INFALL OF GALAXIES INTO THE VIRGO CLUSTER

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There are a subtantial number of galaxies in the Virgo southern extention just beyond the Virgo Cluster which are blueshifted with respect to the cluster and a lesser number of galaxies slightly nearer than the Virgo Cluster which are redshifted with respect to the cluster. These galaxies must be falling into the cluster. We are able to model the observed infall motions by following the collapse of spherical shells with the Friedmann equations in a closed universe. A family of mass-age solutions provide satisfactory fits to the observations.

There are two other constraints which confine our models. (a) From a virial analysis there is an independent estimate of the mass of the Virgo Cluster. If the universe is 12-30 Gyr old then there is good agreement between the mass known to exist in the central cluster and the mass required by the infall model. (b) We must also explain the observed motion of our Galaxy with respect to the Virgo Cluster. If the age of the universe is 10-14 Gyr then the mass required to explain the infall of galaxies near to Virgo is sufficient to explain our observed motion. There is an implication in this case that the ratio of mass to light must decrease outside the Virgo Cluster because no additional mass is needed at large distances, at radii where 80% of the light of the supercluster is found. If the age of the universe is less than 10 Gyr then mass is needed outside the galaxies near Virgo to explain our motion. In this case, the mass-to-light ratio need not decrease outside the Virgo Cluster. If the age of the universe is greater than 14 Gyr then there is already too much mass given by our infall fits to the near Virgo data to explain the motion of our Galaxy. A possible solution is to invoke the existence of a repulsive force such as would be implied if the cosmological constant is positive.

We conclude that either (a) the universe is younger than 10 Gyr, or (b) the ratio of mass-to-light drops dramatically outside of the Virgo Cluster, or (c) the cosmological constant is greater than zero.

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There is independent evidence from the ages of globular clusters and nuclear cosmochronology against the first possibility.

The infall models permit us to calculate the present rate of galaxy accretion in the Virgo Cluster. Using distance estimators, each infalling galaxy can be located in space and its moment of arrival in the cluster can be determined. It is found that there will be a dramatic influx over the next 3 Gyr. The rate over the near future is sufficiently high that it is very plausible to suppose that all spiral and irregular galaxies now in the cluster have arrived in significantly less than a Hubble time. By contrast, the present influx of ellipticals and lenticulars is insignificant compared with the number of these types already in the cluster. Either infalling spirals are being converted into ellipticals and lenticulars or the cluster was once more extremely segregated by type than it is today. In accordance with this second possibility, we have developed a schema of galaxy formation which anticipates that first generation cluster members would be deficient in angular momentum content compared with field galaxies.

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