

Observation Operators and Cosmology

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1. Introduction. Because the resolving power of any optical or radio telescope has a definite lower bound, the fundamental observables in distant galaxies derive from aggregate properties of stars, gasses, and dust clouds rather than from the individual properties of these constituents. Thus, if theory and observation are to mesh, models of galactic structures should be representative of aggregate or averaged behavior; indeed, it is only through considerations of such averages that mass density and luminosity are meaningfully associated with galaxies. As the domains of general relativity and classical relativistic cosmology are currently envisioned, galaxies and clusters of galaxies play the role of indicator points whose properties must themselves be averaged in order to determine the salient parameters of the various cosmological models. Unfortunately, classical cosmology denies the very existence of such indicator points and hence a description of the averaging processes and domains of averaging that are consistent with the classical models can not be obtained within the discipline of classical cosmology.

On the other hand, the Einstein field equations are experimentally known to relate only the local differential geometric quantities (curvature and infinitesimal metric structure) and the local momentum-energy distributions that are characteristic of a stellar or planetary neighborhood. Since these field equations and their associated physical interpretations are carried over directly as a basis for the classical cosmological models and for the description of galaxies and clusters of galaxies, a fundamental problem must be resolved—namely, the construction of the governing equations for aggregates when the individual elements of the aggregate are governed by the Einstein field equations. A solution of this problem will give not only a clear understanding of the gross structures of the universe in terms of the known properties of their constituents, it will also define the possible structural environments for galaxies and clusters of galaxies that is demanded by the conditions of internal consistency with the Einstein field equations.

This paper is dedicated to my friend and mentor, Tracy Yerkes Thomas, on the occasion of his 70th birthday.