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The Coma–Leo I distance ratio and the Hubble constant

Michael D. Gregg[1]

Institute for Geophysics and Planetary Physics, Lawrence Livermore National Laboratory, L-413, 7000 East Avenue, Livermore, CA 94550, USA

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Robert P. Kirshner

Abstract

The diameter–velocity dispersion relation in B, V, and K for three early-type galaxies in the Leo I (M96) group is derived from published photometry and kinematic data. The relations in all three colors have slopes which agree well with those for the Coma cluster. The RMS scatter of the Leo I galaxies in each color is extremely small, consistent with the group's compactness. These relations yield estimates of the Coma–Leo I distance ratio of 9.01 ± 0.51, 8.77 ± 0.43, and 8.82 ± 0.31, respectively, with a weighted mean of 8.84 ± 0.23. The general agreement among the three colors indicates that the early-type galaxies in Leo I and Coma have similar stellar populations.

The Coma–Leo I distance ratio coupled with estimates of the absolute distance to the Leo I group allows the Hubble constant to be determined, free of the uncertainties which arise when working with the Virgo cluster. Several high quality distance estimates are available from a variety of techniques: Cepheids in M96 (Tanvir et al., 1995) and M95 (Graham et al., 1997), surface brightness fluctuations (Tonry et al., 1997), planetary nebulae luminosity functions (Ciardullo et al., 1993), and the luminosity of the red giant branch tip (Sakai et al., 1996). Adopting a cosmic recession velocity of the Coma cluster in the microwave background frame of 7200 ± 300 km s^{-1}, these distance estimates lead to values of the Hubble constant ranging from 70 to 81 km s^{-1} Mpc^{-1}, with an unweighted mean of 75 ± 6 km s^{-1}.

Keywords: Galaxies: distances; Galaxies: elliptical

1. Introduction

Cepheid distances to at least five Virgo cluster galaxies have now been obtained using the Hubble Space Telescope (see van den Bergh (1996) for a summary). While these studies are milestones in the effort to establish the extragalactic distance scale, they have not yet settled the controversy over the value of the Hubble constant for two critical reasons. First, it is now widely recognized that the line-of-sight depth of the Virgo cluster is large, perhaps as great as a factor of 1.5 or more (Tonry et al., 1990; Tammann et al., 1996). The Hubble constant based on even many Virgo spirals will be subject to uncertainty because the centroid of the Cepheids, in spiral galaxies, relative to the centroid of the Virgo cluster as measured by elliptical galaxies is not well determined. Second, both the infall of the Milky Way

[1]E-mail: gregg@igpp.llnl.gov

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into the Virgo cluster and the cosmic recession velocity of Virgo are still controversial. Estimates range from 100 to 450 km/s, large compared to the mean Virgo recession velocity of ~1100 km/s (Huchra, 1988; Tammann et al., 1996).

The uncertainty in distance introduced by the depth of the Virgo cluster can be overcome by working with more compact objects, such as the Fornax cluster or the Leo I group, an approach being taken by **the Hubble Key Project on the Extragalactic Distance Scale**[2] and others (see Freedman (1996) for a summary). The additional uncertainty introduced by the local peculiar velocity field remains a problem for distance scale determinations using clusters within a few thousand $\mathrm{km\,s^{-1}}$, where peculiar velocities may be a significant fraction of the Hubble velocity. It can be mitigated by determination of the Hubble constant, not directly from the recession velocity of the nearby cluster, but by using the relative distance to the Coma cluster to step well beyond the local velocity field. This technique has been used by the HST Extragalactic Distance Scale Key Project (Farrarese et al., 1996) and by Pierce et al. (1994) to derive the Hubble constant from Cepheid measurements in Virgo and by Tanvir et al. (1995) in the Leo I group.

The Leo I group is relatively nearby, with a mean recession velocity of $\sim 850\ \mathrm{km\,s^{-1}}$, and is compact, with a line-of-sight depth estimated to be just ~2% compared to its distance, assuming spherical symmetry. It contains two spirals, NGC 3368 (M96) and NGC 3351 (M95), which now have Cepheid distances (Tanvir et al., 1995; Graham et al., 1997) and several early-type galaxies, including NGC 3377 (E6), NGC 3379 (E0), and NGC 3384 (SB0). In principle, use of the Leo I–Coma distance ratio plus a direct measure of the distance to Leo I allows the Hubble constant to be determined free of the uncertainties introduced by the Milky Way's space motion and the large depth of Virgo.

