WYHAT
Have you tried to wrap your head around this [WYHAT], how fast the universe is expanding according to the latest data?

Technology Changes the Viewpoint
First off the numbers put forth by scientists regarding these wyhat figures change as technology improves. For example, for a long time the prevailing view of most ancient civilizations was that the earth was the center of the universe (geocentrism) which some noted individuals, i.e., Ptolemy, Aristotle, most Greek philosophers, and the Catholic Church (during the Medieval age), believed, based upon a limited observation or viewpoint and the limited technology at the time.

Tycho Brahe correctly saw the Moon as orbiting Earth, and the planets as orbiting the Sun, but erroneously considered the Sun to be orbiting the Earth.

The technology used when geocentrism was the accepted viewpoint included the astrolabe, planisphere, armillary sphere (celestial globes), the nocturnal, radius astronomicus (Jacob's Staff), quadrant, dioptra, the astronomical clock, i.e., astrarium, Antikythera mechanism and the quadrant.

Using a geometric mathematical model the noted mathematician Nicolaus Copernicus in the 16th century along with Johannes Kepler who elaborated upon and expanded this model to include elliptical orbits along with the invention of the telescope allowed Galileo Galilei to prove that the earth is not at the center of the universe, thus heliocentrism was born and eventually accepted in the centuries that followed. The telescope (technology) changed the prevailing viewpoint to a different one.

"The telescope not only gave us a better look of celestial objects, but also fundamentally changed the very nature of astronomy." [1]

Another example of how technology changes our viewpoint is that the evidence learned from the Cosmic microwave background (CMB) math, with the technology we have today, indicates that the universe is composed of mostly dark energy and matter (68% dark energy, 27% dark matter which is a total of 95%), and only 5% is composed of normal matter! You would think we could detect and measure this dark energy or matter in our solar system. Alas, the technology hasn't been invented to detect or measure any dark energy or matter. As Ethan Siegel writes in *Forbes*, "But until our measurements become more and more precise, there simply isn't enough of a gravitational effect to result in anything detectable." You can imagine that if the technology is invented to detect and measure dark energy or matter, this will without a doubt present some new questions and change our viewpoint again.

Age of the Earth and Universe Figures Change with Technology

19th century calculations of the age of the earth were between 20 million and 400 million years old. [2]

“In the 1920s, Earth's age crept up toward 3 billion years, making it for a time even older than the universe, which was then estimated to be about 1.8 billion years old.” [2]

Allan Rex Sandage (1926 - 2010), astronomer, calculated the age of some stars at 25 billion years old.

As technology improved, i.e., radiometric dating, the earth’s age is calculated at 4.54 billion years ago. [3] The age of the universe is now estimated to be 13.8 billion years old. [4] These examples show that as technology changes the viewpoint (including the math) changes.

Expanding Universe

By the turn of the 20th century Einstein was working on a mathematical model to prove that the universe was static, but later abandoned this when technological evidence showed that the universe is expanding with the discovery of the redshift that convinced Einstein to change his view. “A redshift occurs whenever a light source moves away from an observer. A special instance of this is the cosmological redshift, which is due to the expansion of the universe, and sufficiently distant light sources (generally more than a few million light years away) show redshift corresponding to the rate of increase in their distance from Earth.” Wikipedia

Velocity Rate?

This rate of expansion is called the Hubble Constant, because Edwin Hubble was one of the firsts to try to measure this rate but was way off in his calculation. As *Wikipedia* explains, “Then Georges Lemaître, in a 1927 article, proposed the expansion of the universe and suggested an estimated value of the rate of expansion, which when corrected by Hubble became known as the Hubble constant.” [5]

“Hubble’s own estimate—500 kilometers per second for megaparsec—was way off, but such is the nature of discovery when the right technology isn’t around yet.” [6]

67.8 Kilometers per second for megaparsec

“In 2015, another team, using observations of the cosmic microwave background, determined the rate was 67.8 kilometers per second for megaparsec. And last year, a different team, using observations of Cepheid stars and supernovae put it at 73.2 kilometers per second for megaparsec. That figure was higher than most earlier estimates, and surprised many astronomers.” [6]

“The more modern value is 68 kilometers per second per megaparsec, plus or minus a couple, but close enough.” [6]

What is a megaparsec?
“One megaparsec is 1 million parsec, which is 3.26 million light-years.” [2]

Paul Sutter, an astrophysicist explains, “It means that if you look at a galaxy 1 megaparsec away, it will appear to be receding away from us at 68 km/s. If you look at a galaxy 2 megaparsec away, it recedes at 136 km/s. Three megaparsec away? You got it! 204 km/s. And on and on: for every megaparsec, you can add 68 km/s to the velocity of the far-away galaxy.” [2]

The velocity then grows until it reaches faster than the speed of light, according to the math. [7]

So in a galaxy far, far away, its velocity is faster than the speed of light, but as Paul explains, velocity is measured only in local regions of space, and “can only measure something's velocity and actually call it a "velocity" when it's nearby and when the rules of special relativity apply.” [7]

To wrap your mind around how fast this is, one parsec is equal to about 3.26 light-years (30 trillion km or 19 trillion miles) in length. [8] Astronomers prefer using parsec over a light-year as well as using the term, astronomical unit [9], which is a fundamental component in the definition of parsec. A megaparsec (Mpc) is one million parsecs (3.26 million light years or 19 million trillion miles).

