WHAT DO THE COSMOLOGICAL SUPERNOVA DATA REALLY TELL US?

Ibrahim Semiz (Bogazici Univ, Physics Dept., Istanbul, Turkey)

Abstract:

Not much by themselves, apparently.

We start discussing in elementary terms how the expansion of the universe is observed, and describe the tools and methods for these observations. The most important distance markers are a type of supernovae (SN).

At the end of last century, analysis of SN data revealed that the expansion of the universe is accelerating. The common interpretation of the data assumes that Einstein gravity (general relativity — GR) is correct, leading to a universe dominated by matter (some of it dark) plus a cosmological constant-like dark energy.

However, dark matter and dark energy may be artificial concepts, and maybe GR should be replaced by a better theory. Here, we do not go into this argument, and try to determine the expansion history of the universe from the SN data, using only the homogeneity and isotropy of the universe and the assumption that gravitation is due to the geometry of the universe, not necessarily obeying Einstein’s Equations ("model-independent," or "cosmographic” approach). We find that the acceleration history of the universe cannot be reliably determined in this approach due to the irregularity and parametrization-dependence of the results.

However, adding the gamma-ray-burst (GRB) data to the dataset cures most of the irregularities, at the cost of compromising the model-independent nature of the study slightly. Then we can determine the redshift of transition to cosmic acceleration as function of the spatial curvature of the universe.

If GR is assumed, we find a redshift at which the density of the universe is independent of curvature. We use this to derive an upper limit on matter density today, hence a lower limit on the density of dark energy. While these limits do not improve the generally accepted ones, they are derived only using the SN and GRB data, i.e. without making any assumptions about the properties of dark energy.