THE FIRST STARS AND THEIR ROLE IN GALACTIC CHEMICAL EVOLUTION AND COSMOLOGY

Abstract

by

Timothy P. Ashenfelter

This dissertation is composed of studies on the formation of the observed elemental abundances and the subsequent distribution of stars. The dissertation highlights many of the large uncertainties in galactic chemical evolution, stellar evolution, and the relationship between the interstellar medium (ISM) and stars. Despite these uncertainties, chemical evolution provides a rich and growing field of study to test hypotheses of importance to astrophysics, cosmology, nuclear physics, and atomic physics. The emphasis is to explore what the first stars were and the cosmological consequences of their formation. A higher than expected optical depth towards the Milky Way's bulge is numerically studied for possible evidence of a bar structure. Chemical evolution models are described and applied to the observed phenomena of galactic abundance gradients through the use of semi-analytic models of their formation that removes one of the largest uncertainties, the time evolution of the star formation rate (SFR). Chemical evolution also constrains recent observations of a cosmological variation of the fine structure constant, which is shown to depend significantly on the isotopic ratios of magnesium. A chemical evolution scenario that favors an early enhancement of asymptotic giant branch stars (AGBs) can account for the apparent variation in α.