

Dark energy

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“ The most beautiful thing we can experience is the mysterious. It is the source of all true art and science.” Albert Einstein Dark energy is one of the most important forces in our universe, yet we know almost nothing about it. It is a very recent discovery and it has changed our entire point of view of the universe as we knew it. Dark energy, in the end, is what will decide the fate of our universe. This is why it is important to discover what this mysterious force is, and what impact it will have on the universe in the future. We know that there is some type of field or energy that is accelerating the universe outward into space, but we don't know what this force exactly is, if it is a repulsion of gravity, a property of space, or another property of gravity that we haven't realized before. If we find that there is something about gravity that we haven't yet realized, then that would mean that we would need a new theory of gravity. Dark energy is just a term used to describe what is pulling our universe apart, and also what it is that fills about 70% of the universe.

In order to understand the fate of our universe and its present situation, we need to find out more about this mysterious substance that we have coined “ dark energy.” First, I would like to discuss the physics behind dark energy. Before I start to explain the functions of this supposed dark energy, I would like to put out there that the term “ dark energy” is nothing more than a phrase used to describe the reason behind the acceleration of the universe. It was given this nickname in 1998 when its discovery through the observations of supernovas was officially published, and the name has stuck. When observing the supernovas, the scientists expected the supernovas to appear brighter, and by looking at how much brighter the supernovas were

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across the universe, they would be able to calculate the rate of slowing down in the expansion of the universe. However, they found that the supernovas were actually dimmer, meaning that the universe wasn't slowing down, but speeding up in expansion rate.

(Panek) We know almost nothing about what it actually is, and so all we have are theories about what it could be. Dark energy can be considered a field or a force, a repulsive force to gravity, or perhaps another property of gravity that the theory of relativity has failed to identify. We know that there is something out there that is slowing down the production of dark matter, the "glue" that it is holding our universe together. Dark matter also gives rise to gravity. (Ouellette) According to Einstein's Theory of Relativity, gravity is a distortion in the space-time dimension, meaning that matter curves space and time and results in gravity, so the more matter there is the, the greater the curve of space, therefore, the greater the gravity.

(Griswold) This curve of space that would supposedly result from dark matter in the universe would end up leading the universe down a path toward a "big crunch," or a collapse of the universe to its original state before the big bang. (HUBBLESITE) So, if this were the fate of the universe, one would expect that the universe should be slowing down in expansion, but recent studies have shown that we are not slowing down. In fact, we are speeding up. This counter-gravity force is obviously what is accelerating our universe into space, but what it exactly is is what we don't know. Dark matter is estimated to make up about 25% of the universe, and material that we can see makes up less than 5% of the universe. What makes up the other 70% or

so of the universe then? There are several theories as to what this dark energy is.

It can either be a new dynamic fluid or field that fills space and is the repulsion to gravity, it can be a property of space, it can be a property of gravity, which would call for a new theory of gravity, or it can be the resultant energy of virtual particles, which would signify that dark energy is a vacuum energy or a cosmological constant. (LSST) Firstly, dark energy can be considered a new element or field that makes up a majority of the universe. If this is the case, dark energy is like the “quintessence” of the universe, or the fifth element. This “quintessence” is the counter-gravity, accelerating the universe in the opposite direction of the influence of gravity. (Ouellette) Dark energy can also be a property of space, thus existing because space exists. Since space can be created, that would mean that more dark energy would be created as space is created.

This would account for the domination of dark energy over dark matter in present times. This creation of dark energy would cause the universe to expand outward at a more rapid rate into space. As more of this energy is created, the more it dominates dark matter, therefore, the more the universe will accelerate. (NASA) Dark energy can also possibly be a property of gravity, thus making Einstein’s theory of gravity incorrect. If this is the case, we will need a new theory of gravity.

(NASA) Gravity is commonly accepted as an attractive force, not a repulsive force. This mysterious energy could possibly be the repulsive aspect of gravity. According to Einstein, gravity is the result of a distortion of the

space-time dimension, which means that matter can curve space and time around it, thus disrupting the straight path that the object should follow. The more matter, the greater the curve, therefore, the greater the gravity. So, in space, dark matter should be curving the space-time dimension, which would result in a greater amount of gravity in the universe.

