

“Endings”

An initial commentary to go with Alex Reynolds’ “Origin”

By David Rountree

Well, Einstein believed in the Big Crunch. In other words, if there is enough matter in the Universe eventually gravitational forces will stop its expansion. At the point of maximum expansion, gravity will cause the universe to reverse its direction and it will begin to collapse under its own weight. This phase of the Universe's life is known as the “Big Crunch”.

Eventually, according to Einstein, all of the matter in the Universe will collapse into a super dense state and possibly a massive black hole. Some theorize that the Universe could collapse into the same state that it began as and then blow up in another Big Bang. In this way the Universe would last forever but would continually go through these phases of expansion and contraction, Big Bang and Big Crunch and so on...

Einstein believed in a “Closed” universe

I do not...

Mathematically, if $\Omega > 1$, then the geometry of space is closed like the surface of a sphere. The sum of the angles of a triangle exceeds 180 degrees and there are no parallel lines, therefore all lines eventually meet. The geometry of the universe is, at least on a very large scale, elliptic.

In a closed universe lacking the repulsive effect of dark energy, gravity will theoretically halt the expansion of the universe, after which it starts to contract until all matter in the universe collapses to a point, a final singularity termed the "Big Crunch," by analogy with Big Bang. However, if the universe has a large amount of dark energy (as suggested by recent findings), then the expansion of the universe can continue forever – even if $\Omega > 1$.

This is why I don't buy into it. The universe DOES have a large amount of Dark energy. Gravity as a force is far too weak to pull all the mass back in, much less stop the accelerating. Remember, we are not moving forward at the same terminal velocity, we have yet to reach terminal velocity. We are still accelerating away from the big bang event horizon.

But, if the universe does not contain enough matter to stop its expansion it will continue to expand forever.

Using the currently understood laws of physics it is possible to project into the future what the Universe may look like in very distant eras. Two astrophysicists at the University of Michigan have outlined the future history of the Universe.

These guys have divided the future into Eras. The current Era is known as the Stelliferous or Star-Filled era. The state of the Universe is filled with stars and

galaxies and planets. This era ends when all the stars have exhausted their fuel and have died leaving behind only remnants of their brilliance.

The next era is known as the Degenerate era. The universe is composed of dead planets, brown dwarfs, white dwarfs, neutron stars, black holes, and some theoretical forms of dark matter. This era ends with the disintegration of all protons, which compose the nuclei of all atoms.

Then the universe enters the Black Hole era. Black holes will be the only gravitationally important objects remaining in the universe. Black holes do not last forever. They will eventually evaporate, radiating away into nothingness.

After that all that will remain is radiation and particles which have an infinite lifetime such as electrons, positrons, and neutrinos. From this point on it is impossible to fathom what will happen as we have reached the limits of our knowledge.

In other words, they propose a scenario called an "Open" universe.

If $\Omega < 1$, the geometry of space is open, or negatively curved like the surface of a saddle. The angles of a triangle sum to less than 180 degrees, and lines that do not meet are never equidistant; they have a point of least distance and otherwise grow apart. The geometry of such a universe is hyperbolic.

But even in the absence of dark energy, a negatively curved universe expands forever, with gravity having little effect in slowing the rate of expansion. With dark energy, the expansion not only continues but accelerates, which seems to be our current condition after some 13.6 billion years of existence. The ultimate fate of an open universe as proposed is either universal heat death, the "Big Freeze", or the "Big Rip," in which the dark energy inspired acceleration eventually becomes so strong that it completely overwhelms the effects of the gravitational, electromagnetic and weak binding forces. I have issues with this scenario as well.

On the other hand, a negative cosmological constant, which would correspond to a negative energy density and positive pressure, would cause even an open universe to recollapse to a big crunch. This has been ruled out by recent observations. But there are aspects of all of this that remain problematic.

Another theory is the Flat universe...

If the average density of the universe equals the critical density so that $\Omega = 1$, then the geometry of the universe is flat: as in Euclidean geometry, the sum of the angles of a triangle is 180 degrees and parallel lines continuously maintain the same distance.

Absent of dark energy, a flat universe expands forever but at a continually decelerating rate, with expansion asymptotically approaching a fixed rate. With dark energy, the expansion rate of the universe initially slows down, due to the effect of gravity, but eventually increases. The ultimate fate of the universe is the same as an open universe. I don't buy into this either, as current observations cast doubt on this.

So what is the nature of the universe?

