

NWS11-2011-020002

Abstract for an Invited Paper
for the NWS11 Meeting of
the American Physical Society

Cosmological “Truths”

GREG BOTHUN, Univeristy of Oregon

Ever since Aristotle placed us, with certainty, in the Center of the Cosmos, Cosmological models have more or less operated from a position of known truths for some time. As early as 1963, for instance, it was “known” that the Universe had to be 15-17 billion years old due to the suspected ages of globular clusters. For many years, attempts to determine the expansion age of the Universe (the inverse of the Hubble constant) were done against this preconceived and biased notion. Not surprisingly when more precise observations indicated a Hubble expansion age of 11-13 billion years, stellar models suddenly changed to produce a new age for globular cluster stars, consistent with 11-13 billion years. Then in 1980, to solve a variety of standard big bang problems, inflation was introduced in a fairly ad hoc manner. Inflation makes the simple prediction that the net curvature of spacetime is zero (i.e. spacetime is flat). The consequence of introducing inflation is now the necessary existence of a dark matter dominated Universe since the known baryonic material could comprise no more than 1% of the necessary energy density to make spacetime flat. As a result of this new cosmological “truth” a significant world wide effort was launched to detect the dark matter (which obviously also has particle physics implications). To date, no such cosmological component has been detected. Moreover, all available dynamical inferences of the mass density of the Universe showed in to be about 20% of that required for closure. This again was inconsistent with the truth that the real density of the Universe was the closure density (e.g. $\Omega = 1$), that the observations were biased, and that 99% of the mass density had to be in the form of dark matter. That is, we know the universe is two component – baryons and dark matter. Another prevailing cosmological truth during this time was that all the baryonic matter was known to be in galaxies that populated our galaxy catalogs. Subsequent observations showed that a significant population of baryons was contained in both a) a population of not easily detected galaxies (i.e. they had been missed for decades) and b) in intergalactic space. In 1999, the balloon borne Boomerang experiment gave good evidence that space was flat (total energy density = 1). Around this same time, various lines of evidence suggested that the “cosmological constant” (Λ) maybe non-zero meaning we now live in a three component universe of baryons, dark matter and dark energy. The WMAP mission a few years later then produced our current cosmological truth that 5% of the Universe is baryons, 20% is Dark Matter, and 75% is Dark energy. What happened to Dark Matter dominance? Where did it go? Is this a fine tuned Universe? Our current cosmological truth, as defined by the WMAP results, rests on two important assumptions: a) that we fully understand gravity as a long range force and that alternative models, such as Modified Newtonian Dynamics (MOND) can therefore be dismissed and b) observationally we are fully confident that we understand supernova explosion physics to the point that they can be used as reliable cosmological indicators. This talk will attempt to summarize this evolution of cosmological truths, cast doubt on the certainty of the previously stated assumptions, and to culturally suggest that we should not continue with arrogance of Aristotle is assuring ourselves that we do in fact, know the “truth”.