

Questions for study I (science)

The questions refer to the reading: Marcia Bartusiak, "Beyond the Big Bang", *National Geographic*, May 2005. Due: Tuesday, April 4.

1. Vocabulary question: What is a **galaxy**, anyway? How is it different from the **universe**? How is it different from a **star** or a **nebula**? How is it different from a **constellation**?

Galaxy — collection of stars and other material, orbiting a common center, held together by gravity

Universe — All energy and matter, and the extent of that

Star — A gravitationally-bound ball of gas, internally powered by nuclear fusion

Nebula — A gravitationally-bound ball of gas and/or dust, internally powered by gravitational contraction

Constellation — A pattern of stars as seen from the Earth's surface; the stars are not themselves gravitationally bound

2. At the end of the first paragraph, Bartusiak states that Hubble and Humason discovered that "[t]he universe is swiftly expanding, carrying the galaxies outward." What was the prevailing (scientific) view of the universe *prior* to their discovery?

On page 117, Isaac Newton is cited as a physicist who believed that the universe was "inert". Even during Hubble's time, "astronomers conceived of the universe as a large collection of stars fixed forever in the void." Einstein also accepted that picture.

3. In the middle of the first text column on page 117, Bartusiak makes an analogy for the structure of **space-time** between the Earth and the Sun "as a rolling marble would circle around a bowling ball sitting in a trampoline." Find and either photocopy or print out an illustration of this point from a book, periodical or website. For books and periodicals, include the author, title of article (if appropriate), title of book or magazine, year or date of publication, and page number. For websites, include the author or sponsoring organization of the site, the URL and the last update date, if given. At this point in your academic career, avoid encyclopedias – find primary sources. This extends to avoiding Wikipedia. Make sure you are accessing the true website – no citations to sites beginning with "yahoo.com" or "google.com".

See attached from Nick Strobel, <http://www.astronomynotes.com/relativity/s3.htm>, last updated March 23, 2006

4. Why did Einstein call his invention of the **cosmological constant** “his biggest blunder”, according to Bartusiak? What is a **constant**, anyway, mathematically speaking, and what is a constant’s purpose?

Because Hubble’s discovery that the galaxies were moving further apart from each other, and therefore expanding the size of the universe, meant that there was no need for a cosmological constant to make the equations of general relativity work out correctly. A constant is “a fudge factor” — literally, a number that makes a mathematical equation yield useful results. An example is pi (3.14159...), which allows the calculation of the area or circumference of a circle based on its radius.

5. What do modern astrophysicists think of the cosmological constant?

According to Bartusiak, page 121, modern astrophysicists have revived the notion of a cosmological constant because there is evidence that, far from slowing down in its initial expansion, the universe is speeding up its expansion. This observation leads to a revision of Einstein’s general relativity equations, which in turn then would require a cosmological constant to yield useful predictions.