**THE SKEPTIC ARENA.COM**

**December 27, 2014**

**Viewpoint: Arrow of Time Emerges in a Gravitational System**

**by Steven Carlip**

**Study of masses interacting via gravity challenges the idea**

**that special initial conditions are needed to give time a direction.**

***The fundamental laws of physics, we believe, do not depend on the direction of time. Why, then, is the future so different from the past?***

**Steven, different in what way?**

**I could list a million ways that they aren't different, as many things in nature are very similar to the way they were in the past; and I could also list a million ways that they are different, since so many things change.**

**Steven, I've read verses in the Bible that made more sense than the question you just asked.**

***The origin of this “arrow of time” has puzzled physicists and philosophers for more than a century, and it remains one of the fundamental conceptual problems of modern physics.***

**Steven, not when time is properly understood.**

[**http://theskepticarena.com/scienceOther.aspx**](http://theskepticarena.com/scienceOther.aspx)

**(scroll down to "The Theory of Time")**

***Although a preferred direction of time can occur in models of physical systems, this typically happens only if one inserts very special initial conditions. Julian Barbour at the University of Oxford and his colleagues have now shown this tinkering isn’t necessary to produce an arrow of time in a system of masses interacting via Newtonian gravity. They demonstrate that the evolution of this surprisingly simple system almost always contains a unique moment of lowest “complexity,” a point they identify as a “past” from which two distinct (and more complex) “futures” emerge.***

**Steven, the problem is that in reality ... only one future has ever been observed to emerge.**

***The work of Barbour and his colleagues is the latest in a long history of attempts to explain the arrow of time.***

**Steven, go back to that link I gave you. It really isn't all that complicated.**

***One possibility, of course, is that we don’t know the right laws of physics—perhaps the correct fundamental laws do determine a preferred direction of time. Alternatively, if the laws of nature do not pick out a preferred “future,” perhaps boundary conditions do.***

**Steven, "the future" does not exist in reality. It is a "concept" that we use to talk about "present times" that we have not yet experienced.**

**For example: any future that you pick, if it comes to pass (for example, one in which Britney Spears is elected president), it will be experienced as "the present," before changing into a concept we call "The past."**

**The present is the only reality (And even that is difficult to define since we cannot break time down into basic units. Even the smallest defined unit, Planck time, has not been proven to be indivisible).**

***For example, most cosmological models assume, explicitly or implicitly, that the big bang was a moment of exceptionally low entropy. Indeed, most physicists accept the view that the direction of time is the same as the direction of increasing entropy. But this is, at best, an incomplete picture, failing to explain why there should have been a rare condition of low entropy in the past.***

**Steven, if you guys really get stuck you can always contact "Answers In Genesis." They seem pretty sure that they already have the answers. If they do, then they might be able to save you an awful lot of wasted time.**

***More than a century ago, Boltzmann suggested that our visible Universe might merely be a temporary, low-entropy statistical fluctuation, affecting a small portion of a much larger equilibrium system. In that case, the direction of time would simply be the one that takes us back towards equilibrium.***

**Steven, why did you equate, returning a system to equilibrium, to time running backwards? Why can't a system return to equilibrium with time running just as it does in our universe?**

***But most contemporary physicists find this explanation unsatisfying: a random fluctuation containing “us” would have been far more likely to produce a single galaxy, a planet, or just a “brain” rather than a whole universe.***

**Steven, the odds are also pretty long against life surviving the Earth's mass extinctions, but that didn't stop us. Long odds only indicate an improbability ... not an impossibility.**

***Moreover, according to the “Loschmidt irreversibility paradox,” if one posits such a moment of low entropy, entropy should increase both to the future and to the past, giving two separate arrows of time.***

**Steven, it doesn't make sense to say that entropy should increase to the past. The Past does not exist. Those events you call "The Past" were actually "The Present" ... at that time.**

**Events that happened in what you are calling the "past" actually happened in the present. But the present is always moving because there exists nothing in our visible universe that is not in motion. So from any later period in time, we can look back to "presents" that have already occurred; and we do that by referring to them as "The Past."**

**But the past ("presents" that have already occurred) is just a concept; a tool that we find useful for pursuing science.**

**The same is also true of the future.**

***In their gravitational model, Barbour and his colleagues find a state of “low complexity” that is analogous to Boltzmann’s low-entropy fluctuation. But in their case, no rare statistical fluctuation is necessary to explain this state; instead, it arises naturally out of simple physical laws that have no explicit dependence on the direction of time. The authors study one of the simplest possible systems: a collection of N point particles interacting through Newtonian gravity. Their only assumptions are that the total energy (potential plus kinetic) and the total angular momentum of the system are zero. From earlier numerical simulations and analytic analysis, it is known that in the distant future, such a system tends to break up into weakly interacting subsystems—typically, pairs of masses in Keplerian orbits. Starting with such a dispersed system and running time backwards, one might expect that it would coalesce in the past into a state of high density.***

**Steven, is there any evidence in the history of science that indicates that time can run backwards? Are there any observations that prove that time has ever gone backwards?**

**So your mistake may have been running time backwards when there is no evidence that it even makes sense to do so.**

***Barbour and his coauthors show analytically that this expectation is right: for almost every initial configuration of masses, there is a unique moment of minimum size and maximum uniformity. From this point, the system expands outward, approximately symmetrically in both directions of time. The system is therefore globally symmetric in time, as the equations dictate, and yet has a local arrow of time.***

