Paul Artale 22.10.18

Review: Lawrence M. Krauss, *A Universe From Nothing-Why There Is Something Rather Than Nothing*, Simon and Schuster, London, 2012

Pages: 245

False Advertising

The author, an ardent materialist, fails to deliver on his promise to the reader. His 'reason' simply boils down to "eternal quantum-fluctuations" did it (the common evolution-of-the-gaps idea).

Experimental observation of the initial 'Big Bang' event and the cascade of subsequent hypothesised events such as cosmic inflation [a miraculous "negative false vacuum energy" on a universal scale], star formation [from the self-collapsing hydrogen gas clouds], galaxy formations [no explanation given] etc., are non-existent.

For example, on p. 17: "we can extrapolate...when the universe was about one second old...all observed matter was compressed in a dense plasma whose temperature should have been 10 billion degrees". This is a modern creation myth having nothing to do with the scientific method.

By faith he assumes many things, e.g., that the universe has no edge and is homogeneous from every location and in every direction. Further, space is somehow 'endowed' with energy for the 'free lunch' to create everything, but the begged-question of who this mysterious endower is left off.

The faith of other devoted atheists in the power of 'nothing' to create everything will find little nourishment in this book.

A single star for some historical and scientific educational value the reader can salvage.

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<u>**Preface (p. xi-xix)**</u>

The potential to create is not true nothingness for if there were no potential, God couldn't have created.

Science is based on:

(i) Follow the evidence,

(ii) Try to disprove the hypothesis.

(iii) Experiment.

Most energy in the universe resides in for inexplicable form of permeating the entirety.

<u>**I) A Cosmic Mystery Story: Beginnings**</u> (pp. 1-21)

Since gravity is purely attractive, it is impossible to have a set of masses located in the universe in a state of perpetual rest.

The Big Bang occurred 13.72 Ga with our galaxy one of an estimated 400B.

Jesuit Priest George Lemaitre was the first to propose a Big Bang (but not the name).

Hubble made his 1925 breakthrough with a 100-inch Hooker telescope.

Nebulae (Latin for 'fuzzy thing').

Cepheid variable stars were first observed in 1784; these have a predictable brightness and period of variation allowing distance calculations. Observed brightness reduces proportionately with the square of distance.

Absorption lines are light wavelengths absorbed by known materials.

In 1868, two new yellow-spectral absorption lines were identified as representing the element He.

Austrian physicist Christian Doppler was the inspiration for the “Doppler effect” when in 1842 he explained that incoming waves are stretched if the source is regressing, and compressed if approaching the fixed observer.

Hubble’s Law posits a relationship between recessional velocity and galaxy distance.

As long as there is no edge to the universe, and the matter is equally distributed, then all locations would seem like the centre.

Today’s visible galaxies are likely receding at a velocity of 500km/s.

The Hubble age-estimate of the universe in 1929 was only 1.5Gya.

When the universe was one second, old protons and neutrons could bind together [where did they come from?] and temperatures should have been about 10B°K. As the universe cooled H_2, He, and elements only up to Li could have formed.

A quarter of the mass became He, one in ten billion a Li nucleus, and the rest hydrogen.

200M stars have exploded over the Milky Way galaxy’s history.

Type 1a supernovae are intrinsically brighter and shine longer (they are very good “standard candles”).

Kepler’s famous three laws of motion from the 17thC are:

1. Planets rotate elliptically.

2. A line connecting planet to sun sweeps out equal areas during equal time intervals.

3. The square of the orbital plane of a planet is directly proportional to the cube of the semi-major axis.

Since supernovae explode once per hundred years per galaxy, and there are approximately 100,000 visible galaxies, each night on average about three exploding stars should be visible.

II) A Cosmic Mystery Story: Weighing the Universe (pp. 23-37)

Gravity is the chief force operating on a galactic scale.

Vera Rubin from Georgetown University did pioneering work in gravity in the early 1970s.

