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THE DARK AND STELLAR MASS ASSEMBLY OF GALAXIES

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RESUMEN

De acuerdo al cuadro empírico del ensamblaje de masa estelar ($M_{\rm s}$) de las galaxias, el establecimiento de la población de galaxias procede de arriba a abajo en $M_{\rm s}$. Conectando galaxias con halos ΛCDM y sus historias se infieren trazas individuales de $M_{\rm s}$. Estas trazas muestran que galaxias masivas ensamblaron su $M_{\rm s}$ más temprano mientras más masivo es el halo, y que galaxias menos masivas aún están creciendo activamente, más mientras menos masivo es el halo. Predicciones hechas en base a estas trazas coinciden con observaciones directas lo cual implica que el escenario ΛCDM es consistente con dichas observaciones. El reto es explicar cómo es que el ensamblaje de $M_{\rm s}$ se desvía sistemáticamente del ensamblaje de la masa del halo correspondiente.

ABSTRACT

The emerging empirical picture of galaxy stellar mass ($M_{\rm s}$) assembly shows that galaxy population buildup proceeds from top to down in $M_{\rm s}$. By connecting galaxies to ΛCDM halos and their histories, individual (average) $M_{\rm s}$ growth tracks can be inferred. These tracks show that massive galaxies assembled their $M_{\rm s}$ the earlier the more massive the halo, and that less massive galaxies are yet actively growing in $M_{\rm s}$, the more active the less massive is the halo. The predicted star formation rates as a function of mass and the downsizing of the typical mass that separate active galaxies from the passive ones agree with direct observational determinations. This implies that the ΛCDM scenario is consistent with these observations. The challenge remains in explaining how the $M_{\rm s}$ assembly (downszing) systematically shifts from the corresponding halo mass assembly (upsizing).

Key Words: cosmology: theory — galaxies: evolution — galaxies: formation

1. INTRODUCTION

One of the current challenges in the study of galaxies is determining and understanding how did they assemble their stellar and dark halo masses. The main observational imprint of the complex galaxy assembling processes is probably the stellar-to-dark mass ratio, $F_s \equiv M_{\rm s}/M_{\rm h}$, as a function of mass and redshift z. The growth of $M_{\rm s}$ can be due (1) to local star formation (SF) fed by available or infalling gas and/or (2) to capture of other stellar systems. In the former case, SF is driven by internal physics, mainly by self-regulation processes in the galaxy disk (e.g., Firmani & Avila-Reese 2000), or is induced by external interactions and mergers – mainly those with high gas content. In the latter case, $M_{\rm s}$ can grow by accretion of small satellites or by major mergers. Even more, the mentioned processes imply feedback effects, like SN-driven outflows and AGN-driven intrahalo gas reheating/ejection effects that inhibit further $M_{\rm s}$ growth. *Which of these channels and their respective feedback effects did dominate in the $M_{\rm s}$ growth of galaxies as a function of their halo masses, types, and environment? How does proceed the stellar and dark mass assembly of galaxies?*

2. DIFFERENT APPROACHES TO GALAXY FORMATION AND EVOLUTION

2.1. *The inductive or 'archaeological' method*

The approaches for studying galaxy formation and evolution have changed over time. In the past, the main approach was the 'archaeological' method: ages and star formation rate histories of our and other local galaxies are reconstructed by means of stellar population synthesis and chemical evolution models from the observed spectro-photometric and chemical properties. The application of this method to modern data and large galaxy surveys have allowed to obtain key constraints to galaxy mass assembly as a function of mass, galaxy type, and environment (e.g., Thomas et al. 2005; Panter et al. 2007; Asari et al. 2007).

2.2. *The deductive or ab initio method*

With the consolidation of the popular Λ Cold Dark Matter (ΛCDM) cosmology in the last twenty years, a powerful theoretical background for galaxy

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