lence (~ 8 km s^{-1}). It is entirely comparable to a normal H II region. Gentle stellar winds appear as the most likely explanation.

Full correlations between the various physical quantities extracted so far will still need a few months, but the trend is already clear: Filamentary structures, large turbulence and/or large expansion velocities, and high intensity sulfur lines are usually connected, a result that can be seen as blithely encouraging or sorrowly banal, depending on one's mood.

Some abnormal cases yet could happen: N 120—a 20 pc bubble—shows no expansion, a medium [S II]/Hα ratio and turbulence (~ 20 km s^{-1} r.m.s.) and is clearly a young supernova remnant from radio data. N 48 E has the largest [S II]/Hα ratios in our sample (> 1) and is absent from catalogues of non-thermal radio sources.

Conclusion

Through the detailed two-dimensional data—both kinematical and physical—obtained in the course of our study, as well as from the work of other groups, a better picture of the processes at work is slowly emerging. There are some difficult points which, however, cast a gloom over the picture: The origin of the bubbles (SN explosions (Hodge 1967, *P.A.S.P.* **79**, 29), supersonic stellar winds (Gardis and Meaburn 1978, *Astron. Astrophys.* **68**, 189), or even collision with an extragalactic H I cloud (Tenorio Tagle 1979, ESO preprint No. 74)) is quite difficult to assess in each case. Moreover, the range of sizes goes from 20 pc diameter (N 100) to 110 pc (N 70), physical properties and diameters being not related. Some of the largest bubbles after analysis appear just heterogeneous projected structures. Especially lacking is a comprehensive survey with high angular resolution in radio wavelengths to reveal the thermal or non-thermal nature of the objects.

The edge of the bubbles, where, because of its expansion, fresh interstellar matter is being presently compressed, appears as a likely site for generation of new stars and could—according to the so-called "contagion hypothesis" —explain the large-scale chaotic appearance of spiral arms in galaxies. Star formation however appears too erratic in the Magellanic Clouds, and we must turn to more distant, but more regular spirals.

Large-Scale Structure of the Universe

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One of the major tasks of astronomy is to find how matter is arranged and distributed in our Universe. On the largest scale it has usually been assumed by cosmologists and by the majority of astronomers that matter is spread uniformly throughout the Universe. This picture is changing and astronomers are recognizing, by focussing more and more on the study of the distribution of visible matter, that the distribution of galaxies is very clumpy on a small scale (pairs and groups) as well as on a much larger scale (superclusters or filamentary structures). It is not clear, in fact, whether any isolated structure exists.

We can preserve homogeneity, but only on a much larger scale than was previously recognized. An observer located in a different part of the Universe could not distinguish one location from the other over scales larger than 50–100 Mpc. The main characteristics would remain the same. For an excellent review and discussion on this matter see Chapter 1 of "The Large-Scale Structure of the Universe", by Peebles (1980).

Evidence that the surface distribution of matter is clumpy has been collected, even if somewhat disregarded until recently, since long ago. I refer to the catalogue by Messier of 1784, to the surveys by the Herschels in the 18th and 19th centuries, to the work by Shapley and Ames (1932, *Harvard Obs. Ann.* **88**, No. 2) and to the later work by Shapley on the distribution of galaxies. Four more recent surveys are of particular importance: The survey of clusters of galaxies by Abell (1958, *Astrophys. J. Suppl.* **3**, 211), the catalogue of galaxies and clusters of galaxies by Zwicky and coll. (1967), the counts of galaxies by Shane and Wirtanen (1967, *Pub. Lick Obs.* **22**, part 1) and the counts in the Jagellonian field by Rudnicki *et al.* (1973, *Acta Cosmologica* **1**, 7). The distribution of galaxies is clumpy also in depth. The first evidence came during the observations of a non-cluster field near the Seyfert sextet located north of the Hercules cluster A 2151 (Chincarini and Martins, 1975, *Astrophys. J.* **196**, 335). However, this evidence was based on a sample of ten galaxies only. The first confirmation of this result was obtained by Tifft and Gregory (1976, *Astrophys. J.* **205**, 696) from the study of a larger sample.

