WHAT IS DARK ENERGY?

or HOW BIG IS THE UNIVERSE?

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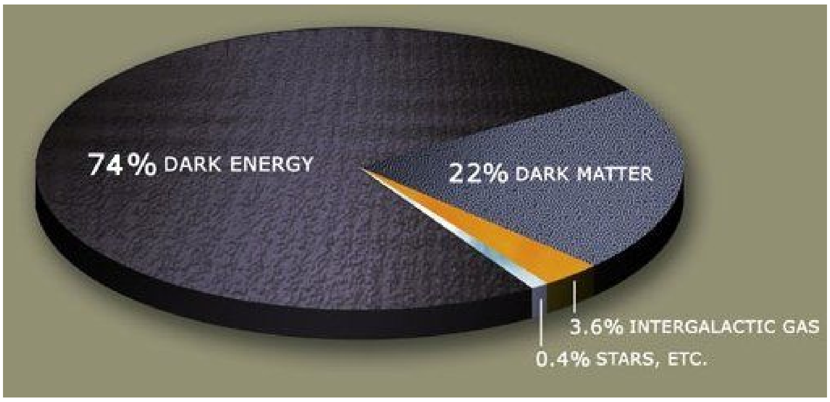
In this paper I present a hypothesis about Dark Energy. The attraction of this idea is that it offers a simple explanation for Dark Energy and it provides a model of the cosmos which simplifies much more.

We have no idea about 95% of the universe.



The universe is so much bigger than the bit we can see in our observable bubble and we know nothing about what lies out there in the cosmos. The challenge is so much bigger than is shown on this chart and it is evident that we really only understand a tiny fraction of the whole cosmos.

Theories for Dark Energy have been around for a long time but we still have no satisfactory explanation. None of the theories are adequate, some are clearly wrong – an error of 10^120 is a really big miss!

Scott Dodelson of Carnegie Mellon University, one of the lead scientists behind the Dark Energy Survey's new map of cosmic structure says:

"We're not sure our current way of thinking [about the universe] is correct because it essentially ***requires us to make stuff up*** *, namely dark matter and dark energy. My bet is that we're looking at things all wrong. Someone who's 8 years old today is going to come around and figure out how to make sense of all the data without evoking mysterious new substances."*Source- Astronomy, November 8, 2017.

Consequently, I make no apologies for putting forward this idea even if its simplicity may be disparaged by those who "know better". I understand that such a simple solution to a problem which has been defeating science for so long carries little credibility especially when you consider the resources put to it. However history has taught us that often the solution to complex problems are staring us in the face.

As we reach out into the universe in search of answers we do well to be guided by the history of our science. The lesson from the history of astronomy is very clear.

The universe has always been much bigger than we thought.

We are struggling for an explanation: so look at the problem from a different angle.

Take a trick from Claude Shannon's methods, simplify and "*change the viewpoint. ... Break loose from certain mental blocks which are holding you in certain ways of looking at a problem.*" So look at the problem from a different angle.

I have been told that, "*as far as we can tell, the universe is totally self-contained. All of its dynamics are governed purely by its interior contents.*" (source withheld).
It is time to think outside of the box. Not a cliché, I mean, quite literally, look outside of the box. Why should we believe that our universe is totally self-contained?

Why do we consider that the universe is restricted to the bubble we can see? What are the odds against that? Are we to believe that our field of vision is exactly sufficient to see all there is? How egocentric is that? How irrational is that?

Buchalter Cosmology Prize.

My thanks to Sean Carroll for Tweeting this, it confirmed that I was not alone in my frustration with the theories of cosmology.

What grabbed my attention was the way the challenge was written. It refers to the **"fundamental gaps in our understanding of cosmology"**.

Unusually it also criticises the Standard Big Bang model and is damning about some of the theories - **"there is a one-to-one trading of ignorance"**. I reproduce some of it below because it expresses the problem so well.