Since the acceleration of universes cannot be explained by gravitation from other objects, a huge amount of "dark matter" must be invoked (a ratio of 10:1 dark matter to baryonic matter).

The three structural universe geometries are *open, closed,* and *flat.*

Curved three-dimensional universes are difficult to picture.

An open universe expands eternally at a finite rate and a flat universe decelerates forever.

Galaxy *super clusters* contain thousands of galaxies and have a diameter of tens of millions of light-years.

The Milky Way is within the Virgo super cluster whose centre is 60LY away.

In 1936, Albert Einstein demonstrated that space itself could act like a lens; light rays could bend around and reconverge on the other side of an intervening mass, or perhaps create multiple images given no reconvergence.

Fritz Zwicky in 1937 proposed three uses for this ‘gravitational lensing’:

1. Test general relativity.

2. Use intervening galaxies as a ‘telescope’ to see farther ones.

3. Discover ‘dark matter’.

A flat universe is the only mathematical 'beautiful' one.

A ‘flat’ universe still permits local ‘ripples’.

Dark matter experiments are performed sub-terraneously so as to be shielded from cosmic rays.

<u>III) Light From the Beginning of Time</u> (pp. 39-54)

Plasma can be opaque to radiation as charged particles within absorb photons and re-emit them. This means there is ultimately an impenetrable plasma ‘wall’ which light cannot penetrate and refract to enable vision beyond. The wall is an estimated 300,000 [light] years in diameter.

No information can travel faster than light speed, and gravity propagates at c.

Light travels in a straight line in a flat universe, bends outwards in an open one, and converge in a closed system.

A balloon [BOOMERANG] was used to measure the CMB from Antarctica to not be contaminated by the hotter material on earth.

Geometric hot and cold spots from BOOMERANG match a flat universe, as opposed to either a sphere (closed) or a saddle (open).

The largest 'bump' in space is ~one degree.

WMAP is the Wilkinson Microwave Anisotropy Probe, launched 1/7/2001, and sent a million miles from earth for seven years to measure microwaves.

IV) Much Ado About Nothing (pp. 55-74)

Einstein's General Relativity theory had an extra *cosmological term* which implies that empty space has mass.

Quantum mechanics was developed 1912 to 1927 by Niels Bohr, Erwin Schrodinger, and Werner Heisenberg.

Bohr proposed electrons orbiting around a central nucleus, which could move between levels by absorbing or emitting discrete frequencies or *quanta* of light.

Electrons could behave like waves and particles but only probabilistic measurements are possible and combinations of property (e.g. velocity and position) are not simultaneously available (Heisenberg's "Uncertainty Principle").

Electrons have "spin" like a top which can be clockwise or anti-clockwise.

Dirac used matrices to unify quantum mechanics with relativity, but this required *new* particles like electrons but with an opposite charge.

Protons are 2,000 times heavier than electrons. Dirac's electron anti-particle was called the *positron*.

Time will slow for fast-moving objects, and exceeding light speed would be travelling backwards in time.

A single electron is moving and meets and annihilates with a positron that itself has ‘appeared’ (from nothing!) as half of a positron-electron pair, and leaves the new electron travelling along in a parallel direction to the original (now annihilated) electron). At a point(s) in time, there are actually three particles in existence simultaneously! These are on timescales too short to measure, and are called *virtual* particles.

A proton’s interior may contain three quarks.

The Heisenberg principle states that measured energy is inversely proportional to the length of time of observation. Particles can be infinitely energetic, so long as they disappear in an infinitesimally small period.

Virtual particles contribute 120 orders of magnitude of energy larger than the universe itself (the Cosmological Constant Problem, discovered by Yakov Zel'dovich in 1967).

V) The Runaway Universe (pp. 75-89)

The longest estimated remaining lifetime of the universe is 20Ga.

Evidence for an accelerating universe are supernovae at high redshifts.

“Dark Energy” is invoked as the cause of this expansion and is ~70% of the universe.

