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TITLE HALOS AROUND ELLIPTICALS AND THE ENVIRONMENT
DEPENDENCE OF HUBBLE TYPE.

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Halos Around Ellipticals and the Environment Dependence of Hubble Type.

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I. Shells and Halos.

Shells are often observed around elliptical galaxies (Malin and Carter 1983). Stars in the shells can be regarded as test particles. Therefore for a simple shell morphology (Hernquist and Quinn 1985) the distances between shells allow one to trace the shape of the potential of the host galaxy (Quinn 1984). One can also deduce the distribution of gravitating material. Following this method we estimate that the shell elliptical NGC 3923 has a halo that terminates at $\sim 5r_e$ (15 kpc.). The ratio of dark to luminous matter inferred from the shells is ~ 10 . Similar halo parameters can be determined for NGC 1344 and, with much less confidence, for NGC 3051 (Figure 1).

The sample of elliptical galaxies for which shells provide sufficient information about their halos is at present limited. However, unless the halos of these ellipticals are very unusual, we can deduce that :

A typical elliptical has a halo which is far more compact (smaller by a factor of no less than two and considerably denser) when compared with a spiral of similar luminosity.

If we accept this correlation between halo parameters and Hubble type as given, we can; (1) Enquire about the origin of this relation and; (2) Attempt to use it to explain other observational facts.

11. Elliptical halos: Why are they compact ?

In the remainder of this note we accept the idea that galaxies have formed from primordial fluctuations through collapse. This leads one to expect that the baryonic mass of a galaxy (presumably related to its luminosity) is roughly proportional to the amount of dark material in its

Fig.1. The distribution of shell locations as a function of the number of a shell for three galaxies. The outermost shells (small n) are consistent with the Keplerian potential. The change in this behavior occurs near $5r_e$.

halo, since the baryonic and non-baryonic components of the initial fluctuation have—presumably—collapsed together. Therefore, it is not surprising that the baryonic material inside the more compact halos will tend to form a more compact, luminous elliptical. What needs to be explained is the difference in the value of the spin parameter (λ). It might be tempting to speculate that more compact, dense halos have systematically smaller values of λ . Such an effect is predicted by linear calculations (Hoffman 1985). Our simulations show that it may exist (Fig.2) but it appears to be too small compared to the random scatter of the values of λ and ρ to be decisive. It is more likely that the baryonic material has initially similar λ both in the future spirals and ellipticals; but compact halos damp out the λ of the dissipative, baryonic material more readily.

III. The environment dependence of Hubble Type

Given that for galaxies of comparable mass, elliptical halos are more compact than spiral halos, one can understand the increase in the relative fraction of elliptical galaxies in those regions of the universe which have an overall higher galaxy density. To this end let us consider two galactic size perturbations. Suppose that their relative overdensities with respect to their neighborhoods is the same, δ . Assume that one of the two perturbations exists in a region which is also overdense on a larger scale by a relative factor Δ . (Such a region may eventually collapse to form an Abell cluster). Suppose that the other perturbation is inside a region underdense by the same factor of Δ . In spite of the fact that the two perturbations have locally similar sizes, their future fate will differ: the relative overdensity of one of them is $\delta^+ = \delta + \Delta$, while the other has an overdensity $\delta^- = \delta - \Delta$. If we now assume that the perturbations are approximately spherical so that the spherical collapse approximation (Peebles 1980) applies, then in an $\Omega=1$ universe the densities of the objects they will form after collapse will be substantially different:

$$\frac{\delta^+}{\delta^-} \propto \left(\frac{\delta + \Delta}{\delta - \Delta} \right)^3$$

This strongly suggests that the relative abundance of compact halos will be significantly higher in those regions which are also overdense on a large scale. A more detailed, quantitative discussion of this effect will be given elsewhere (Zurek and Quinn 1985 in preparation).

Fig.2 : The spin parameter λ as a function of the average halo density after collapse ρ . While there is an indication that λ decreases with increasing ρ , such systematic changes in λ are smaller than its random scatter. These results are from Quinn, Salmon and Zurek 1985 (in preparation).

Hernquist, L. and Quinn, P.J. 1985 in preparation

Hoffman, Y. 1985 Ap.J. in press

Malin, D.F. and Carter, D. 1983 Nature 285 643.

Peebles, P.J.E. 1980 The Large Scale Structure of the Universe, Princeton

Quinn, P.J. 1984 Ap.J. 279 596.

Zurek, W.H. and Quinn, P.J. 1985 in preparation.