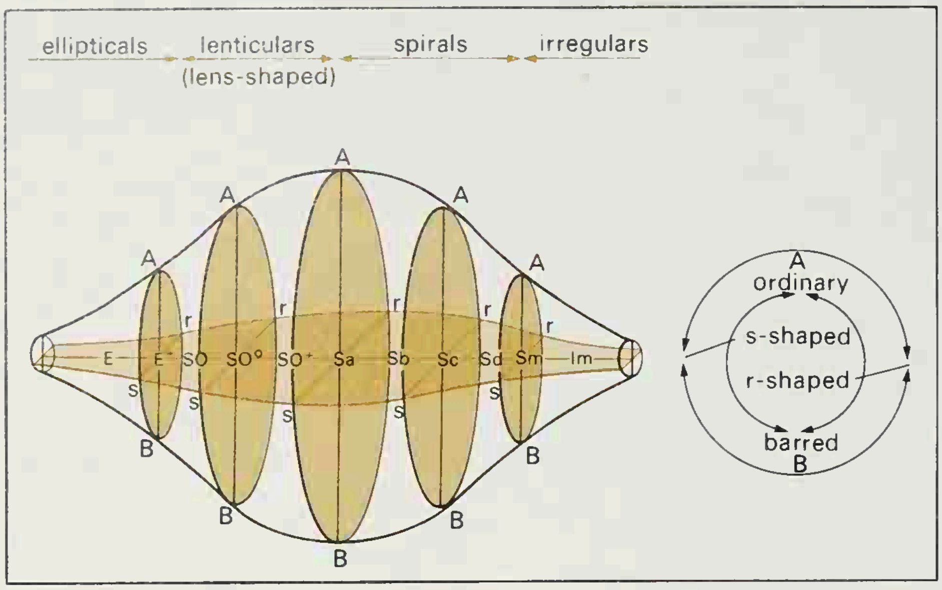


Fig. 7·2
Above: *A three-dimensional representation of de Vaucouleurs' classification scheme.*

The redshift

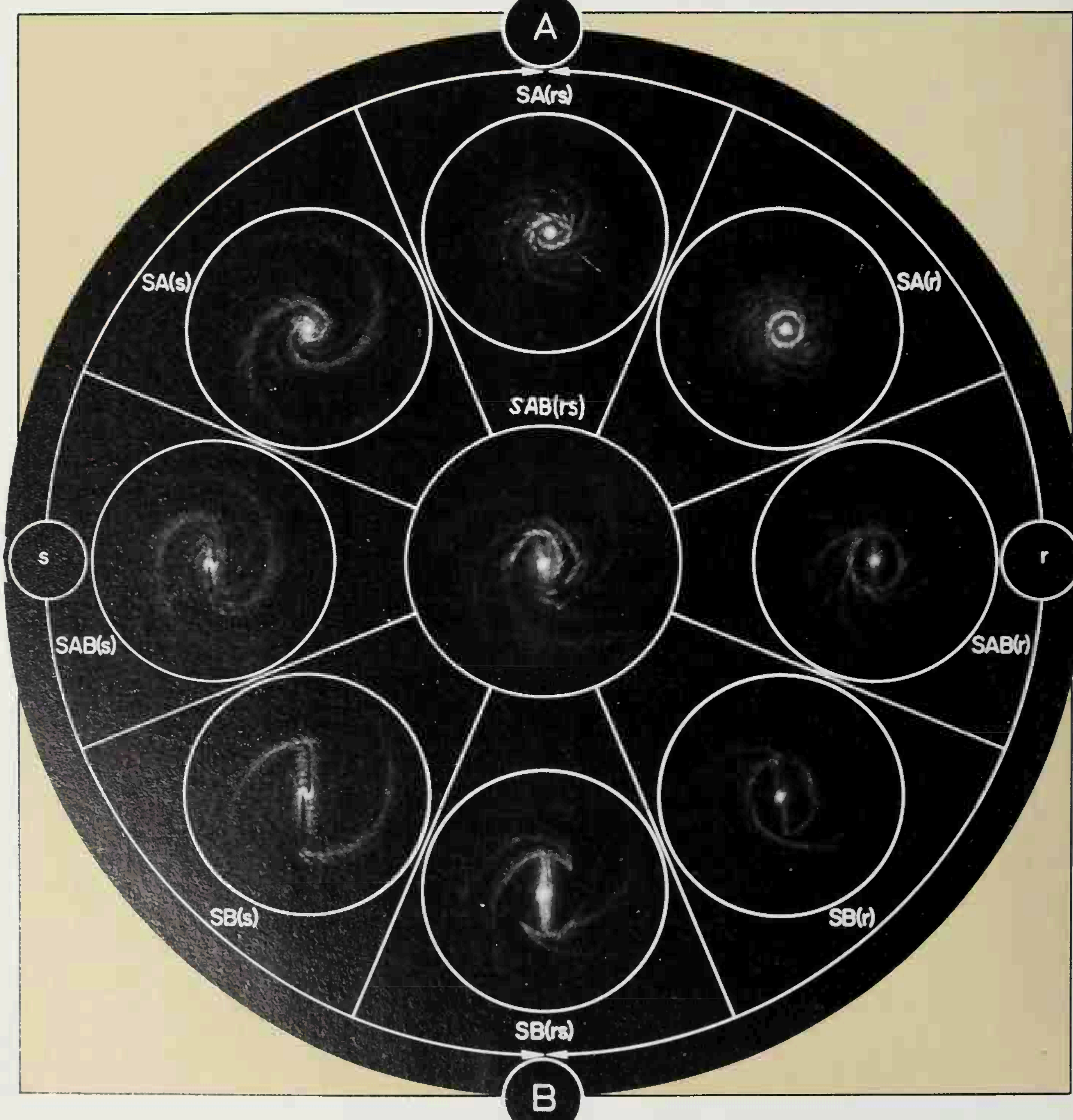
It is found that for all galaxies, apart from a few of the very nearest ones, the spectral lines are shifted to longer wavelength; for optical lines, this means a shift towards the red. The more distant galaxies have larger redshifts, and the exact relationship between redshift (z) and distance – **Hubble's law** – was established by Hubble in 1929. It states that the redshift of an extragalactic object is equal to its distance multiplied by a constant. Mathematically it can be written in the form

$$cz = H_0 D$$

where c is the velocity of light and d is the distance corresponding to redshift z. The constant, H_0, is now called Hubble's constant. (If λ_0 is the wavelength at the source and λ the wavelength observed, $z = (\lambda - \lambda_0)/\lambda_0$. The value of z is the same for all lines in the spectrum.)

The implications of the redshift, z, are discussed fully in Chapter 8, but for the moment it suffices to note that if the redshift is a Doppler shift caused by motion away from us, it is evidence for the expansion of the universe.

The rate of expansion may have changed as the universe has evolved; H_0 is the value at the present epoch, corresponding to all but a very few of the



Below right: *A cross-section through the above figure, near the region of the Sb spirals, showing transition cases between the ordinary (SA) and barred (SB) spirals and between those with (r) and without (s) inner rings.*

Fig. 7·4 Opposite page, bottom: *The range of distance over which various extragalactic distance indicators can be used. The step-by-step nature of distance determination is clearly seen.*