"The Buchalter Cosmology Prize was conceived on the premise that there are still fundamental gaps in our understanding of cosmology and that ***currently-accepted paradigms such as inflation and dark energy are incomplete****, and possibly even incorrect descriptions of our Universe.*

The Standard Big Bang model has done a remarkable job in explaining many fundamental observations, such as the microwave background (CMB) radiation, the Hubble expansion, primordial element abundances, and more. ***However many other, seemingly fundamental, observations are not immediately explained by the model.***

A few examples include dark matter (introduced to explain large-scale dynamics), inflation (introduced to explain the so-called Horizon Problem), and dark energy (re-introduced to explain the apparent cosmic acceleration).

These examples share a common issue: they explain a phenomenon that is not understood in the context of an existing theory, by introducing a new idea or mechanism which itself is not understood and which has no physical motivation to exist, other than to explain the original phenomenon. In effect, there is a one-to-one trading of ignorance, so to speak."

Source- Buchalter Cosmology Prize 2018
Bold text emphasis is mine.

Dark Energy

First a brief summary of the current theories, thanks to the NASA website paraphrased here.

1. Dark energy is a property of space itself, it would not be diluted as space expands.
As more space comes into existence, more of this energy-of-space would appear. As a result, this form of energy would cause the universe to expand faster and faster.

2. From the quantum theory of matter, "empty space" is actually full of temporary ("virtual") particles that continually form and then disappear. But the answer comes out wrong - in a big way - 10^120 is a big miss.

3. A new kind of dynamical energy fluid or field, something that fills all of space but something whose effect on the expansion of the universe is the opposite of that of matter and normal energy "quintessence".

4. Modified gravity, in its various forms, none of which explain all observations.

Current theories on Dark Energy are reminiscent of the "aether theories" which held sway until only 100 years ago. *"Dark energy is an unknown form of energy which is hypothesized to permeate all of space, tending to accelerate the expansion of the universe"* Source-Wikipedia

I propose to explain Dark Energy without the need to introduce new particles, new forces, new dimensions, no creative mathematics and certainly no additional universes. I make only one assumption - an assumption which is fully supported by the history of astronomy.

The universe has always been much bigger than we thought.

Let's do a thought experiment and let's stick to what can happen in the real world. The universe is a real place, only real things happen.
Although the universe is enormous, our observable universe is 93 billion miles across, it's generally accepted that it's bigger than that, possibly infinite. Now don't confuse this with multiverses, that's quite different, don't go there.

Sir Martin Rees, the U.K.'s Astronomer Royal, calls the multiverse "*speculative science, not just metaphysics*." He said he's confident there is far more to physical reality than the vast domain that we see through our telescopes, and he would be amazed, he said, "*if the universe didn't extend thousands of times beyond what we can see*."

Let NASA have the last word. "*All we can truly conclude is that the universe is much larger than the volume we can directly observe.*"

In this thought experiment we are going to assume that this enormous universe is not an empty vacuum. The only assumption in this thought experiment is that the universe is infinite **and full of mass.** Why not? Why do we assume that the only significant mass in the cosmos is in our observable universe?

We are going to look at the universe from a different perspective. But once you get your head around this simple idea then Dark Energy and more is easy to explain.

I propose that there is no need for negative forces or negative mass. No problem with a dilution of energy needing more space to appear to provide this 'energy-of-space'.
In a cosmos which is much bigger than our universe and is full of matter:-

The acceleration of our universe, the force which is propelling our galaxies out into the cosmos, is just gravity.
Dark Energy does not *push.*
The gravity of the cosmos pulls on our observable universe.
Dark Energy is just plain old gravity!

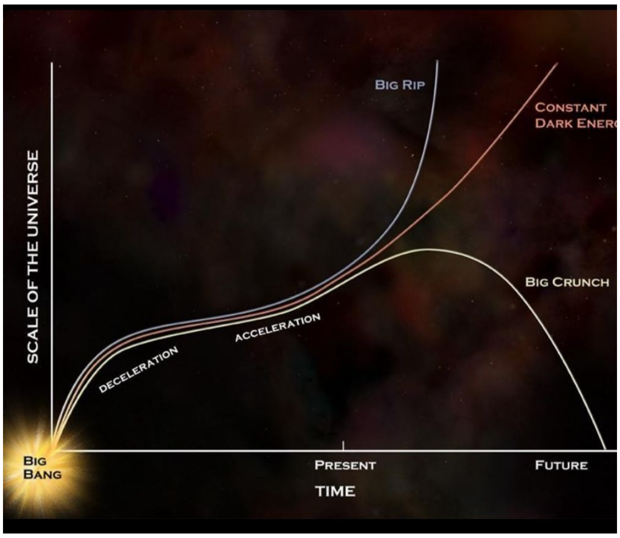
EVIDENCE

Here are my suggestions, but others, more able, are invited to add to this list.

