Overview

It is proposed to use cosmic microwave background radiation observations deriving from a time when the universe was less than a thousandth of its present size and combine them with the results of recent surveys of galaxies to produce a comparatively low resolution, three dimensional map of the universe as it is today out to a radius of over forty billion light years and to follow its evolution back to the time of inflation when the structure was set down. The approach that is used is predicated on recent findings that both the geometry and the starting conditions are about as simple as can be imagined, given the essential constituents that we now know must be included. New methods will be developed to combine heterogeneous future datasets and determine and achieve the best resolution possible. It is also proposed to determine what improvements will be possible from new data that will become available over the next decade. Finally, we will consider what are the theoretical limits to making a map like this using the best possible observations we can imagine making long term. Although the primary product is a crude map of our entire universe, the results should also help refine the investigation of the underlying physical processes. In particular, it should be possibly to check in new ways that the initial conditions were indeed as “random” as has been inferred.

Intellectual Merit

This ambitious proposal is enabled by the quality and quantity of existing and anticipated cosmological datasets. If it is successful in making a map with linear resolution as good as roughly three billion light years, then it should be possible to connect the cosmic microwave background to “local” observations of galaxies and thereby improve the interpretation of both data sets. If, and this is very ambitious, it is ever possible to connect the first acoustic peak exhibited by the microwave background on a wave by wave basis and not just statistically, then the improvement in measurement and discovery potential will be large.

Broader Impacts

If this proposal achieves it most modest goals the results should have broad popular appeal as well as scientific utility. Even at low resolution, new images of previously unresolved cosmic structure is seen as a big step. The public presentation of the results will be a large part of this research using movies, modern graphics and three dimensional printing. The research proposed involves an unusually large number of cosmological efforts that are typically combined pairwise. In order to facilitate a broadly integrated investigation, it is proposed to work through an open website. Combining large, heterogeneous data sets optimally is raising new issues in inference and assigning criteria for deciding that structure will persist after more data is acquired. Problems such as these are showing up increasingly in modern data-driven science and there are strong connections to many other fields, which it is intended to investigate.