A NEW METHOD FOR EVALUATING THE HUBBLE CONSTANT

Vera C. Rubin and Norbert Thonnard
Department of Terrestrial Magnetism
Carnegie Institution of Washington

We have devised a procedure for evaluating the absolute magnitudes of galaxies from their optical rotation curves, as an extention of the conventional Fisher-Tully method. We describe here how this method can be employed to evaluate the Hubble constant. From observations of 23 Sb field galaxies with luminosities ranging from -19.5 to -23.0 (adopting H=50 km s^{-1} Mpc^{-1}), we have produced synthetic rotation curves showing the systematic progression toward increasing velocity with increasing luminosity within a given Hubble type. (See Thonnard and Rubin, Carnegie Yrbk 80, p. 551 for details of producing such a set of curves). By matching even a small portion of a rotation curve with these curves, the absolute magnitude of an Sb galaxy can be estimated to about $\pm$0.5 mag. This magnitude, of course, is based on an assumed value for H.

Instead of assuming a value for H, we can calibrate the curves directly if we have one galaxy with a known rotation curve and a known absolute magnitude. For example, if the rotation curve of M31 matches the synthetic curve with absolute magnitude equal to that of M31, then H = 50. But if the rotation curve of M31 matches a curve with an M different from that known for M31, then H $\neq$ 50.

We have attempted to use the rotation curve and absolute magnitude of M31 to evaluate H, and the results are surprising. In Table 1, we show the values of distance, internal and external extinction from Sandage-Tammann (RSA; internal extinction to face-on) and de Vaucouleurs et. al (RC2). As can be seen, the absolute magnitude of M31 differs by 0.9 mag. on the two systems! This translates to a difference in H as shown. We conclude, based solely on a comparison of the rotation curve and absolute magnitude of M31 with 23 field Sb galaxies, that H = 80 $\pm$25 km s^{-1} Mpc^{-1}.

TABLE 1 PARAMETERS FOR M31

	SANDAGE-TAMMANN	DE VAUCOULEURS
Apparent magnitude	4.38	4.36
External extinction	0.64	0.41
Internal extinction	0.82	0.36
Distance	730 kpc	660 kpc
Absolute magnitude	-21.4	-20.5
Value of H needed to match curves	69$\pm$11	91(+16,-14) km s^{-1} Mpc^{-1}

Richard M. West (ed.), Highlights of Astronomy, Vol. 6, 288.