BIMODAL STAR FORMATION AND REMNANT-DOMINATED GALACTIC MODELS

Richard B. Larson
Yale Astronomy Department

Current data on the luminosity function of nearby stars allow the possibility that the stellar initial mass function (IMF) is double-peaked and that the star formation rate (SFR) has decreased substantially with time. It is then possible to account for all of the unseen mass in the solar vicinity as stellar remnants. A model for the solar neighborhood has been constructed in which the IMF is bimodal, the SFR is constant for the low-mass mode and strongly decreasing for the high-mass mode, and the mass in remnants is equal to the column density of unseen matter; this model is found to be consistent with all of the available constraints on the evolution and stellar content of the solar neighborhood. In particular, the observed chemical evolution is satisfactorily reproduced without infall. The total SFR in the model decreases roughly with the 1.4 power of the gas content, which is more plausible than the nearly constant SFR required by models with a monotonic IMF.

Similar models can account for the high formation rate of massive stars in the inner disks of our Galaxy and M83 without predicting more mass in low-mass stars than is allowed by the rotation curve. In these regions, the high-mass mode of star formation is more dominant than in the solar neighborhood and stellar remnants account for a large fraction of the mass. Bimodal remnant-dominated models also account better than conventional models for the colors, mass-to-light ratios, and gas contents of spiral galaxies. The colors of the bluest galaxies can be explained without requiring extreme youth or bursts, and the mass-to-light ratio as a function of color can be accounted for with a simple two-population model. Because of the decreased importance of low-mass stars and the increased importance of recycling from massive stars, the time-scale for gas consumption is larger than previously estimated, and is consistent with a simple exponential decay of the gas content. The increase of both metallicity and mass-to-light ratio with mass among giant elliptical galaxies can also be accounted for by a bimodal model if the characteristic mass and the relative amplitude of the high-mass mode both increase with increasing galactic mass.

All of the data are consistent with a picture in which the formation of massive stars is strongly favored in regions where the SFR is high. An extension of such a picture to the earliest stages of star formation in galaxies suggests that rapid formation of large numbers of massive stars took place, and that the dark matter in galactic halos may consist of the remnants of these early generations of massive stars.

J. Kormendy and G. R. Knapp (eds.), Dark Matter in the Universe, 413.