

KINEMATICS

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Cosmos Controversy: The Universe Is Expanding, but How Fast?

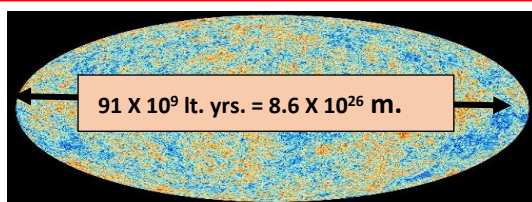


A Hubble Space Telescope image of a group of galaxies called Arp 273. Credit NASA

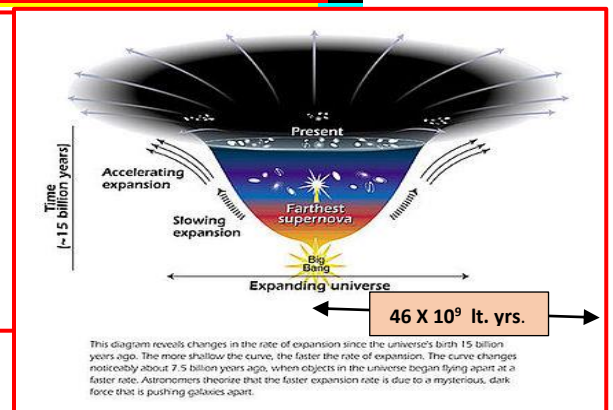
There is a crisis brewing in the cosmos, or perhaps in the community of cosmologists. The universe seems to be expanding too fast, some astronomers say. **The Hubble constant**, named after Edwin Hubble, the Mount Wilson and Carnegie Observatories astronomer who discovered that the universe is expanding, has ever given astronomers fits. In an expanding universe, **the farther something is away from you, the faster it is receding. Hubble's constant tells by how much.** Only three decades ago, renowned astronomers could not agree on whether the universe was 10 billion or 20 billion years old. Now everybody has settled on its **(((age as about 13.8 billion years.)))**



Albert Einstein, left, and Edwin Hubble, second from left, at the Mount Wilson Observatory in 1931.



Cosmic microwave radiation left over from the Big Bang, as seen by the Planck spacecraft.



INTRODUCTION: Object of this application is to confirm edge of universe is accelerating faster than speed of light (c). The old light the galaxies emitted is traveling at light speed c , but the actual universe is expanding (like flour dough) at $> c$.

QUESTIONS: The universe is 91 Billion light years wide(diameter) see graphic below. Since the **big bang it has expanded half that distance or ~ 46 billion(10^9) light years. (t).** The Hubble constant (see below) states the universe is expanding at accelerated rate of **$a = (72 \text{ km./s.})/(3.3 \times 10^6 \text{ lt. yr.})$** . A light year is the distance traveled by light in one year. $c = 3.0 \times 10^8 \text{ m./s.}$ (a) Find number of seconds in a year?, (b) Find distance in meters in a light year?, (c) Find distance in meters the universe has expanded to?, (d) At the start of the Big Bang the initial speed $V_0 = 0$. Knowing the Hubble constant (a) and time of expansion (t), find speed at edge of expanding universe?

HINTS: 365 days/yr., 24 hrs./day, 3600 s./hr., $x = vt$, $v = v_0 + at$

ANSWERS: (a) $3.154 \times 10^7 \text{ s./year}$, (b) $\text{lt. yr.} = 9.46 \times 10^{15} \text{ m.}$, (c) $R = \sim 4.35 \times 10^{26} \text{ m}$, (d) $v = \sim 10 \times 10^8 \text{ m./s.}$ or $3.33 c$

COMMENT: **Space is stretching faster than speed of light.** Light goes at c .

In 2001, a team led by Dr. Freedman reported a value of **(((72 kilometers per second per megaparsec (about 3.3 million lightyears))))**, in the galumphing units astronomers prefer. **The universe consists of roughly 5 percent atomic matter by weight, 27 percent mysterious dark matter and 68 percent of the even more mysterious dark energy that is speeding up the cosmic expansion.**