The present work derives the Coma–Leo I distance ratio based on photometrically independent diameter-velocity dispersion relations in B, V, and K bands using data in the literature. The internal uncertainties are small, establishing the relative distance with precision as 8.84 ± 0.23. Adoption of a distance to the Leo I group allows the Hubble constant to be determined without reference to the Virgo cluster. Five Leo I group distances with small errors have been published and range from 10.05 Mpc (Graham et al., 1997) to 11.6 Mpc (Tanvir et al., 1995); curiously the Cepheid distances define the two extremes. These imply a Hubble constant in the range 70 ± 7 to 81 ± 8.

2. D–σ relations

The D–σ relation for elliptical galaxies is based on a near-optimal projection of the fundamental plane (Dressler et al., 1987; Djorgovski & Davis, 1987; Jorgensen et al., 1993). The diameter D is defined as the size of a circular aperture which encloses a fiducial mean surface brightness: 20.75 in the B band (Dressler et al., 1987), 19.80 in V (Lucey et al., 1991), or 16.75 in K (Gregg, 1995a). The diameters, referred to as D_n, D_V, and D_K, respectively, are tightly correlated with central velocity dispersion (σ) and provide a relative distance indicator for early-type galaxies of accuracy comparable to and perhaps better than the infrared Tully–Fisher relation for spirals (Dressler et al., 1987; Gregg, 1995a).

2.1. Coma and Virgo clusters

The K band D–σ relation for 24 E and S0 galaxies in the Coma cluster and 12 E galaxies in Virgo was derived by Gregg (1995a) from the IR photometry of Bower et al. (1992a); Bower et al. (1992b) and Persson et al. (1979). The velocity dispersions come primarily from Davies et al. (1987). Fig. 1 shows the K band D–σ relations from Gregg (1995a) for Coma and Virgo along with the B and V band relations from Faber et al. (1989) and Bower et al. (1992a); Bower et al. (1992b). The D–σ relation for the Coma cluster is significantly tighter in the K band than in either B or V (Gregg, 1995a). The RMS