There are actually many theories about the end of universe, and that fate will be determined by the density of the universe. The preponderance of evidence to date, based on measurements of the rate of expansion and the mass density, favors a universe that will continue to expand indefinitely, resulting in the "big freeze" scenario.

The Big Freeze or Heat death

The Big Freeze is a scenario under which continued expansion results in a universe that asymptotically approaches absolute zero temperature. It could, in the absence of dark energy, occur only under a flat or hyperbolic geometry. With a positive cosmological constant, it could also occur in a closed universe. This scenario is currently the most commonly accepted theory within the scientific community. A related scenario is Heat death, which states that the universe goes to a state of maximum entropy in which everything is evenly distributed, and there are no gradients — which are needed to sustain information processing, one form of which is life. The Heat Death scenario is compatible with any of the three spatial models, but requires that the universe reach an eventual temperature minimum. While this is getting a lot of juice now among astrophysicists, I have issues with it as well.

The Big Rip: Finite Lifespan

In the special case of phantom dark energy, which has even more negative pressure than a simple cosmological constant, the density of dark energy increases with time, causing the rate of acceleration to increase, leading to a steady increase in the Hubble constant. As a result, all material objects in the universe, starting with galaxies and eventually (in a finite time) all forms, no matter how small, will disintegrate into unbound elementary particles and radiation, ripped apart by the phantom energy force and shooting apart from each other. The end state of the universe is a singularity, as the dark energy density and expansion rate becomes infinite. While on the surface this makes sense, it too is problematic.

The Big Crunch

The Big Crunch theory is a symmetric view of the ultimate fate of the universe. Just as the Big Bang started a cosmological expansion, this theory postulates that the average density of the universe is enough to stop its expansion and begin contracting. The end result is unknown; a simple extrapolation would have

all the matter and space-time in the universe collapse into a dimensionless singularity, but at these scales unknown quantum effects need to be considered such as Quantum Gravity.

This scenario allows the Big Bang to have been immediately preceded by the Big Crunch of a preceding universe. If this occurs repeatedly, we have an oscillatory universe. The universe could then consist of an infinite sequence of finite universes, each finite universe ending with a Big Crunch that is also the Big Bang of the next universe. Theoretically, the oscillating universe could not be reconciled with the second law of thermodynamics: entropy would build up from oscillation to oscillation and cause heat death. Other measurements suggested the universe is not closed. These arguments caused cosmologists to abandon the oscillating universe model. A somewhat similar idea is embraced by the cyclic model, but this idea evades heat death, because of an expansion of the branes that dilutes entropy accumulated in the previous cycle. While I don't believe the Universe is oscillating, I believe the multiverse does. The multiverse oscillates and the universes are small subcarriers floating on the quantum wave, like the static surfboard.

Big Bounce

The Big Bounce is a theorized scientific model related to the beginning of the known Universe. It derives from the oscillatory universe or cyclic repetition interpretation of the Big Bang where the first cosmological event was the result of the collapse of a previous universe.

According to one version of the Big Bang theory of cosmology, in the beginning the universe had infinite density. Such a description seems to be at odds with everything else in physics, and especially quantum mechanics and its uncertainty principle. It is not surprising, therefore, that quantum mechanics has given rise to an alternative version of the Big Bang theory. Also, if the universe is closed, this theory would predict that once this universe collapses it will spawn another universe in an event similar to the Big Bang after a universal singularity is reached or a repulsive quantum force causes re-expansion. While this has merit, it is still incomplete.

The False vacuum

If the vacuum is not in its lowest energy state (a false vacuum), it could tunnel into a lower energy state. This is called the vacuum metastability event. This has the potential to fundamentally alter our universe; in more audacious scenarios even the various physical constants could have different values, severely affecting the foundations of matter, energy, and spacetime. It is also possible that all structures will be destroyed instantaneously, without any forewarning. I have issues with this as well.

Cosmic uncertainty

Each possibility described so far is based on a very simple form for the dark energy equation of state. But as the name is meant to imply, we know almost nothing of the real physics of the dark energy. If the theory of inflation is true, the universe went through an episode dominated by a different form of dark energy in the first moments of the big bang; but inflation ended, indicating an equation of state much more complicated than those assumed so far for present-day dark energy. It is possible that the dark energy equation of state could change again resulting in an event that would have consequences which are extremely difficult to parametrize or predict. It is also possible the universe may never have an end and continue in its present state forever.

Choosing among these rival scenarios is done by 'weighing' the universe, for example, measuring the relative contributions of matter, radiation, dark matter and dark energy to the critical density. More concretely, competing scenarios are evaluated against data on galaxy clustering and distant supernovae, and on the anisotropies in the Cosmic Microwave Background.

