LIMITS ON THE MISSING MASS IN DARK STELLAR REMNANTS

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A set of comprehensive computer models for the chemical evolution of galaxies have been used to determine the limits on the amount of mass that could exist in the form of dark stellar remnants deriving from normal stellar evolutionary processes. In these models, the instantaneous recycling approximation is not assumed: stars are binned into 10 mass intervals, with different lifetimes, yields and remnant masses. The models were run using many different values for the IMF (including non-Salpeter and varying IMFs), star formation rates, yields, remnant masses, gas infall and outflow rates, primordial metalliciy and initial conditions. The Galaxy is described by a two-zone halo-disk system, where gas from the halo falls onto the disk. Elliptical galaxies are described by single-zone models.

The results of the computed models were compared to detailed observational data, using both globular cluster and halo field stars for the halo zone of our Galaxy, and solar neighbourhood stars for the disk. The errors for the parameters were determined by
(a) considering samples with different selection cutoffs, and
(b) calculating the effect of an artificially constructed selection bias.

The most striking feature of the models is the relative insensitivity to the many parameters of the amount of material left as dark stellar remnants. The total amount of dark matter depends sensitively on the observed metallicity of the system, and no amount of fiddling the other parameters can vary that mass by very much. The reason for this is very clear: in order to make a lot of stellar remnants, there must be a lot of cycles of stellar evolution, and this produces a lot of high metallicity gas. Even when the value of the remnant mass is made artificially high (which produces inconsistencies both with stellar evolution theory and with chemical evolution models in the solar neighbourhood) the relationship between metallicity and total dark matter remains strong: metal rich systems have more stellar remnants than metal poor ones because they have undergone more cycles. Thus metal-rich elliptical galaxies are found to have a large amount of dark matter: 10 to 1000 times that of our Galaxy. Metal-poor ellipticals have less: dwarf ellipticals cannot have massive haloes composed of normal dark stellar remnants, regardless of the amount of gas lost by stripping. Similarly, the halo of our Galaxy is found to have a low mass compared to the disk: M(disk)/M(halo) = 10.6. The addition to the models of a dominant population of low mass "Jupiters" does not help the situation, as they increase the hidden mass in both regions without changing the mass ratio significantly.

The total amount of mass in dark stellar remnants in our Galaxy was found to be: halo 27%, disk 36%, Galaxy 35% for the best fit model. Note that the value of 36% for the disk accords well with the estimated amount of dark matter in the solar neighbourhood.

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