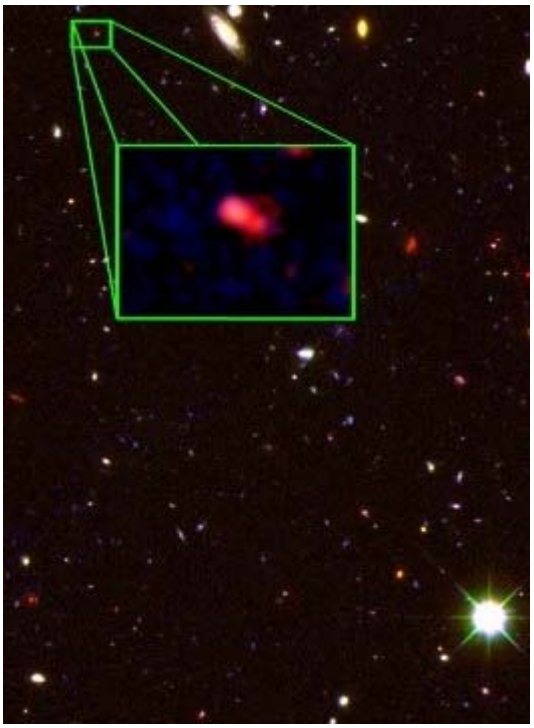

Astronomers have recently discovered one of the most distant galaxies in our universe using a list of candidates from the Hubble Space Telescope's Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey (CANDELS). This survey found 42 objects that seemed to be good choices for a follow-up study to determine their exact distances.

Astronomers used the MOSFIRE infrared camera on the Keck Telescope in Hawaii to study each of these candidates spectroscopically. One of these objects called z8_GND_5296 was then discovered to be the most distant galaxy known after studying the Lyman-alpha spectral line of hydrogen. This line should have appeared at an ultraviolet wavelength of 121 nanometers. Instead, thanks to the expansion of the universe, this line was detected at a wavelength of 1029 nanometers in the infrared part of the light spectrum.

Problem 1 – Astronomers define a quantity called the redshift by the formula

$$Z = (\lambda_m - \lambda_r)/\lambda_r$$

where λ_m is the observed wavelength of a spectral line and λ_r is its wavelength when measured under laboratory conditions. What was the redshift of the new galaxy based on the lyman-alpha spectral line?

Problem 2 – According to the Big Bang theory, the redshift of a galaxy is related to the time since its light left the object, called the look-back time, T, by the approximate formula T(Z) = 12.65 + 0.06Z. What is the look-back time for the galaxy z8_GND_5296?

Problem 3 – The Big Bang occurred 13.8 billion years ago. How soon after the Big Bang, in millions of years, did the light from z8_GND_5296 begin its journey?

http://hubblesite.org/newscenter/archive/releases/2013/39/image/a/
Galaxy Found in Hubble Survey Has Farthest Confirmed Distance
October 23, 2013

Problem 1 – Astronomers define a quantity called the redshift by the formula $Z = (\lambda_m - \lambda_r)/\lambda_r$ where λ_m is the observed wavelength of a spectral line and λ_r is its wavelength when measured under laboratory conditions. What was the redshift of the new galaxy based on the lyman-alpha spectral line?

Answer: λ_r = 1029 nanometers λ_r = 121 nanometers, so z = (1029-121)/121 = **7.5**

Problem 2 – According to the Big Bang theory, the redshift of a galaxy is related to the time since its light left the object, called the look-back time, T, by the approximate formula T(Z) = 12.65 + 0.06Z. What is the look-back time for the galaxy z8_GND_5296?

Answer: T = 12.65 + 0.06(7.5) = **13.1 billion years**.

Problem 3 – The Big Bang occurred 13.8 billion years ago. How soon after the Big Bang, in millions of years, did the light from z8_GND_5296 begin its journey?

Answer: 13.8 – 13.1 = 0.7 billion years or **700 million years**.