This means that our universe should be curved which would result in the eventual collapse of the universe, but this is not the case. According to recent studies, as of 2013 conducted by NASA observatory programs, the universe is flat, with a 0.4% margin of error. (Griswold) If the universe is flat, then that means that there is a possibility of infinite expansion. That means that dark matter is not the dominant substance in our universe, but there is something else that is not allowing the space-time dimension to curve to create a closed universe.

The total energy density, which can be measured by the cosmic microwave background, is dominated by the unknown field or force of dark energy, which explains why the universe is not curved or spherical. (LSST) The other theory behind dark energy, and perhaps the least reliable, is that it is created from the energy generated by virtual particles, which are particles that pop in and out of existence. The only problem with this theory is that they calculated the energy emitted by these virtual particles, and the number came out 10¹²⁰ times too big. (Ouellette) Although this theory could possibly be correct, we cannot mathematically account for the large amount of energy that current calculations are getting. As a part of the virtual particle energy theory, dark energy could then possibly be a vacuum energy, whose density is independent of time or expansion of the universe. In this <https://assignbuster.com/dark-energy/>

way, dark energy would be near constant, varying very slowly and very minutely.

The vacuum energy is a cosmological constant, which is a part of Einstein's Theory of General Relativity, making it a uniform, constant density of dark energy. (LSST) The cosmological constant was once used to justify a stagnant universe, meaning that the universe wasn't expanding or collapsing, but when this theory was proven wrong in 1929 by Edwin Hubble, the cosmological constant was used to justify the acceleration, or expansion, of the universe instead of the force that is keeping the universe still. In both scenarios, the cosmological constant is described as something opposing gravity, a sort of vacuum energy. (Davis & Panek) This opposition to gravity sort of matches the effects of dark energy, making it a possibility that dark energy is a cosmological constant or vacuum energy. This, however, is a highly debated theory, because many argue that Einstein's cosmological constant is unstable.

The theorized vacuum energy density was calculated to be about 10^{112} erg/cm³. However, the vacuum energy density calculated according to cosmological observations is about 10^{-8} erg/cm³. (Davis) This leaves about 10^{120} difference between the theorized, calculated energy density and the observed energy density. This is why the possibility that dark energy is a cosmological constant is highly debated. Dark energy is a hot topic especially in the science world today. It is important to learn about dark energy since it does constitute a large portion of the universe, and it is impacting all of us, accelerating us deeper into space and causing many of our neighboring galaxies to be accelerated farther away from us.

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Dark energy is the dominating force or energy in the universe today, which helps to explain the shape of our universe, thus giving a possible explanation to the fate of our universe. The shape as we know it today is flat, thus allowing the universe to expand infinitely. (Griswold) We used to believe, prior to dark energy's official discovery in 1998, that the universe was of a spherical shape, meaning that gravity would eventually win and pull us back in to our original state at the center of the universe before the big bang.

What we are able to measure and discover today has impacted our view of the universe, changing our view from closed universe to an infinite universe. Dark energy plays a very important role in what we believe will be the fate of our universe. Previously, before the official discovery of dark energy, it was a common belief that our universe was closed, meaning that it would expand to a certain point before gravity would pull everything back in to the center of the universe, or the point of the Big Bang.

This would give our universe a spherical shape, since matter, or dark matter in this instance, curves space and time, thus making gravity take a spherical shape. Since the discovery of dark energy in 1998, this theory has been and is being disproven. Scientists now believe that the universe is not a closed universe, nor even an open universe, but an infinite universe. This means that everything is allowed to expand infinitely. There are also different fates that are associated with these universes. For the closed universe, the universe would end in the Big Crunch which is the event in which everything is pulled back to the center of the universe by gravity.

For the open universe, which is the gradual, almost stagnant, expansion of the universe would end in the Big Chill, which means that all particles and <https://assignbuster.com/dark-energy/>

elements of the universe would freeze and no longer be mobile. For the infinite universe, however, the universe would end in a cataclysmal event known as the Big Rip. This means that the works of gravity will be undone by dark energy, thus causing the galaxy clusters to disband and be thrown apart, and the galaxies, solar systems, stars, and planets themselves would be torn apart. (HUBBLESITE) It is even possible that this violent expansion could tear apart molecules and atoms. According to what we know of our universe and the effects of dark energy, this event would occur in approximately 100 billion years.

If dark energy is constant, which it seems to be, then this fate is what is most likely to occur. If we can find out exactly what dark energy is and if it is constant, then we can either prove the Big Rip theory to be correct, or we can define the fate of our universe based on a different theory. Our universe and our future lie in the hands of dark energy. As you know, prior to 1998, the universe was thought to be made up of dark matter and “normal” elements such as atoms, molecules, gas, planets, stars, etc. Dark matter was believed to make up about 60% of the universe, and normal elements made up about 40%.

