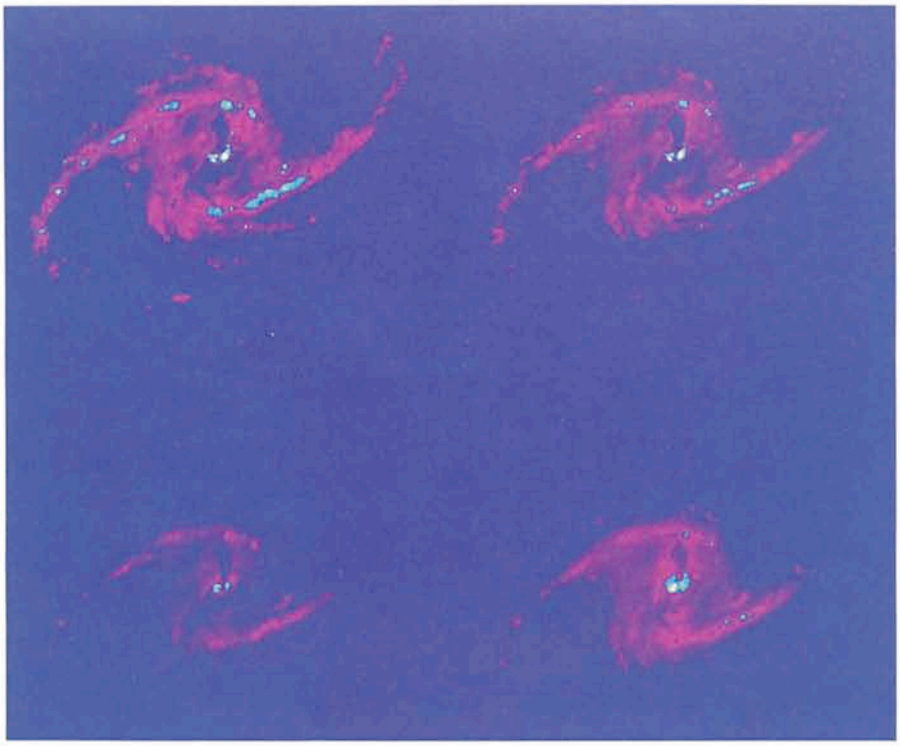

Figure 3: *Same galaxy and colours as Figures 1 and 2 but at z = 1.*

methods and show to which extent the information content of the image can be recovered.

Figure 6 gives the resulting B image after a 5,000-s integration. On this image, only the brightest features can still be distinguished. This shows the great difficulty to obtain colour information using U and B filters for extended objects with the WFC. In this wavelength domain, the faint object camera is expected to be more sensitive. Its smaller field of view will however reduce the sample of objects available in random fields.

We thank P. Vettolani for providing us with one of his simulations of the location, redshift and magnitudes of a random field of galaxies.

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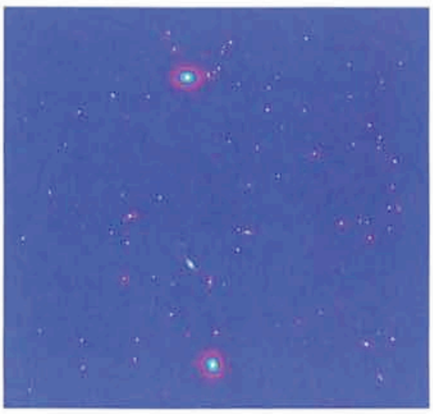

Figure 4: *Simulated field of galaxies 3′ × 3′. The galaxy distribution is a 3-D random distribution without clustering.*

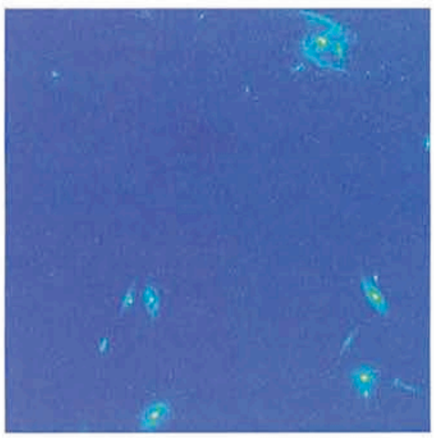

Figure 5: *Simulated "observation" of the 51″.2 × 51″.2 lower left part of Figure 4 with the WFC of HST. The image is in a wide band filter approximating the V band, the exposure time of 2,500 s.*

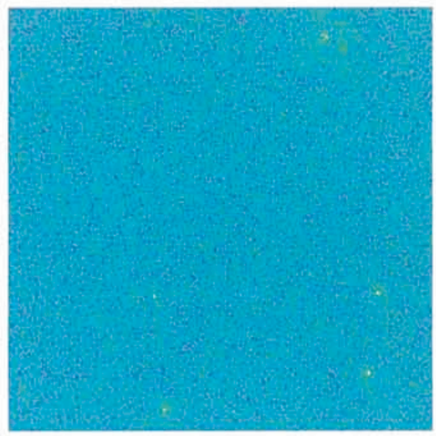

Figure 6: *Same as Figure 5 but through a filter approximating the blue band and with an exposure time of 5,000 s.*

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(March–May 1988)

