

## Offered Title: Darkness and Dread?

Everything we can detect with devices small and large, on the ground, in the ground, under the ice, or in space, is everything we can detect so far. This amounts to a measly 5% of all the mass-energy that exists. How do we know this and what/where is the rest?

The trail started in the early 1920's when a couple of Dutch astronomers, Jacobus Kapteyn and Jan Oort predicted the need for more mass than was measurable to account for galaxy spin. Matter in galaxies simply went around too fast for gravity to keep galaxies together. Ten years later Swiss astrophysicist Fritz Zwicky also calculated the need for more mass in galaxies, and he called it *dunkle materie* or dark matter. In the 1960's and 1970's Vera Rubin and Kent Ford added further evidence for dark matter. Now we know dark matter exists and it likely represents around 27% of all mass-energy in our universe. It can even be mapped by its gravitational effects. We just have not detected it...yet. What about the remaining 68% of mass-energy in our universe?

Let's go back to Einstein and his theory of general relativity (gravity) equations. If they were correct, all visible matter should be coalescing via gravitational attraction... into black holes. If his equations were correct there is an unknown form of energy preventing the big crunch. Believing in a static universe, Einstein came up with a 'fudge', the cosmological constant (CC). The CC proposed an 'anti-gravity' force, he called vacuum energy, pervading our universe, that kept everything from clumping. Well, isn't that special, anti-gravity! Einstein didn't recognize that relativity was correctly describing an expanding universe until observations by Edwin Hubble and others showed it. He called this his biggest blunder. Relativity predicted it but what is motivating our universe's expansion?

We have hypothetical models. We call it dark energy. We don't know what it is. It appears to uniformly pervade the universe (sound familiar?), even taking up the space in atoms. If this is correct, it is so rarefied it is not currently detectable. The only thing it appears to interact with is gravity. 17<sup>th</sup> century scientists such as Maxwell came up with a thing called the aether that supported everything in our universe. Now theorists suggest it is related to Einstein's cosmological constant, vacuum energy, also known as zero-point energy.

This is spooky stuff. The concept infers virtual particles and anti-particles popping into existence then annihilating each other. Quantum fluctuations in a vacuum that produce energy. From what? Popping into existence? Sounds like the big bang to me.

That's the darkness part. The dread? Our universe appears to be forever expanding so sometime, maybe trillions of years from now, there will be no light. Oh, that's darkness too.

## What's in the Sky?

Early risers go out before dawn on the 15<sup>th</sup> and look to the southwest. A gibbous Moon, Jupiter, and Spica form a nice group.