(NASA) The universe was also believed to be spherical, meaning the universe would expand out from its original point at the Big Bang to a certain point when gravity would pull everything back in. Due to Einstein's theory of gravity, which states that the more matter, the greater the curve of space and time, therefore, the greater the gravity, dark matter would create enough gravity to eventually stop the expansion of the universe at certain point, giving the universe a spherical shape. This spherical shape of the <https://assignbuster.com/dark-energy/>

universe would also represent the way in which dark matter curves space and time. This model of the universe would make sense at the time. Since dark matter produced gravity by curving space and time, then it would only make sense that the curve of the universe would only allow a finite amount of expansion before gravity would collapse everything back into the point of the Big Bang. When dark energy was discovered, however, our entire perception of the universe changed.

We found that the expansion of the universe was not slowing down, like it should be if gravity was slowly pulling everything back to the center. Instead, it was accelerating outward. We found that many of the objects we were observing were red-shifted, not blue-shifted, meaning that more objects were getting farther away rather than closer. I explained before when scientists were observing a few supernovas in 1998, they discovered a new, opposing force called dark energy. (Panek) To this day, we only know of its effects on the universe, but we don't know exactly what it is.

Not only was this new force opposing gravity, but it was actually overpowering gravity. So far, we have found that dark energy is constant. Because of dark energy, we believe that our universe is an infinite, accelerating universe, meaning that the universe is capable of infinite expansion and it won't be slowing down anytime soon. (LSST & Griswold) If our current theory of the universe is true, we should expect the universe to end in a violent event known as the Big Rip, the disbanding of all elements of the universe and the undoing of the works of gravity. This would be expected to occur in 100 billion years.

By that time, we will not be able to see the billions of galaxies we are capable of seeing today. Rather, we will only be able to see a few hundred. (NASA) Our universe is also no longer spherical, but flat. We have found that the total energy density is near the critical density to make the universe flat. (NASA) Since dark energy dominates the energy density, it is no wonder that the universe has almost no curve.

Our current model of the universe has dark energy making up about 70% of the universe, dark matter as 25%, and “ normal” matter at 5%. (NASA) If “ normal” matter only makes up 5% of the universe, is it really “ normal matter?” Learning about dark energy now will impact what we will know for certain in the future. If we are able to learn more about dark energy and exactly what it is, we will take a few steps toward discovering the mysteries of our universe such as our origins and our eventual fate. By knowing what dark energy is, we will be able to define either a new element of the universe, define a new theory of gravity, or learn more about what “ empty” space is really made of. Is it really “ empty” at all? Because of what we know of virtual particles and dark energy, we know that space isn’t really empty, but how can this impact us? How can nothing be so significant? Because of what we know currently of the shape of the universe, we know that the universe is capable of infinite expansion.

Since space can be created, we know that the creation of more space will give rise to the creation of more dark energy, that is, if dark energy is in fact a property of space. This would provide for the domination of dark energy of the total energy mass of the universe. This would mean that the universe would continue to accelerate exponentially. If dark matter is nothing more

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than a property of gravity, then we would need to create a new theory of gravity where gravity is a force with both an attractive and a repulsive aspect. Making this change to a commonly accepted theory, of course, would involve much more research on the behavior and properties of both gravity and dark energy.

We also know that there is an existence of virtual particles, which is also a very recent discovery, and we know that the energy they produce when they pop in and out of existence could possibly result in the energy of dark energy, making it cosmological constant or vacuum energy. The calculations of the energy produced by these particles were way too high to be considered reliable scientific evidence, although the theory itself is not that unbelievable. Only time and a lot of research will tell what dark energy actually is and how it will affect the present and future of the universe. All in all, dark energy is one of the most interesting and mysterious aspects of our universe. Dark energy is a highly controversial and highly fascinating subject that has the capability of changing all that we thought we knew about the universe. It is something that we are aware of yet we do not completely understand it nor do we know what it is.

Sometimes, the things we don't know are the most significant elements in our universe. The mysterious is the center of all expansion in knowledge because when we discover certain elements of the mysterious, we progress in our journey of making more of the unknown become known. Bibliography Davis, Tamara, and Brendan Griffen. "Cosmological Constant." Scholarpedia.org.

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