[2] http://www.ipac.caltech.edu/H0kp

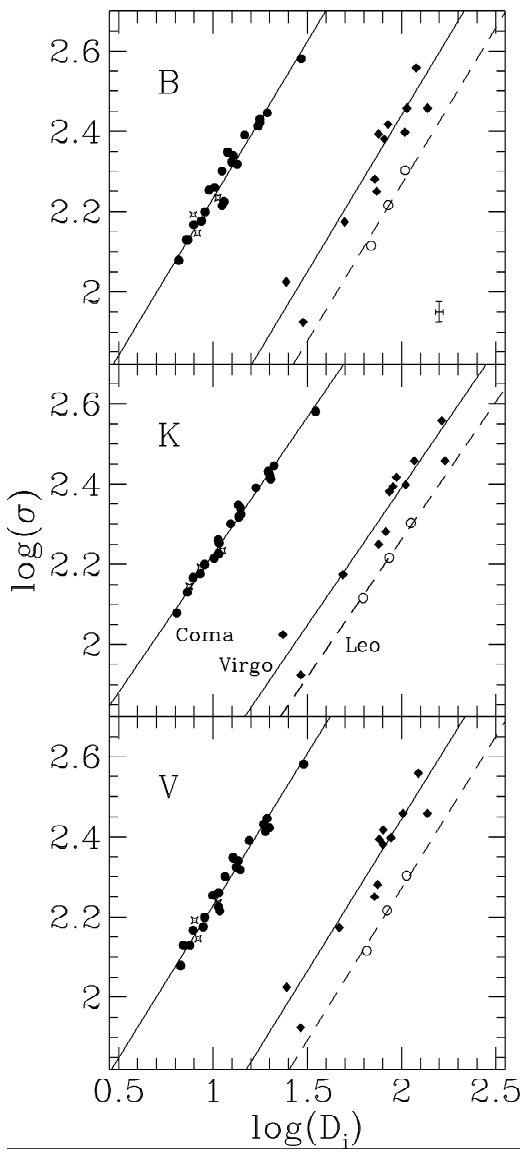

Fig. 1. Upper panels: comparison of the B, V, and K D–σ relations for the Coma and Virgo clusters and the Leo I group. Filled circles are Coma ellipticals, 4-pointed stars are Coma S0's, filled diamonds are Virgo ellipticals, and open circles are the Leo I early-type galaxies. The lines through the Coma cluster data are robust fits. The lines through the Virgo and Leo I data sets are forced to have the same slope as the Coma relations and the fits are achieved by adjusting only the intercept. The Leo I relations have slopes in excellent agreement with those for Coma and the Leo I galaxies exhibit very little scatter.

dispersion of the 24 Coma galaxies in B, V, and K is 0.035, 0.029, and 0.021 in log(D) and 8%, 7%, and 5% in distance, respectively. The lines through the Coma D–σ relations are derived using a robust fitting technique (see Gregg (1995a) for details); the lines through the Virgo data are forced to have the same slopes as the Coma fits and the residuals are minimized in a least squares sense by choice of intercepts.

The large scatter in all colors exhibited by the Virgo cluster can be attributed to its depth along the line of sight, providing graphical illustration of the difficulties in determining its centroid for either absolute or relative distance estimates. The envelope containing most of the Virgo galaxies in these diagrams implies a front-to-back distance spread of ~ 1.5 *for the elliptical galaxies in Virgo*, similar to the spread found for Virgo spirals and implying that not even the early-type galaxies in Virgo define a locally condensed cluster core. Some of this spread can perhaps be attributed to aperture effects in determining the central velocity dispersion (Jacoby, 1995), but much of it is probably real.

2.2. Leo I

Persson et al. (1979) also give multiaperture K and V band data for three Leo I early-type galaxies, NGC 3377, 3379, and 3384. The diameters D_K and D_V can be derived by fitting an $R^{1/4}$ law (Gregg, 1995a). Burstein et al. (1987) and Davies et al. (1987) give B band D_n and velocity dispersion data for the ellipticals, but not for NGC 3384. To include this galaxy in the analysis requires adopting the velocity dispersion of McElroy (1995), corrected for its redshift by Eq. (1) of Davies et al. (a 5% effect). The B-band diameter, D_n, for NGC 3384 has been estimated using its $B-V$ of 0.95 (de Vaucouleurs et al., 1991) and the V-band photometry from Persson et al. (1979); as such, this one diameter is not independent of the V-band data. Leaving NGC 3384 out of the B-band relation does not significantly affect the results. For comparison and as a test of the fitting technique, B-band diameters (called D_B to distinguish them from published D_n) for NGC 3377

and NGC 3379 were derived from the Persson et al. data, adopting B − V colors from Burstein et al. (1987). In both cases, the derived diameters agree to much better than 0.01 in log(D) as given in Burstein et al.

Table 1 lists the diameters and adopted velocity dispersions for the 3 Leo I galaxies along with other relevant data. The reddening model used by Persson et al. (1979) predicts no reddening for the Leo I group. Their V and K photometry have been corrected here using the Galactic reddening estimates of Burstein & Heiles (1984).

The resulting B, V, and K D–σ relations for the three Leo I galaxies are shown in Fig. 1. All display remarkably little scatter, particularly the K band. The dashed lines have the same slopes as derived for the Coma cluster fits; the intercepts are determined by minimizing the residuals. The RMS residuals in log(D) for Leo I for B, V, and K are 0.029, 0.018, and 0.009, corresponding to a scatter in distance of only 6.9%, 4.2%, and 2.1%, respectively; the K-band relation is consistent with the estimated depth of the cluster along the line of sight. The very small scatter obtained for the Leo I galaxies is probably fortuitous as the estimated errors for the velocity dispersions by themselves should produce a somewhat larger scatter, especially at K. To be conservative in estimating the total uncertainties, it is assumed that the error per point in Leo I is equivalent to the RMS scatter as determined empirically from the larger sample in the Coma D–σ relations.