So the rate the universe is expanding according to the latest figures is approximately 68 kilometers (**42.2 miles**) per second per megaparsec (3.26 million light-years), which is the most widely accepted rate. To wyhat the velocity rate is **151,920 miles per hour** per megaparsec.

“If astronomers could calculate how fast the universe is expanding, they could use that calculation to estimate its age. Moreover, the rate of expansion might have serious implications for the future. How so? It is reasoned that if, for instance, the universe is expanding too slowly, gravity might ultimately win out and cause everything to collapse in a final “big crunch”! But if the expansion is too rapid, the universe might expand forever and dissipate entirely.”
A Universe Full of Surprises, Awake!, 8/2009

Math Viewpoints
There are at least five different math viewpoints on this.

(1) Spitzer Space Telescope Data
74.3 plus or minus 2.1 kilometers per second per megaparsec [10]
(2) Team data from the NASA/ESA Hubble Space Telescope and the Keck-I telescope in Hawaii
73.2 kilometers per second per megaparsec [6] [11]
(3) H0liCOW
71.9 kilometers per second for megaparsec [6] [12]
(4) Planck 2015 results

67.8 kilometers per second for megaparsec [6] [13]

(5) Allan Rex Sandage

57 kilometers per second for megaparsec [14]

As Ethan Siegel, *Forbes* points out there are basically two methods used in the data used for the above figures, the 'distance ladder' method and the 'leftover relic' method. He discusses a third method called the 'standard siren' method. Siegel says, “What that rate is, however, is the subject of a great debate raging in cosmology today. If you measure that rate from the Big Bang's afterglow, you get one value for Hubble's constant: 67 km/s/Mpc. If you measure it from individual stars, galaxies, and supernovae, you get a different value: 74 km/s/Mpc. Who's right, and who's in error? It's one of the biggest controversies in science today.” [15]

“The equations of the expanding universe have three possible solutions, each of which predicts a different eventual fate for the universe as a whole….The three possible types of expanding universes are called open, flat, and closed universes.” [16]

Shape of the Universe

“The exact shape is still a matter of debate in physical cosmology, but experimental data from various, independent sources (WMAP, BOOMERanG, and Planck for example) confirm that the observable universe is flat with only a 0.4% margin of error.” Shape of the Universe, Wikipedia

Spaceship Earth

The earth is a spaceship traveling around the sun at 67,000 miles per hour while at the same time revolving on its axis at 1000 miles per hour. The sun is traveling around the galaxy (galatic year) at 514,000 mph while also revolving on its own axis. Another source says the Milky Way Galaxy is spinning around at 515,000 mph. Now factor in the expanding universe at 151,920 miles per hour and we certainly have a lot of movement. Wrap your head around this!

End Notes

[1] Measuring the Heavens: Astronomical Instruments before the Telescope, R. Egler, Journal of the Royal Astronomical Society of Canada, Vol. 100, Issue 1, p.37

[2] How is Earth's Age Calculated?, Jeanna Bryner, Managing Editor, Live Science

Age of the Earth, Early Calculations, *Wikipedia*

“In 1895, John Perry produced an age-of-Earth estimate of 2 to 3 billion years.” Age of the Earth, Early Calculations, Convective mantle and radioactivity, *Wikipedia*

[3] Age of the Earth, *Wikipedia*

[4] Age of the Universe, *Wikipedia*

“However Sandage, like Einstein, did not believe his own results at the time of discovery. His value for the age of the universe was too short to reconcile with the 25-billion-year age estimated at that time for the oldest known stars.” Wikipedia

*“*Sandage performed photometric studies of globular clusters, and calculated their age to be at least 25 billion years. This led him to speculate that the universe did not merely expand, but actually expanded and contracted with a period of 80 billion years.” Wikipedia

[5] Hubble’s Law, *Wikipedia*

[6] How Fast Is the Universe Expanding?, by Marina Koren, Atlantic

[7] How Can the Universe Expand Faster Than the Speed of Light?, By Paul Sutter, Space

[8] Parsec, *Wikipedia*
Names of large numbers, *Wikipedia*

[9] An astronomical unit is “roughly the distance from Earth to the Sun.” *Wikipedia*

[10] Spitzer Provides Most Precise Measurement Yet of the Universe’s Expansion, by Nancy Atkinson, *Universe Today*

[11] Hubble finds universe is expanding faster than expected, UC Berkeley, *Astronomy Now*

[12] Astronomers measure universe expansion, get hints of 'new physics', University of California - Davis, *EurekaAlert!*

[13] Planck 2015 results. XIII. Cosmological parameters, arXiv:1502.01589v3 [astro-ph.CO]

[15] “The debate over the Hubble constant has divided astronomers into two main camps. Dr. Sandage and his partisans have long maintained that this constant is somewhere between 42 and 56, while Dr. Freedman and many other astrophysicists have argued for a value of about 80, which would imply a much younger universe, perhaps as young as eight billion years old.” Age of Universe Is Now Settled, Astronomer Says, By MALCOLM W. BROWNE, NY Times, MARCH 5, 1996

[16] The Expanding Universe, Sloan Digital Sky Survey,

Scientists Still Don't Know How Fast The Universe Is Expanding

http://skyserver.sdss.org/dr1/en/astro/universe/universe.asp

http://adsabs.harvard.edu/full/2006JRASC.100...37E