During the seventies two lines of studies developed independently. On the one hand, various astronomers intensified studies on the detailed three-dimensional distribution of galaxies in large regions of the sky; on the other hand, thanks especially to Peebles (1974, *Astrophys. J.* Letters **189**, L51), a sophisticated autocorrelation analysis was developed and extensively applied to the interpretation of counts of galaxies[1]. Previously Totsuji and Kihara (1969, *Publ. Astron. Soc. Japan* **21**, 221) had derived, using an autocorrelation analysis and the catalogue by Shane and Wirtanen, the same coefficients for the autocorrelation function: $g(r) = (r_\odot/r)^{1.8}$ with a characteristic length $r_\odot = 4.7$ Mpc. Their work went unnoticed for some time.

Ideally we should have a catalogue, or a random subsample of it, complete to a reasonably faint magnitude giving redshifts (possibly accurate to better than 50 km/sec), magnitudes, morphological types and positions. Such a work has been undertaken by Davis from the Center for Astrophysics in Cambridge, Mass.

It appears, today, that galaxies are not distributed at random and that clusters of galaxies are not isolated systems. The distribution of pairs of various separation is described by the autocorrelation function. The function is a measure of the deviation from a random distribution. It also measures the characteristic size of clumpiness and allows confrontation of theories on the clustering of galaxies with observations. Studies on selected regions of the sky show the existence of very asymmetric, often filamentary-like structures, separated by regions which are void of galaxies.

Oort, Arp and de Ruiter (1981, *Astron. Astrophys.* **95**, 7) give evidence that quasars are part of superclusters and Burns and

[1] Peebles' understanding of the cosmological significance of the analysis of the data became a guide to theoretical and observational work and to its physical interpretation.

Owen (1979, *Astron. J.* **84**, 1478) show that such large structures can also be recognized from the distribution of radio sources. (In Figure 1 is a reproduction of the largest one recognized so far and connecting the Hercules complex to the group of clusters A2197–A2199.)

Our Galaxy is part of such a structure: the Local Supercluster. The Local Supercluster was recognized by the work of Shapley and Ames (1932), extensively studied by de Vaucouleurs (1956, *Vistas in Astronomy* **2**, 1584) and most recently by Yahil, Sandage and Tammann (1980, *Astrophys. J.* **242**, 448), after completion of the observations of the galaxies of the Shapley-Ames catalogue. This structure may be tenuously connected to others, it is dominated by the Virgo cluster of galaxies towards which we may be falling (Aaranson *et al.* 1979, *Astrophys. J.* **239**, 12).

Following the IAU symposium in Tallin (1978), theoretical and observational works are flourishing and our understanding deepening and progressing very fast. It is exciting because it makes us sense the satisfaction of mapping an as yet unknown world, but what are the goals? Knowledge on how the distribution of visible matter is structured at the present cosmological time will essentially ask for theories which are able to explain how and when such structures and voids (density fluctuations) were formed in an expanding Universe. Observations have therefore to define clearly the basic parameters of the distribution of visible matter. The irregular distribution of matter, furthermore, causes gravitational pulls at large distances so that by studying the statistical distribution of gravitational forces and masses we may be able to detect and understand peculiar motions of galaxies and measure the mean mass density of the Universe. We already have estimates of this parameter, the problem is that in this case, and at this phase of the game, we have too many determinations so that almost any value between 0.01 and 1 has been derived. Certainly the understanding of the large-scale structure will also give insights in the processes of galaxy and cluster formation.