1. More and better values for the Hubble Constant.(Ho)

After the initial expansion following the Big Bang, the acceleration of the universe slowed down until about 7 million years ago when Dark Energy started to take over and increase the rate of acceleration. If Dark Energy is a constant energy-of-space then Ho will tend to a constant in deep space well out into the Hubble Flow. If, however, Dark Energy is the gravitational pull of the cosmos then Ho will increase.

Out in the deep Hubble Flow it will start to increase exponentially as the gravitational forces within our universe become weaker and the gravitational pull from the cosmos increases.



The different ways dark energy could evolve into the future. NASA/CXC/M.WEISS

As the universe expands the balance of power moves towards cosmic gravity the rate of expansion will increase exponentially.

When we have more and better data on Ho from the extremes of the observable Universe, the theory of cosmic gravity will have support.

On 28th January 2019 in Nature Astronomy, G Risaliti and E Lusso "Cosmological constraints from the Hubble diagram of quasars at high redshifts" arXiv:1811.02590, "measurements of the expansion rate of the Universe based on a Hubble diagram of quasars." "a deviation from the ΛCDM model emerges at higher redshift, with a statistical significance of ~4σ. If an evolution of the dark energy equation of state is allowed, the data suggest dark energy density increasing with time."

This paper claims that Dark Energy is not constant, but it is increasing with time.

So much sooner than expected we have data in support of cosmic gravity.

2. Galaxy Clusters

The formation of galaxy clusters is not properly explained by a flat Lambda-CDM cosmology. It suggests that Dark Energy is evolving, slowing down the growth of these structures.

Catherine Heymans 'The Dark Universe'

"Interestingly, assuming a flat ΛCDM cosmology, they find fewer clusters today than they would expect given the cosmological parameters favoured by the CMB power spectrum.

This could suggest that dark energy is evolving, slowing down the growth of these structures, or, perhaps more mundanely, that the cluster selection or mass calibration is still missing an important ingredient in the analysis."

Perhaps cosmic gravity better explains the data?

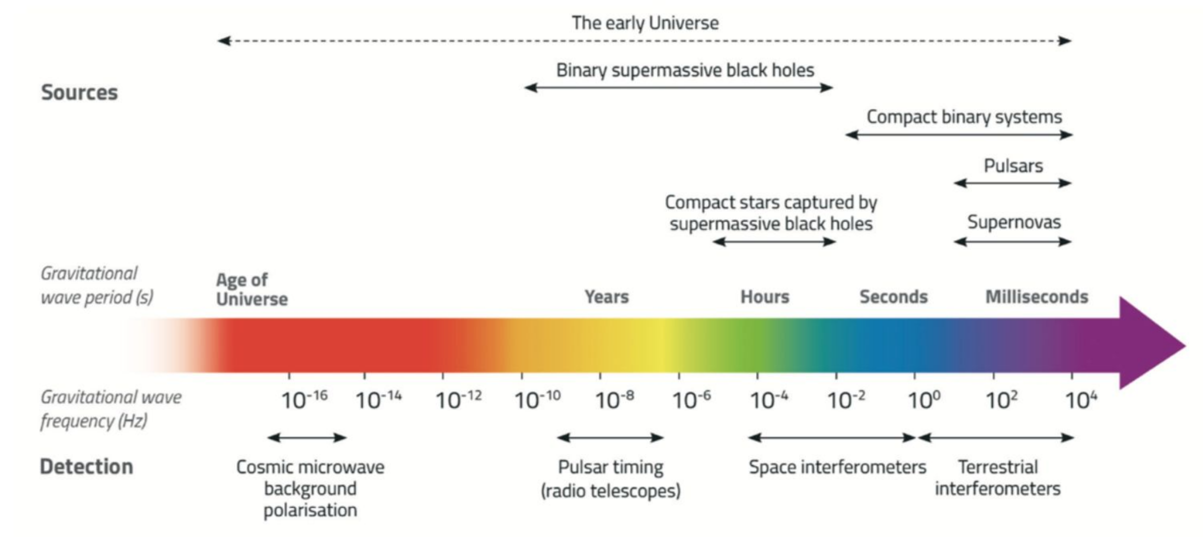
However this and Ho data can only support this hypothesis. To confirm the existence of a cosmos full of matter we will need direct observation.

