the very nature of the universe itself. To maintain conservative or change-averse philosophies would be to live one's life in contradiction to the very way things are. The consequences of widespread acceptance of such a view could be considerable.

Metaphysically, the existence of advanced life forms which interact with our universe in fundamental (although non-intrusive) ways would be a blow to religious and philosophical viewpoints which hold that humankind is God's "special creation" and the highest expression of sentient life. However, it might simultaneously bolster other religious or quasi-religious views which propose that "God" is the end-point of human physical and/or spiritual evolution, toward which we are all inexorably drawn, such as Teilhard DeChardin's "Omega Point" or the ideas of unorthodox theoretical physicist Frank Tipler.

Conclusions

The specific consequences of such paradigm shifts, including a general move away from anthropocentric thinking, have been discussed elsewhere in considerable detail by numerous authors in a variety of contexts, so I will not rehash the particulars here. It is sufficient to say that the most obvious implication of the idea that the universe is inherently progressive, whether that idea is arrived at via the route suggested here or other paths, is that progressive, pro-change, pro-evolution, and pro-advancement views in all areas of thought should be taken seriously, and that their antitheses should be treated with proportional skepticism. In short, the chief philosophical implication of an information-theoretic model of dark energy (or other cosmological hypotheses which involve the emergence of trans-biological intelligence) is that if and when they are fully developed and supported by evidence, we should begin to accept the possibility that we still have some evolutionary growing up to do.