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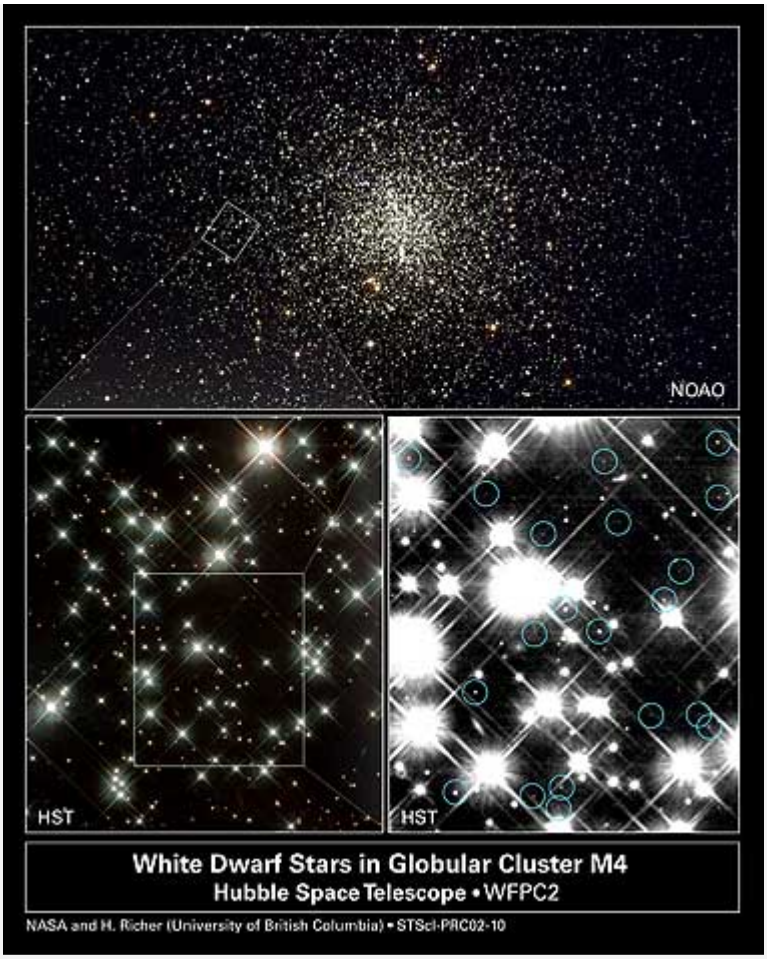
How old is the Universe?

Week 52

In the field of archaeology the age of finds or the time of events can sometimes be determined relatively easily, for example via the number of tree rings or the rate of decomposition of radioactive elements. However, there is unfortunately no direct and absolute indicator for the age of the Universe. Astronomers have, however, found two ways to arrive at a good estimate.



White dwarfs in the globular cluster M4

The Universe is at least as old as the oldest objects within it. What are the oldest objects whose age can be determined? Stars are promising candidates; however, several things must be taken into account. The higher a star's mass, the shorter its lifetime. In addition, many of the stars that are observable today contain chemical elements that are heavier than hydrogen and helium. These stars must have formed later in the history of the Universe’s development, because heavy elements did not exist at the very beginning. The heavy elements had to be produced in the first stars or early star generations. (See also the astronomy question from week 36: Are we made of 'stardust'?)

As a result, the oldest stars must have only a relatively low mass and contain hardly any heavy elements. Stars such as this can, for example, be found in the globular clusters that are grouped around the Milky Way. In particular, white dwarf stars, which have consumed their nuclear fuel and are slowly cooling down, can be used for age determination. (See also the astronomy question from week 27: How long will the Sun continue to shine?) Observations of the globular clusters and the cooling time of white dwarfs allow us to conclude that the age of the Milky Way is approximately 12 billion years.

The Milky Way – only a little younger than the Universe

Independent of the age of individual objects that allow a minimum age to be determined for the Universe, its age can also be determined using the Big Bang theory. To do this, we use the expansion of the Universe after the Big Bang, the same expansion that is continuing today, to calculate backwards – back in time until the zero point of the expansion. However, cosmic expansion (see also the astronomy question from week 38: How quickly is the Universe expanding?) has not always taken place evenly; this would only have been the case in a completely empty Universe. Radiation, matter (including 'dark matter') and dark energy (see the question from week 39: What is dark energy?) influence this expansion. Astronomers determine these influences using satellite observations, among other things, and ultimately they calculate that the Universe is 13.7 billion years old.

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