

### Offered Title: The Shape of Things

"Oh, you don't know the shape I'm in" seems to be the mantra of our universe. This 1970 song, "The Shape I'm In" by a band named 'The Band' is possibly a more appropriate description of today's world.

What shape is our universe? Our universe has a shape, and spacetime has a shape too. From years of study by brilliant minds using the best technology available we have a picture of our universe that is sort of like an onion, "layered". Let's try to peel, from inside out.

The core is what we can see from here, called the *visible universe* and it's spherical in shape. That seems pretty strait forward.

The next "layer" is our *observable universe* and appears to be 93 billion light years in diameter! Hold on you might say, how can that be? Our universe is just 13.8 billion years old. How can it be so much larger? What gives? A little thing called inflation.

Before there were stars or even atoms, just a moment after the big bang, the new universe, nothing but opaque plasma, supposedly inflated by a factor of  $10^{26}$ , creating an expanded space. Space continued to expand (and continues today) and cooled, allowing atoms to form. Voilà! The universe became transparent. This was still way before any stars, much less galaxies formed. So, while our universe is 13.8 billion years old, the space of our early universe briefly expanded faster than light and is larger than its age. Our *visible universe* is limited by the speed of light to those objects we can detect, about 13.8 billion light years away.

What does this mean? It means there are things out there we cannot detect now because their light has not reached our planet. Theoretically they can eventually be seen as their light reaches us. Don't wait up.

The next "layer" is called the Cosmic Microwave Background (CMB). The CMB is a remnant of when the opaque plasma of free ions (protons and electrons) combined to form hydrogen atoms and our young universe became transparent. This happened approximately 380,000 years after the big bang. Studying the CMB has provided supportive evidence of inflation theory and it shows our universe to be very homogeneous overall.

Drilling past the CMB is the next challenge and the "layers" beyond it are unknowns. They might just be plasma, the condition just after the big bang.

Spacetime has a shape too depending on factors such as energy and mass within spacetime. Energy, especially dark energy causes expansion and mass causes gravity, which causes contraction. The struggle by these forces determines the geometry of spacetime, which determines the ultimate fate of our universe. Will it be infinite expansion, or eventual contraction to a big crunch? We don't know yet.

### What's in the Sky?

February 27 – March 3; dawn; south-southeast: A waning crescent Moon lines up variously with Antares, Jupiter, Saturn, and Venus