So what do I believe?

I believe in the Multiverse.

I believe that once the fuse was lit, there is no complete end.

My multiverse hypothesis states that our universe is merely one Big Bang among an infinite number of simultaneously expanding Big Bangs that are spread out over endless distances. Each universe may be either matter or antimatter, with an equal number in existence at any given time. As the universes each expand away from their individual event horizons they collide and matter and antimatter annihilate, releasing energy. Heat death of a finite universe would be predicted as entropy increases; however, the infinite size of the multiverse and its oscillation coupled with the infinite number of universes could mean that new ones would be formed as old ones were annihilated.

Think of it as a chain reaction multiverse, much like the finale at a fireworks display with each explosion being symbolic of a Big Bang. It begins in one neighborhood and is followed by fireworks displays in surrounding neighborhoods and then in neighborhoods further out. The chain reaction of Big Bangs would continue to expand as Big Bang fuel is consumed. If the multiverse is open and the fuel is infinite then the chain reaction would expand forever. Of course, it is not known what the "fuel" is, (I believe it is the Zero Point Energy Field) but it is logical to assume that matter and energy are the product of a transformation from a real reactant, possibly the Higgs boson. While I tend to think they won't discover the Higgs Boson, there will be a settlement on something called the Higgs Boson Effect if the Higgs Boson is not discovered.

By my reckoning, the multiverse as a whole will never end completely. But this is just a part of the equation. We have to add in the Many-worlds interpretation of

quantum mechanics. As such, each time a quantum event happens that causes the universe to decay from a false vacuum to a true vacuum state, the universe splits into several new worlds. In some of the new worlds the universe decays; in some others the universe continues as before. I believe that both of these theories are part of the same theory. One is entangled with the other creating many reactions relating to the whole.

Recent work in inflationary cosmology, string theory, and quantum mechanics has moved the discussion of the ultimate fate of the universe in directions distinct from the scenarios set out by some of the other theories. Theoretical work by Eric Chaisson and David Layzer suggest that an expanding spacetime gives rise to an increasing "entropy gap", casting further doubt on the heat death hypothesis. Invoking Ilya Prigogine's work on far-from-equilibrium thermodynamics, their analysis suggests that this entropy gap may contribute to information, and hence to the formation of structure. Hence the Information Theory may be a part of the TOE, or Theory of Everything. Add to this aspects of the Holographic principle. The holographic principle is a property of quantum gravity and string theories which states that the description of a volume of space can be thought of as encoded on a boundary to the region, preferably a light-like boundary like a gravitational horizon. First proposed by Gerard 't Hooft, it was given a precise string-theory interpretation by Leonard Susskind.

In a larger and more speculative sense, the theory suggests that the entire universe can be seen as a two-dimensional information structure "painted" on the cosmological horizon, such that the three dimensions we observe are only an effective description at macroscopic scales and at low energies. Cosmological holography has not been made mathematically precise, partly because the cosmological horizon has a finite area and grows with time.

The holographic principle was inspired by black hole thermodynamics, which implies that the maximal entropy in any region scales with the radius squared, and not cubed as might be expected. In the case of a black hole, the insight was that the description of all the objects which have fallen in can be entirely contained in surface fluctuations of the event horizon. The holographic principle resolves the black hole information paradox within the framework of string theory. All of these play a part in the grand scheme of the Multiverse.

Meanwhile, back at the ranch, Andrei Linde, Alan Guth, Ted Harrison, and Ernest Sternglass argued that inflationary cosmology strongly suggests the presence of a Multiverse, (Amen!) and that it would be practical even with today's knowledge for intelligent beings to generate and transmit de novo information into a distinct universe. Alan Guth has speculated that a civilization at the top of the Kardashev scale might create fine-tuned universes in a continuation of the evolutionary drive to exist, grow, and multiply. This has been further developed by the Selfish Biocosm Hypothesis, and by the proposal that the existence of the fundamental physical constants may be subject to a Darwinian evolution of Universes.

Moreover, recent theoretical work on the unresolved quantum gravity problem and the Holographic Principle suggests that traditional physical quantities may possibly themselves be describable in terms of exchanges of information, which in turn raises questions about the applicability of older cosmological models.

And this may just hold the secret to paranormal activity...

So, in a nutshell, this is why I believe that the Universe will go on forever in some fashion or form.

But then I may be wrong. I have been before....LOL