VI) The Free Lunch at the End of the Universe (pp. 91-103)

From one second to today, the universe has increased a trillion-fold.

The Flatness Problem is akin to a pencil balancing on a table; any variation from perfect flatness will cause it to topple.

The Horizon Problem is that the CMB is extremely uniform. When the universe was a few hundred thousand years old, light could only have travelled that time, far less than what would be required to even out temperature given the ‘Cosmic Inflation’.

Cosmic Inflation states the universe expanded by a factor of 10^{28} in a fraction of a second, driven by a “large false vacuum energy”!

As a balloon blows up its curvature reduces so that the end state appears virtually ‘flat’.

If energy density is constant and volume increases, a ‘free-lunch’ arises of necessity due to the violation of the conservation of mass and energy (Alan Guth’s “ultimate free lunch”).

Earth’s escape velocity is ~7 miles per second, where gravitational energy is zero. Similarly, only in a flat universe does the total average Newtonian gravitational energy of each moving object is zero [Newtonian physics can be applied since objects are not moving anywhere near the speed of light].

<u>VII) Our Miserable Future</u> (pp. 105-119)

Stars and galaxies were all created by quantum fluctuations from nothing.

Since the observable universe is it the threshold of expanding faster than the speed of light, the longer we wait the less we will ever be able to observe. Once this point is reached, all light from the expanding objects will be ‘out run’ by the ‘dark-energy’-induced velocity, never to reach us.

In 150Ga light from stars will have red-shifted by a factor of 5,000 and in 2 trillion years the wavelength will equal the size of the visible universe thus the whole universe will disappear.

The Big Bang rests on the Hubble expansion, the CMB, and observed element proportions of H_2, He, and Li.

The Milky Way will merge with Andromeda in 5Ga.

Intra-stellar hot gas can ionise and behave like plasma, becoming opaque to radiation (i.e. it has a "plasma frequency").

<u>VII) A Grand Accident?</u> (pp. 121-139)

Density falls as the universe expands.

"A multiverse is viewed as a cop-out conceived by physicists who have run out of answers".

Linde's cosmic inflation is eternal, in which regions that 'exit' the inflation become separate universes.

On very small scales where problems between gravity and quantum mechanics might first be encountered, elementary strings may curl up into closed loops.

The 'graviton' may be the cause of gravity.

String theory posits vibrating strings in twenty-six dimensions, however, in the mid 1980s, Edward Witten at the Institute for Advanced Study introduced new mathematical symmetries via "super symmetry", reducing these to ten.

At extremely low temperatures, some materials conduct electricity with infinite current.

Muons and tauons are quarks heavier than electrons.

<u>IX) Nothing Is Something</u> (pp. 141-152)

Physicists posit *eternal* laws which ‘required’ our universe to come into existence.

Empty space ‘endowed’ with energy can create everything.

<u>X) Nothing Is Unstable</u> (pp. 153-170)

At the heart of quantum mechanics anything goes.

Massive particles can arise when two charged plates are brought near and a real particle-antiparticles par is created.

The escape velocity of a black hole is greater than c. Black holes can radiate particles where one of a particle-anti-particle pair is created and flies off to infinity while the other goes into the hole. This reduces its total weight since the lost energy is greater than its rest mass.

Feynman developed ‘sum over paths formalism’ which considers all possible trajectories between two points a particle might take, a probability weighting is attached to each then an expected route calculated.

Different observers at different points in a gravitational field measure distances and times differently.

Electric field lines flow outward for positive charges, and inwards for negative netting off to zero.

A closed expanding universe will recollapse as quickly.

Plank time us the characteristic scale over which quantum gravitational processes should operate ($\sim 10^{-44}$s)

<u>XI) Brave New World</u> (pp. 171-180)

The more fundamental nothingness from which empty space may have arisen is eternal

The laws of physics may merely be accidents.

Epilogue (pp. 181-185)

It is common to see salesmen deviate from the principles which first brought them success.

Afterword (pp. 187-191)