k2 Absolute geologic time < apparent age in years >

> In the January 1900 issue of the British science journal *Philosophical Magazine*, the physicist Ernest Rutherford reported his observation that a sample of radioactive material loses half its activity in equal time intervals [which is its half-life or "half transformation" as Rutherford originally termed it]. That statement, which is expressed mathematically as exponential decay, slipped into physics without the usual disparage [!] that accompanies the discovery of a new law of nature. —Hans Christian von Baeyer.[1]
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> British astrophysicist Fred Hoyle coined the phrase 'Big Bang' on a radio show in 1950 to disparage the rival to his beloved 'steady state' theory of the Universe. At the time, astronomer's underestimates of galactic distances put the Big Bang at 1.6 billion years ago[2] (half of Earth's then estimated geologic age).[3]

The Precambrian Eon is 88 percent of geologic time! This fact became known to geologists during the last century. It was part of a revolution in geological thought that became possible after the discovery radioactivity and the realization that this spontaneous and naturally unchanging process provides a reliable clock (*see* Topic *k7*). Geologists have developed radiometric techniques for dating (in years) when various materials originated (***Table k2.1***).

Found, for example, is that the Turin Shroud was woven of plant fibers that grew centuries after historical Christ lived, the first sedimentary rocks of Cambrian Period accumulated 541 million years ago, Akilia gneiss crystallized 3.85 billion years ago, and Earth and the solar system of which it is part is 4.55 billion years old. These claims assume that the accuracy to which the physical constants are known [4] can be improved little and anticipates that these constants have held true down the ages. The latter, naysayer Keith A. W. Crook would have, has not been conclusively demonstrated.[5]

> OMNI (*Interviewer Monte Davis, May 1979*): What about cosmology? Dirac's suggestion that the fundamental constants change with time or the idea that physical law was different at the instant of the Big Bang [or now, possibly, the *Big Crunch*].
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> Feynman: That would open up a lot of questions. So far, physics has tried to find laws and constants without asking where they came from, but we may be approaching the point where we'll be forced to consider history.

As to that,[6] Justin Khoury in *From Big Crunch to Big Bang*, 2001,[7] remarks: "Since the discovery of the cosmic microwave background by Victor Franz Hess [(1883?-1964)[8]], the predominant view has been that the universe originated from a cosmic singularity. An important consequence is that the universe has a finite age and a finite causal horizon distance. For the standard hot big bang model,[[9]] this leads to the horizon puzzle that inspired inflationary cosmology. By introducing a period of superluminal expansion, inflation alleviates the horizon puzzle, but it is generally believed that an initial singularity is still required at the outset."

In *The Extravagant Universe*, 2003,[10] Robert P. Kirshner reminds: "[p. 9] ... Individual stars are very small compared to the distances between stars, but galaxies are not so tiny compared to their separations. ... a scale model where a star like the sun has the size of a pea, neighboring stars would be 100 miles away. [p. 10] ... If you imagine our galaxy as a dinner plate, then our nearest big neighbor galaxy, the Andromeda galaxy [a spiral 28 times Moon's area if the naked eye could see more than the blur of its star-dense core in the night sky] would be just ten feet away. ... As galaxies move under their mutual gravitational pull, it is not rare for them to collide and possibly merge. But ... the individual stars that make up each galaxy are still quite unlikely to hit one another. [p. 90] ... Galaxies do not thin out with distance. The universe is thick with galaxies all the way out. This evidence favors a universe that is homogeneous and isotopically the same (once you average over big enough regions) everywhere and in all directions. The Big Bang is *not* like an explosion with galaxies shot out as shrapnel. The Big Bang is not centered at a particular location when we look in any direction, we see distant objects. The Big Bang is the moment when cosmic expansion began throughout the universe. Hubble's law (1929) [updated since] is that galaxies recede at about 100 mi. per sec. for every million light years."

In 1965, 3K or -270 ºC (*Note*: a º symbol is not used for "degree" in the Kelvin scale, 273 K = 273 kelvins ≅ 0ºC), relic radiation was found by radio astronomy in accordance to George Gamow 1948 (modified Lemaître's) expanding universe theory.[11] Vastnesses of *geologic time* (based on radioactive decay constants λ) and *astronomical time* (based on the velocity of light constant c) measured since,[12] corroborate the reality of deep time independently and the constants λ & c mutually. ❑