**Steven, "both directions of time?"**

**I think I'm finally starting to understand what is meant by the phrase "mental masturbation."**

***As a key step in their argument, the authors analyze the evolution of the masses in “shape space,” a space of observables that describe the shape of the system but are independent of its size and orientation. Three bodies, for instance, form a triangle, and their shape space is the space of similar triangles. Shape space contains a natural dimensionless measure of complexity which is determined by the moment of inertia and the total Newtonian gravitational potential. It describes the degree of nonuniformity and clustering; it has a minimum at the moment of minimum size and grows approximately monotonically from that minimum in both directions of time.***

**Steven, that assumes there is more than one direction of time. That is an assumption that has never been proven.**

***Barbour and his colleagues provide a fairly simple and intuitive explanation for this behavior by showing that the dynamics of the N-body system in shape space has an effective friction term, which provides a sort of dissipation even though the underlying equations of motion are symmetric in time.***

***The idea of time proceeding in two directions, towards two futures, from a moment of minimum complexity is not itself new.***

**Steven, that is true. Fantasies have been entertaining humans for thousands of years.**

***It has appeared, for example, in cosmological models of eternal inflation. But the emergence of this behavior in a system as simple as the one Barbour and his colleagues consider is unexpected. The constraints of vanishing energy and angular momentum were based on a Machian philosophical view; namely, that only relational observables should be relevant to physics. But these choices also appear to match our Universe; vanishing energy, for instance, is an indication of spatial flatness. It is worth emphasizing, however, that the model in this paper is Newtonian—it is not yet clear whether it can be extended to a more realistic general relativistic description of gravity, though the authors suggest this might be possible by using shape dynamics, a modified scale-invariant form of general relativity.***

***Have Barbour and his colleagues solved the problem of the arrow of time?***

**Steven, there is no problem of the arrow of time except in the minds of those who misunderstand the concept of time.**

***Probably not yet. We’re still left with the mystery that the arrows of time we see in different physical phenomena all point in the same direction.***

**Gee Steven, what a surprise.**

**But let's not let observable facts stand in the way of good science fiction.**

***Electromagnetic waves are retarded, not advanced; radioactive nuclei decay, they don’t reassemble; gravitating systems clump, they don’t disperse; we remember the past, not the future.***

**Steven, those should be HUGE hints.**

***A good deal of work would be required to show that these disparate arrows all match the direction determined from a purely gravitational model.***

***Nevertheless, the results of Barbour and his colleagues provide an intriguing new viewpoint.***

**Steven, only to the director of the next Star Wars episode.**

***Standard approaches to the arrow of time typically require a rare statistical fluctuation, or, often, the smuggling in of assumptions about initial conditions. Their work offers evidence that ordinary gravitational dynamics may itself be enough to produce the simple “initial” point that can give time a direction.***

**Steven, reality has already taken care of that ... for us.**

[**http://physics.aps.org/articles/v7/111**](http://physics.aps.org/articles/v7/111)

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**THE SCIENCE SEGMENT**

**Scientists solve reptile mysteries**

**with landmark study on the evolution of turtles**

**Scientists have reconstructed a detailed "tree of life" for turtles. The specifics of how turtles are related -- to one another, to other reptiles, and even to dinosaurs -- have been hotly debated for decades. Next generation sequencing technologies have generated unprecedented amounts of genetic information for a thrilling new look at turtles' evolutionary history. These high-tech lab methods revolutionize the way scientists explore species origins and evolutionary relationships, and provide a strong foundation for future looks into Earth's fossil record.**

**The new genetic tree uses an enormous amount of data to refute the notion that turtles are most closely related to lizards and snakes. Instead, turtles have been placed in the newly named group "Archelosauria" with their closest relatives: birds, crocodiles, and dinosaurs.**

**Major findings also resolve an evolutionary mystery surrounding softshell turtles -- a bizarre group of scaleless turtles with snorkel-like snouts. Until now, studies linked softshell turtles with a smaller semi-aquatic group called mud turtles, despite the fact that softshells appear in the fossil record long before their mud-loving counterparts. Now softshells have been given their own place on the evolutionary tree, quite far removed from any turtle relatives. Their long independent history helps explain their striking looks as well as their ancient presence in the fossil record.**

**Fossils are essential, not only for showing what extinct turtles looked like, but also for letting us know when and where they lived in the past. But studying turtle fossils -- particularly the physical features of their bones -- hasn't always painted an accurate evolutionary picture of turtle relationships across continents and through time. The turtle tree of life based on fossil turtle anatomy didn't match up with the timing of their appearance in the fossil record, as well as their geography. But the tree of life generated by researchers consistent with time and space patterns gathered from the fossil record. These new testing techniques help reconcile the information from DNA and fossils, making scientists confident that they now have the right tree.**

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**FAMOUS QUOTES**

**William F. Buckley Jr. (1925 –2008) 82 years**

**He was an American conservative author and commentator. He founded the political magazine National Review in 1955, which had a major impact in stimulating the conservative movement. He hosted 1,429 episodes of the television show Firing Line from 1966 until 1999, where he became known for his transatlantic accent and wide vocabulary. He also wrote a nationally syndicated newspaper column, and wrote numerous spy novels.**

**For an entire generation, Buckley was the preeminent voice of American conservatism and its first great worldwide figure. His primary contribution to politics was to lay the groundwork for the new American conservatism of U.S. presidential candidate Barry Goldwater and President Ronald Reagan.**

**"I won't insult your intelligence by suggesting**

**that you really believe what you just said."**