573. F. Matteucci and G. Vettolani: Chemical Abundances in Galaxy Clusters: a Theoretical Approach. *Astronomy and Astrophysics.*
574. A. Iovino, J. Melnick and P. Shaver: The Clustering of H II Galaxies. *Astrophysical Journal,* Letters.
575. H.-M. Adorf and E.J.A. Meurs: Supervised and Unsupervised Classification – The Case of IRAS Point Sources. F. Murtagh: Multivariate Analysis Methods: Background and Example. Papers presented at the Bad Honnef meeting on "Large Scale Structures in the Universe – Observational and Analytical Methods". December 1987. In press, Springer-Verlag.
576. G. Meylan: On the Individual Masses of Globular Clusters in the Magellanic Clouds: NGC 1835. *The Astrophysical Journal.*
577. F. Verbunt and G. Meylan: Mass Seggregation and Formation of X-ray Clusters. *Astronomy and Astrophysics.*
578. R. Arsenault and S. D'Odorico: Medium Resolution Spectroscopy of the Supernova 1986 O in the Spiral Galaxy NGC 2227. *Astronomy and Astrophysics.*
579. M. Pierre, P.A. Shaver and A. Iovino: Void Structure in the Lyman alpha Forest. *Astronomy and Astrophysics,* Letter.
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583. G. Contopoulos: Critical Cases of 3-Dimensional Systems. *Celestial Mechanics.*

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589. Bo Reipurth: Herbig-Haro Objects in Flows from Young Stars in Orion. *Astronomy and Astrophysics.*
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591. C. Gouiffes et al.: Light Echoes from SN 1987A. *Astronomy and Astrophysics.*

Large Scale Deviations from the Hubble Flow

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Introduction

All standard Big Bang cosmologies have one thing in common. The initial state from which the Universe has developed, was homogeneous and isotropic to a "very high degree". Indeed we now observe that the distribution of galaxies is very homogeneous and isotropic when smoothed over a suitable large area of the sky. Also we observe that galaxies recede from one another in a universal manner described by the Hubble law, and this law is considered as valid on sufficiently "large scales". There is additional observational evidence in the "very high degree" of isotropy of the microwave background radition, neglecting the very well understood dipole anisotropy for the moment.

As the observational techniques have improved tremendously in recent years, the time has also come for the observers to quantify statements like "large scales" and "very high degree". It seems that the determination of the values of these poorly determined quantities finally are approaching the situation, where it is no longer the equipment of the observer but rather the adopted analysis of the observations, which is the crucial factor.

Such quantities have turned out to be some of the most desired physical parameters for tests of cosmological models, and we are now very close to getting important insights into cosmological phenomena. As the accuracy of observationally determined parameters increases, the number of models which can match them all decreases. The gain is therefore twofold. We can increase our knowledge of the present Universe and at the same time reduce the number of theories which claim to describe the evolution of it. The big trouble of course is that human beings can invent new theories all the time, so in reality it is only the former of these two statements which is true.

Previous Work

Almost since the discovery of the microwave background radiation, a dipole anisotropy has been noticed. It can be rather precisely accounted for if the Sun moves at 377 ± 14 km s^{-1} towards (l, b) = (267°, 50°) (Fixen et al. 1983), where (l, b) are galactic coordinates. With the standard de Vaucouleurs convention for the motion of the Sun relative to the Local Group, this means that the Local Group moves at 614 ± 14 km s^{-1} towards (l, b) = (269°, 28°).

In 1976 Rubin and Ford (Rubin et al. 1976) measured the velocity of the Local Group with respect to Sc I galaxies in the redshift range from ≈0.01 to ≈0.02, corresponding to 3,000 – 6,000 km s^{-1} in the Hubble flow. They considered these galaxies to be standard candles and found a significant motion of the Local Group of 454 ± 125 km s^{-1} towards (l, b) = (163°, −11°). This implied a motion of the frame defined by the Sc I galaxies relative to the microwave background of 862 ± 125 km s^{-1}. Ten years later, Aaronson et al. (1986) found no evidence for any net motion with respect to the microwave background for a sample of cluster spirals in the ring of sky accessible to the large Arecibo radio telescope. Their analysis was based on distances estimated from the infrared Tully Fisher relation. A programme designed to estimate distances to a sample of elliptical galaxies performed by a group of seven collaborators (Lynden-Bell et al. 1988) has changed the game somewhat. This group has demonstrated that the situation is much too complicated to be described by a simple motion of our Local Group towards a system of galaxies as defined above. They have shown that a model in which the bulk flow of galaxies is replaced by the flow generated by a mass concentration centred on (l, b) = (307°, 9°) at a distance corresponding to 4,350 km s^{-1} in the Hubble flow, now baptized "the great attractor", gives a much better understanding of the situation.

Determining Distances to Spiral Galaxies

The original Tully Fisher relation is a correlation between total B magnitude corrected to face-on and the 21 cm linewidth corrected to edge-on. In order to minimize the uncertainties in deprojecting the linewidth, one has to stick to highly inclined galaxies. This on the other hand increases the uncertainties in the estimated total B magnitudes. When the photometry is done in the infrared (H band at 1.6 μm), this problem is expected to be reduced considerably. There is however one disadvantage in using H band photometry. H magnitudes are measured within a standard aperture A, which is determined by the condition that $\log A/D_0 = -0.5$, where D_0 is the isophotal diameter at 25 B mag $arcsec^{-2}$ for the galaxy seen face-on. This choice of aperture has been made primarily because of historical lack of a suitable devise to make detailed surface photometry of galaxies in the near infrared. A nice demonstration of the somewhat complicated situation can be found on one of the figures in Giraud (1987).

The combination of the optical and infrared Tully Fisher relations has suggested another distance indicator. This is an infrared colour-magnitude (C-M) relation which is based upon an observed correlation between $(B\text{-}H)_{-0.5}$ colour and $H_{-0.5}$ magnitude (Wyse 1982), where the subscript$_{-0.5}$ refers to the standard aperture described above. This relation has the advantage over the Tully Fisher relation that galaxies, which are seen face-on, can be used and thereby reduce the uncertain correction procedures for deprojecting inclined galaxies to face-on. However small