The End of the Universe

Liem Fairbairn, 7 Dean Bradley St, London SW1P 3HZ

Introduction:
This poster will cover two popular ways in which the universe will meet its ultimate decay. There are many theories concerning the topic, but these two have the most intriguing happenings. The Universe, we believe all started from the big bang, over 13.8 billion years of development at the hands of gravity. From it, we, the Earth and the milky way, are all products, but, as all things, this all must end somehow, weather that be by fire or by ice.

The Big Crunch :
This is the theory that the expansion of the universe will stop, and then reverse on itself, condensing everything in it into a singularity. But for this to happen, we, as always, have to make a few assumptions.

For this we must consider dark energy and dark matter, two concepts we hardly know anything about, and their only proof of existence is their effects on things around us, and what we can see. Dark energy is a repulsive force while dark matter is simply invisible matter who's only effect on us is its gravity. Many people have theorised that dark matter will decay into dark energy, which would only further accelerate the expansion of the universe. For our purposes however, we must assume that dark energy is a field rather than something that can be decayed into. The field would also have to overcome the force of gravity induced by the matter within our universe and be responsible for its expansion. Were this field to weaken however, we would experience a collapse, where from our vantage point, would see galaxies and stars crashing towards us in the form of blueshifted light.

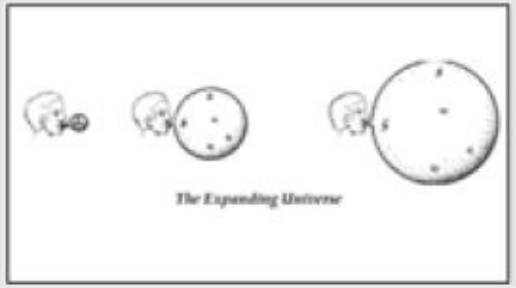
One theory post crunch is the concept that this singularity expands, forming another "big bang", and this cycle is constant, forming and destroying an entire universe in the process.

Concept of the expanding universe:
There are multiple theories revolving around the characteristics of the universe, but one thing we know for certain, is that it is expanding. But not in the way you might enlarge a circle, or square, but its expanding in every direction, everywhere, at once. To demonstrate this at a human scale, imagine it like a balloon (diagram below).

This means that everything around us is getting further and further away, as in the distance between us and them is increasing. We know this due to something called redshift.

The doppler effect is how waves of, say sound, increase in frequency as the source approaches an ear (This could really be anything, but an ear works best in our example). When the source is static however, frequencies between two objects opposite of the source are the same.

We know light to have wave like properties due to Thomas Young's double slit experiment, and so we can apply the same logic to sound to light in this specific case. As an object gets close, its light frequency will increase, and in the case of light this means blue. The same applies as it moves further away, the wavelength is increased, making the object turn red. This red/blueshift has revealed to us that objects are moving away from us, which we have concluded to mean that the expansion of the universe is the cause.



The Big Rip:
This is the most complex and exiting possibility for our demise. It involves the demolishing of planets, galaxies, and eventually Earth over the course of 2 billion years. The main concept is that our cosmic event horizon becomes smaller than the spaces between the smallest possible structure.

This, as does the big crunch, depend on a few assumptions, once again, with dark energy and matter.

$$\ddot{a}/a = -\frac{4\pi}{3}(\rho + 3p)$$

Above is the equation for gravity, but also on the scale of the universe. It simply states how pressure is, like mass or radiation, a different form of energy, and thus induces gravitational attraction to its surroundings. In the above equation, if we were to apply this to dark energy and the universe, we would find that the pressure is exactly negative of the density (-1). A negative relationship between these two things means that the two cancel each other out and we call this the cosmological constant, as in the value will never change.

But what if it did? What if the value of the relationship between pressure and density (we call this value w) was not equal to −1, take −1.5, -2, -13. What would happen?

Well, Robert Cadwell investigated this and published his findings in a paper titled: Phantom Energy: Dark energy with w<-1 causes a cosmic Doomsday. He found something very interesting, that if Dark energy had a value of anything less than −1, it would tear apart the universe, but do so in a time we could measure and predict as our cosmic event horizon shrinks as everything rips apart

Consequences and the happenings of the Big Rip:
The big rip, essentially tears everything apart (as its name would suggest) through the expansion of everything, very quickly, everywhere. This does sound like the big crunch, but the effects are much different. The first objects to be destroyed would be the larger structures, as their size leaves more to be unravelled. This would mean galaxy clusters. Distances would become larger and larger between clusters until one could not see the others. Then would come the death of galaxies. We, from afar, would notice galaxies losing matter in orbit, solar systems and stars would begin to drift into the blackness of space, leaving the dying galaxy behind. In our case, we would see the streak of the Milky Way fade as it is ripped apart.
Earth, as with all planets in a solar system would slowly lose their orbit, the gravitational attraction of the sun unable to account for the increasing distances between it and its planets. Earth slowly floating into space on its own, the moon also lost to the abyss. This state of peace would not last for long, as structures on earth collapse at the expansion of space with in it. We lose our atmosphere, which starts a chain reaction of destruction. The earth's tectonic plates react to the shift in gravity, and at last, the earth, unable to contain itself, is ripped apart. Every election, neutron, proton is separated , and after all is torn to a state of solitude, the universe has killed everything in it, in essence, itself.

With that said, we must remember that all this is mostly theoretical. The big rip and crunch are exiting yet frightening ideas of the end, but not the only one. In finality we can now say, we don't fully know whether the universe will end in fire of ice. Too many theories force us to reconsider, but even so, it is fun to speculate.

Credits – Katie Mack's The End of Everything, Images: balloon – Center for theoretical cosmology, equation – Scientific research publishing