

Alan Lightman, October 2, 2016

The question of how life originated, on Earth and in the universe as a whole, is surely one of the most important scientific questions today. By life, I assume with the biologists that to be considered “alive,” an object must have the ability to form an outer membrane that separates it from the external world, the ability to organize material and processes within itself, the ability to extract energy from the external world, the ability to respond to stimuli from the external world, the ability to maintain stability within itself, the ability to grow, and the ability to reproduce.

I support all experiments and observations that can help us understand the origins of life. Whatever those origins, I believe that they must have operated within the time frame given by the age of the universe as measured within the Big Bang model, that is, 14 billion years or less. Origins that require more than 14 billion years are inconsistent with the Big Bang model. In the Big Bang model, approximately 14 billion years ago the temperature and density of the universe were so high that no structures could exist, including individual atom. Subsequently, the universe expanded and cooled, and eventually composite particles and structures could begin to form.

The Big Bang model is supported by a host of independent pieces of evidence: (1) The age of the universe as measured by the expansion rate agrees with the age of the universe as determined by the ages of the oldest stars, (2) The ratio of hydrogen to helium in the universe, determined when the universe was only a few minutes old and calculated according to the theoretical density and temperature at that time, agrees with the ratio measured today, (3) The measured cosmic background radiation has the form and temperature predicted by the Big Bang model and is further evidence that the universe was once far hotter than it is today, (4) The singularity theorems of Hawking and Penrose require that the universe once had a far higher density and temperature than today, much higher than would allow organized structures.

Finally, by “universe” I mean a spacetime continuum that is causally isolated, not able to receive or give communications outside of itself, and the Big Bang model applies to our universe as so defined. Thus, nothing can interact with our universe since its beginning. All of which supports the argument that life in our universe must have originated in our universe during the last 14 billion years.