

INTRODUCTION

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As we approach the 21st Century, enormous technical advances are being made in the acquisition of galaxy redshifts. This Joint Discussion offers a perspective on those advances and the associated redshift surveys. It is representative, but by no means all inclusive.

My introduction offers some historical background, against which the new methods and achievements can be measured.

Redshift surveys tell us about the spatial distribution and evolution of galaxies. Yet the study of large-scale structures in the distribution of galaxies goes back further than one might imagine. The first accurate description of the Virgo Supercluster was given by John Herschel in the mid-19th Century. To paraphrase Sir John, "Virgo is the central condensation of a roughly spherical cluster of nebulae – our system lies outside the denser part of the cluster, but is involved with its outlying members – forming an element of some one of its protuberances or branches".

Victorian science might have beaten Hubble had more people believed John Herschel – and had he himself more confidence in his interpretation. Few were prepared to accept the 'Island Universe' theory that it implied, and strong criticism followed. Moreover, Herschel was very reluctant to go against the beliefs of his revered father, William Herschel, who, though once believing in the 'Island Universes', had in later life accepted that all nebulae were somehow gaseous condensations in our system. Consequently, even John Herschel's textbook still stated the older, incorrect interpretation.

Richard Proctor, a popularizer of astronomy, was one of those critics of Herschel's, Virgo 'Supercluster'. Yet Proctor also produced plots of Herschel's nebulae over the sky. One of these is quite remarkable; in the Centaurus region, the galaxies are clearly seen to form long filaments surrounding empty voids – much as we have seen in modern days 'redshift slices'. The fabric of the Universe, on its largest scale, had been revealed – long before the first redshift had been obtained. John Herschel had seen it too, and had made the correct guess as to the geometry of the Virgo Supercluster – but the general criticism of the 'Island Universe' theory and his deep respect for his father – kept it for science to rediscover a hundred years later.

The very first galaxy 'redshift' (actually a slight blueshift) was obtained early this century – Vesto Slipher extracted a radial velocity for the Great Nebula in Andromeda in 1913. Yet the observation was made on the basis that spiral nebulae might be solar systems in formation. Slipher worked for Percival Lowell and carried out instructions; Lowell's obsession with Mars had let him to consider looking for other solar systems. Yet Slipher was to persevere, obtaining redshifts of other galaxies – even though some of the exposures took nights to accumulate sufficient signal. By 1914, he presented some 15 redshifts to a meeting of the American Astronomical Association, for which he received a standing ovation. As we know, his early redshifts were later to be interpreted by Hubble as the linear recession of galaxies.

Many redshift pioneers followed. I would particularly like us to remember Fritz Zwicky (for whom I worked as a graduate student) who was the first to obtain redshifts of a cluster of galaxies – the Coma Cluster – and consequently the first to call attention to the presence of 'dark matter'. Also Gerard de Vaucouleurs who from 1953 championed the existence of the Local supercluster – the rediscovery of Herschel's great concentration.

Improved technology greatly speeded up redshift production. The remarkable labyrinth of large-scale structures was revealed as we saw the distribution of galaxies in the three dimensions of redshift space. The early plots of Joeveer and Einasto were confirmed by the statistically controlled redshift surveys of the Center for Astrophysics. The rest is well known. Whereas at the start of the century, a single redshift took many nights of exposure, we now have the prospect of state-of-the-art

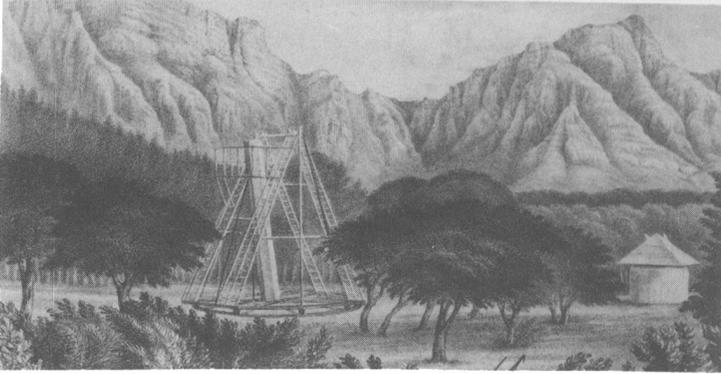


Figure 1. Sir John Herschel's telescope was located at the Cape of Good Hope during 1834-38, thereby enabling him to complete the global survey of nebulae that led to the 'New General Catalogue'

instruments that will gather more than a thousand a night as the new century begins.

References

- Proctor, R., 'The Universe of Stars', *Longmans, Green and Co.*, 1878.
Smith, R., 'The Expanding Universe', *Cambridge University Press*, 1982.