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On the Formation and Evolution of Massive Galaxies

Prof. Jeremiah P. Ostriker

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Jeremiah P. Ostriker has been an influential researcher in one of the most exciting areas of modern science, theoretical astrophysics, with current primary work in the area of cosmology, particularly the aspects that can be approached best by large scale numerical calculations. Ostriker has investigated many areas of research, including the structure and oscillations of rotating stars, the stability of galaxies, the evolution of globular clusters and other star systems, pulsars, X-ray binary stars, the dynamics of clusters of galaxies, gravitational lensing, astrophysical blast waves, active galactic nuclei, the cosmic web, and galaxy formation. Most significantly, Ostriker's research focused on the theories of: Dark Matter and Dark Energy, The Warm-Hot Intergalactic Medium (WHIM), Galaxy Formation and black hole growth, Interaction between Quasars and their surroundings.

Abstract

Looking backwards we have been able to reconstruct from the detailed structure of our own Galaxy and from the fossil evidence derived from the study of nearby galaxies a plausible history of how galaxies formed over the last several billion years. In addition, now that we have a quite definite cosmological model, providing us with a quantitative picture of how perturbations grew from very low amplitude Gaussian fluctuations, we can perform the forward modeling of representative pieces of the universe using standard physical processes to see how well we match our local knowledge and the time-reversed modeling based on the fossil evidence. Finally, we can employ large ground and space based telescopes to use the universe as a time-machine – directly observing the past history of our light-cone. While none of these approaches can give us at the present time results accurate to more than roughly the 5% -> 10% level, a coherent and plausible picture is emerging. Massive galaxies form in two phases. In the first phase, which peaks at redshift $z = 6$ and ends by redshift $z = 2$, cold gas streams in, making stars in a small (<1kpc) region, but as the stellar mass approaches 1011 Msolar, a hot bubble forms which suppresses further inflow of cold gas. But from redshift $z = 3$ to the present time, small stellar satellite systems are accreted at typically 10kpc from the center and the size of the total system grows by about a factor of three as the mass doubles. This added, accreted component is mainly comprised of old and low metallicity stars. Energy release from gravitational infall in various forms will terminate star-formation even in the absence of feedback from SN or MBHs. This physical picture seems naturally to lead to the mass, size, scale and epoch of galaxy formation and, increasingly, to a first understanding of the detailed internal structure of these systems.