1.3.5 Quasar Redshifts

The first few quasars discovered had redshifts that were comparable to those of the most distant known clusters of galaxies. As more and more quasars were discovered with the refinement of techniques for isolating them (see the next section and Chapter 10), the maximum measured redshifts continued to increase dramatically. By the mid-1970s, several quasars with $z \gtrsim 3$ had been found. The distributions of known quasar redshifts and apparent magnitudes as of 1993 are shown in Figs. 1.7 and 1.8, respectively. Aside from interest in how these sources produce such copious radiation over a broad spectral range, it was also recognized that quasars provide a possibly unique probe of the early Universe – the light that we are now detecting from the most distant known quasars was emitted by them when the Universe was only a small fraction of its current age, and has been in transit since. Quasars are still the only discrete objects that can be observed with relative ease at $z \gtrsim 1$, and thus they are a potentially important cosmological probe. However, in the context of cosmological studies, quasars must be used judiciously. For example, early attempts at producing a Hubble diagram for quasars (as in Fig. 1.9) were not very enlightening because the

Source: Peterson, B.M. (1977) An Introduction to Active Galactiv Nuclei, Cambridge University Press.

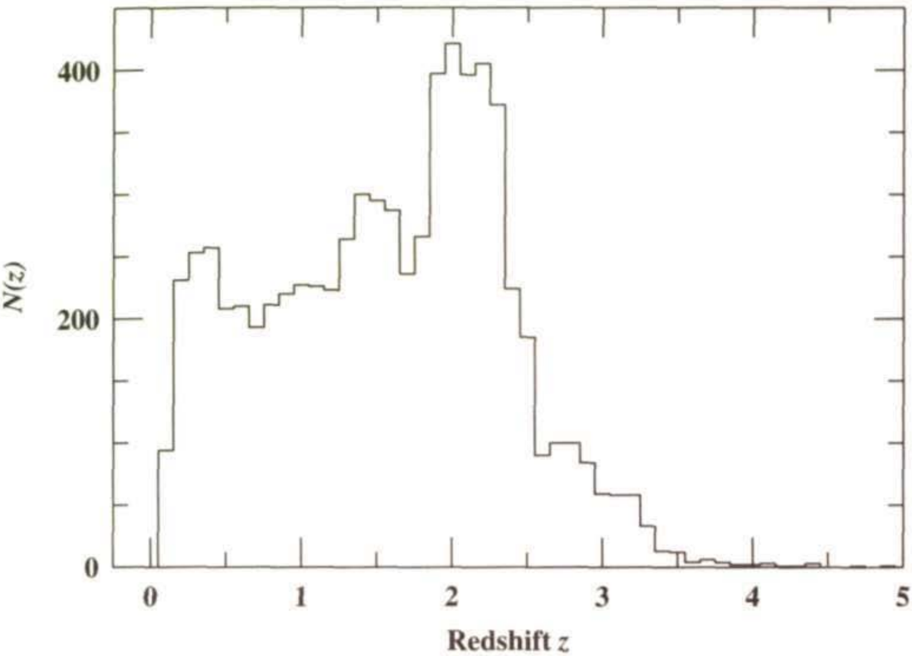

Fig. 1.7. The redshift distribution of 7236 quasars in the Hewitt and Burbidge (1993) catalog.

luminosity function for quasars is very broad, and evolves with time (there are more luminous quasars at high redshift; Chapter 11). An important early finding was that the number of quasars per unit volume reaches a maximum somewhere around $z \approx 2$, even after correction for the Lyα selection effect mentioned in §1.3.4; at earlier epochs (i.e., higher redshifts), they are comparatively rare. Detection of very high-redshift quasars remains of great interest because their existence provides an important constraint on the formation of large structures in the early Universe as well as on the formation of heavy elements, which are clearly seen in the spectra of all quasars.

By the late 1960s, it was also apparent from high-resolution, high signal-to-noise ratio spectra that quasars often have absorption lines in addition to the strong emission features (Chapter 12). The absorption lines are generally much narrower than the emission lines, and are usually detected at redshift *lower* than the emission-line redshift of the quasar itself. These absorption features are thought for the most part to arise in material unassociated with the quasars which lies at lower cosmological redshifts. Thus, quasars also provide an important probe as luminous background sources against which otherwise possibly undetectable structures can be observed.

Source: Peterson, B.M. (1977) An Introduction to Active Galactiv Nuclei, Cambridge University Press.

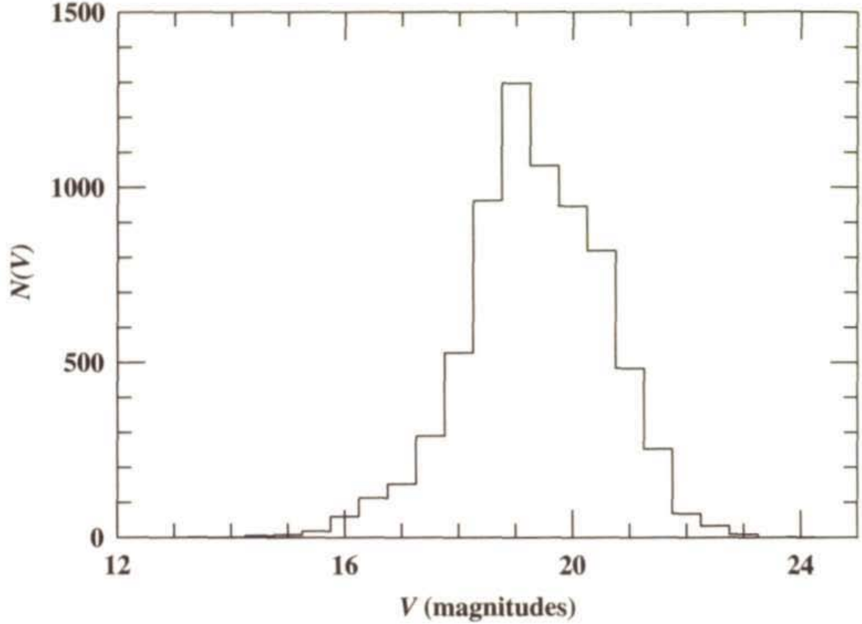

Fig. 1.8. The distribution in apparent *V* magnitude of 7110 quasars in the Hewitt and Burbidge (1993) catalog.

Source: Peterson, B.M. (1977) An Introduction to Active Galactiv Nuclei, Cambridge University Press.