

Minutes of the January 7th Meeting of the Cape Cod Astronomical Society
D-Y High School library

Attendance: 21

The meeting was called to order at 7:30 p.m.

Mike Hunter introduced our speaker, CCAS member, Dr. Jim Lynch of the Woods Hole Oceanographic Institute. Dr. Lynch is the recipient of the Robert W. Morse Chair for Excellence in Oceanography, and is a senior scientist in the Applied Ocean Physics and Engineering Dept. at W.H.O.I.

Dr. Lynch's talk "The Big Bang ...In the Beginning" looked at the details of how, when, and where our Universe originated. A list of references Jim sent us pertinent to this topic is given at the end of these minutes.

Modern understanding of cosmology started with General Relativity in 1915.

The Friedmann-Lemaitre-Robertson-Walker (FLRW) equations give a metric (solution of the Einstein field Equations).

Friedmann Equations (1922) let you compute the expansion of the universe.

In 1917, Einstein "fixed" his field equations by adding a "cosmological constant", which gave a static universe solution.

In 1929 Edwin Hubble proved the Universe was expanding. (Hubble's Law – $v=Hd$)

Fred Hoyle derisively coined the name "Big Bang". Hoyle espoused the Steady State theory.

Penzias & Wilson settled the case in 1965 by discovering the Cosmic Microwave Background (CMB), the remnant of the Big Bang.

Big Bang theory predicted the age of the Universe (13.7 billion years). It described how the Universe expanded and cooled. It described the abundance of the light elements. And it described the basics of how matter congealed into stars, galaxies and galaxy clusters.

Problems with the Big Bang are it didn't explain what caused the expansion or where the matter came from. Also, the "flatness" problem and the "horizon" problem.

Enter Alan Guth. Looking for monopoles in the Universe. (No monopoles have been found.) The quantum field theories that can create monopoles are called Grand Unified theories (GUT's). Guth found that if you "supercooled" the system, the monopoles disappear. Guth also solved the "flatness" and "horizon" problems with his theory of Inflation. Inflation can also explain the "finestructure" of the universe (how matter clumps into galaxies, galaxy clusters and superclusters).

In most inflationary theories, the rate of expansion is much faster than the rate of decay of the inflation field. Once inflation begins, it never stops. The “pocket universes” spawned by eternal inflation grow in the manner of a fractal (self similar at all scales). Each pocket universe lives out the “Big Bang” history.

The inflationary multiverse and the string theory TOE (theory of everything). String theory postulates many universes with different laws of physics, constants, particles, etc.

But how did it all start? This search is really how the laws of physics are trying to prove “nothing” is impossible.

Dr. Lynch took many questions from the audience.

Bernie Young gave a report of work being done with students at the WSO. Spectroscopy and solar viewing (counting sunspots) are some of the projects the D-Y students are working on.

The meeting was adjourned at 9:30 p.m.

Respectfully submitted by Gail Smith for Gus Romano, Secretary.

References from Jim Lynch’s January 7th Presentation “The Big Bang ...in the Beginning”:

- “The inflationary universe”, Alan Guth. This is the primary reference for this talk, augmented by Wikipedia articles. This is an excellent, highly recommended book.
- “Lecture series 2009-10 – “Inflationary cosmology: is our universe part of a multiverse”, Alan Guth. An excellent internet reference.
- “Modern cosmology”, Scott Dodelson. A very well written graduate text on Cosmology. Not for the faint of heart. Best book for an advanced course.
- “The primordial density perturbation”, David Lyth and Andrew Liddle. Nice upper level graduate text on cosmology and inflation.
- “Cosmology”, Steven Weinberg. The best monograph around, by a famous Nobel Laureate. Extremely hard core!