3. Gravitational Waves

The supermasses out in the cosmos will have produced gravitational waves which could reach us. Those masses will predate the Big Bang and have time to reach us.

I understand that Advanced LIGO would not be able to detect the gravitational waves from such massive black holes. However this amazing new astronomy will in years to come offer an entirely new vision of the cosmos. Already new techniques are being developed to observe at different frequencies such as Pulsar timing CMB polarisation. Hopefully LISA and the Big Bang Observer will be built and have the power and sensitivity to detect gravitational waves from the cosmos.

Who would not want to be the first person to detect an event from beyond our observable universe?



The gravitational wave spectrum. The horizontal axis shows the frequency (and the wave period, which is the inverse of frequency) on a logarithmic scale, with the colours representing the corresponding wavelengths (red = longer, blue = shorter). The detectors shown are those existing or planned, while the sources are those known to exist and expected to produce detectable gravitational waves. (Adapted from: https://lisa.nasa.gov)

IT IS NOT JUST DARK ENERGY

Redshifts

This model of the cosmos implies some change to the way we look at cosmological redshift. We measure the 'Doppler like' redshift resulting from the 'expansion' of the universe, the redshift effect of galaxies accelerating away from us. However light coming from galaxies way out towards the edge of our observable universe will have a gravitational redshift caused by cosmic gravity.

How significant this will be I cannot even begin to estimate. Perhaps the universe is not expanding as fast as we think. Certainly calculations of Ho will be affected by cosmic gravitational redshift.

I invite those with the maths to make the calculations.

The Expansion of the Universe.

In this model we do not need the concept of space expanding.

The expansion of the universe is a concept that many science writers struggle with.
"It is an intrinsic expansion whereby the scale of space itself changes. The universe does not expand "into" anything and does not require space to exist "outside" it."
Wikipedia

From my favourite science communicator Sean Carroll.
"What is the universe expanding into?
As far as we know, the universe isn't expanding "into" anything. When we say the universe is expanding, we have a very precise operational concept in mind: the amount of space in between distant galaxies is growing. (Individual galaxies are not growing, as they are bound together by gravity.) But the universe is all there is (again, as far as we know), so there's nothing outside into which it could be expanding. This is hard to visualize, since we are used to thinking of objects as being located somewhere in space; but the universe includes all of space."
https://preposterousuniverse.com/cosmologyprimer/faq.html

So where does space expand? It does not happen in the solar system. It does not happen within galaxies. Perhaps within galaxy clusters? Andromeda and the Milky Way are gravitationally bound. Does it happen between distant galaxies? Does it happen within Superclusters? Where does the Hubble flow start?

I postulate something much simpler.

In space all matter moves under the forces of gravity applied to it.

The space between matter is just - space.
No need to create new space to explain the expansion of the universe.
The observed expansion of our universe is just the action of cosmic gravity.
It is just gravity; the balance of gravitational forces in the cosmos.
Beauty is not a reliable test, but how beautifully simple is that?

Summary

Given the assumption that the only matter in the cosmos is in and around our observable universe then ‘energy of the vacuum’ is possibly the best explanation for Dark Energy. Or, it is the least worse of a rather unlikely bunch.

It is well accepted that the cosmos is much bigger than our observable universe. Throw in the assumption that the cosmos is not empty but full of matter and it all becomes a lot simpler.

DARK ENERGY IS COSMOLOGICAL GRAVITY.

The structure of the cosmos is governed solely by the force of gravity.
Space is not expanding - it is just space.
There is no Dark Energy - it is just gravity.

Last word

A cosmos which predates our Big Bang may offer solutions to more of the “fundamental gaps in our understanding of cosmology”.

My thanks to those who have helped and given advice. They know who they are but are probably grateful for not being named.

I am extremely grateful to viXra for the opportunity to publish.