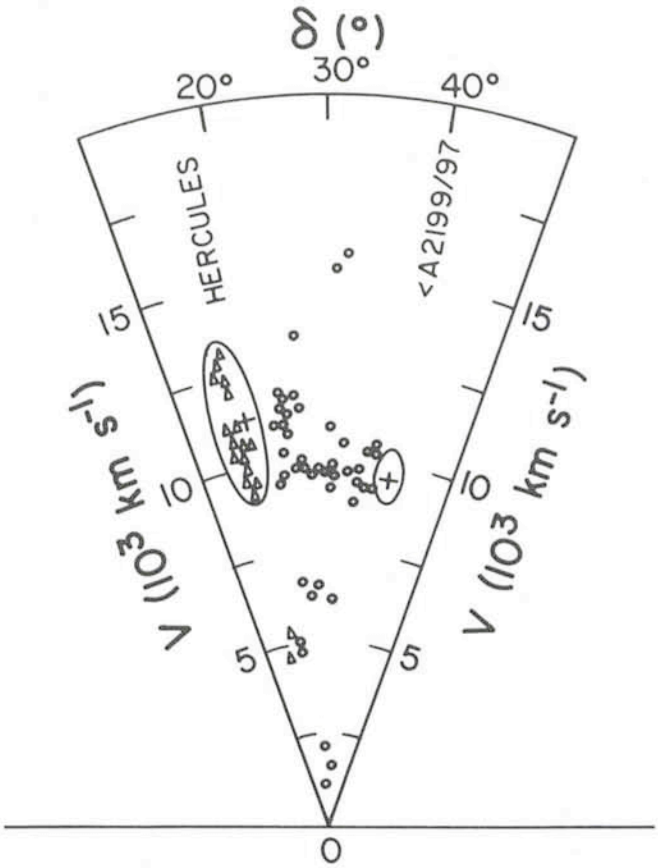

Fig. 1: *Redshift vs. declination for a subsample of galaxies between the two clusters A 2197/99 and A 2151. The two groups of Abell clusters are represented by large oval outlines (From* Astrophys. J. Letters.*)*

In 1977, after we read the work of Shapley, "A catalogue of 7,889 external galaxies in Horologium and surrounding regions", M. Tarenghi and myself became interested in the study of this region of the southern sky. Together with P. Crane, J. Materne and Hélène Sol we are now working on it.

The Horologium region appears to be extremely complex. As pointed out by Peebles, some of the irregularities in the distribution are certainly introduced by vignetting at the edge of the photographic field, the majority of the structures are, however, real. Groups and clusters are packed together and embedded, probably, in a supercluster dispersed component expanding with the Hubble flow. Cluster-cluster interaction and cluster accretion may be at work so that it may become a serious problem to disentangle, and correctly interpret, the redshifts. On the other hand such complicated regions are rich in information and need also to be accounted for from theoretical models.

We selected from Shapley's catalogue a random sample of about 300 galaxies for which we obtained redshifts using the observing facilities of La Silla (ESO) and Cerro Tololo (I.A.O). In addition we observed all the galaxies brighter than m = 15.0 and Manousoyannaki and H. Sol obtained at La Silla (ESO) B and V photoelectric magnitudes for more than 100 galaxies. The majority of redshifts are in the range between 7,000 km/sec and 22,000 km/sec with groupings at about 8,000 km/sec, 11,000 km/sec and 17,000 km/sec. The cluster CA 0340–538, part of one of the observed superclusters, is at a distance of 17,400 km/sec; it is also an extended source of X-ray emission.

From the observations of simpler structures, Perseus-Pisces and Coma-A1367 (these seem to look like filaments almost perpendicular to the line of sight) it is possible to estimate that these superclusters are about 500 km/sec in depth, 50–100 Mpc in the other dimension (since these structures may be interconnected such estimates may be of limited significance), have a column density of about 10^{-4} gr/cm^2 and a mass (for the part of the supercluster which has been observed) of about 10^{16} solar masses. The dispersed component is not very massive and its mass is of the order of magnitude of the mass of a cluster of galaxies (Chincarini 1981, preprint). By interpreting the Lyα absorption in quasars as originating in a supercluster gaseous component left over during the process of galaxy formation, Oort (1981, *Astron. Astrophys.* **94**, 359) estimates a gas column density of about 6.8 10^{-4} gr/cm^2.

Further information will be added from the 21-cm survey that Giovanelli, Haynes and the author have been carrying out at the Arecibo Observatory since 1977.

These data will make possible the determination of the hydrogen and total masses of the supercluster galaxies. It is possible, therefore, not only to measure the hydrogen deficiency as a function of the location of galaxies in a supercluster (Giovanelli, Chincarini, Haynes, 1981, *Astrophys. J.* in press), but to determine the distribution of galaxy masses in the supercluster and whether the masses of the single galaxies are correlated with the density of the supercluster. We are progressing very fast towards the understanding of the distribution of visible matter in the Universe; even faster progressing are the theory and the understanding of the evolution of these structures thanks to the work of Peebles, Gott, Zeldovich, Doroskhevic, Novikov and many others. All these new developments, data and interests are bound to generate in the coming years a deeper enlightening understanding.