The derived intercepts for B, V, and K are 0.900, 0.995, and 1.298, respectively. Combined with the Coma cluster fits (Gregg, 1995a), these imply 9.01 ± 0.51, 8.77 ± 0.43, and 8.82 ± 0.31 for the Coma–Leo I distance ratio. The uncertainty in the relative distance is the uncertainty in the separation of the fits to the two clusters and can be estimated as

$$\sum_{\mathrm{Coma}} \frac{\sigma_i}{\sqrt{\mathrm{N}}} + \sum_{\mathrm{Leo}} \frac{\sigma_i}{\sqrt{\mathrm{M}}} \quad (1)$$

where N and M are the number of points in Coma (24) and in Leo I (3). The three estimates agree, within the uncertainties, considerably better than the 1σ level, suggesting that the adopted errors are, indeed, conservative. The weighted mean distance ratio is 8.84 ± 0.23. This direct measure of the distance ratio agrees remarkably well with the Tanvir et al. (1995) value obtained by a more circuitous route through Virgo based on many different distance indicators: 8.85 ± 0.32.

2.3. Systematics affecting in the Coma–Leo I distance ratio

There are at least two possible systematic effects which may influence the Coma–Leo I distance ratio as derived from the D–σ relation: reddening and stellar populations. Neither appears to be significant.

2.3.1. Stellar populations

If a systematic difference in age, metallicity, or initial mass function (IMF) exists between the stellar populations of the early-type galaxies in Coma and Leo I, then the slopes and/or zeropoints of the D–σ relations would be different in the two environments and the derived relative distance would be in error (Gregg, 1995b). Systematic age differences in early-type populations are expected to be in the sense that objects in dense environments have greater mean ages than those in small groups, suggesting that the Leo I galaxies would be younger than the Coma

Table 1
Data for Leo I early-type galaxies

NGC	Type	A_B	log(σ)	$\log(D_n)$	$\log(D_B)$	$\log(D_V)$	$\log(D_K)$	$(B-V)_0$	$(V-K)_0$
N3377	E6	0.06	2.116	1.838	1.835	1.816	1.796	0.90	2.99
N3379	E0	0.05	2.303	2.018	2.019	2.027	2.050	0.97	3.27
N3384	SB0	0.07	2.216	–	1.929	1.923	1.935	0.95	3.13

objects. Younger, brighter ellipticals in Leo I would cause them to appear nearer, relative to Coma, and the Coma–Leo I distance ratio would be overestimated. A value of H_o based on such an affected distance ratio would be a *lower* limit. Systematic effects due to stellar population variations will be a function of wavelength (Gregg, 1995b), being greater at B than V or K. The consistency of the distance ratios derived in the three bandpasses argues that the stellar populations do not differ greatly in age, metal abundance, or initial mass function at a given velocity dispersion between the two environments. The similarities of the slopes of the D–σ relations in Leo I to those derived for Coma also imply a consistency in the stellar populations in the two environments.

Fig. 2a plots V − K (Persson et al., 1979; Bower et al., 1992a; Bower et al., 1992b). colors against velocity dispersion for the Leo I (open squares), Coma (solid dots) and Virgo (filled diamonds) early-type galaxies. Bower et al. (1992a); Bower et al. (1992b) corrected the V − K colors for Virgo and Coma to remove aperture effects due to color gradients to facilitate comparison; the colors are for aperture sizes of 60″ and 11″, respectively, which were chosen to be equal to the relative distance of the two clusters. The Persson et al. V − K colors for Leo I are for an aperture size of 56″; to be completely compatible with the Bower et al. data, these should be corrected to an aperture of 90″. While the Persson et al. V − K data for Leo I do exhibit color gradients of ~0.05–0.1 between 29″ and 56″, correction to a 90″ aperture will be only a few hundredths of a magnitude bluer at most and will not alter the main conclusion from Fig. 2a, that the Leo I galaxies do not have unusual V − K colors. The lower panels of Fig. 2 demonstrate that the Leo I galaxies have typical B − V (Burstein et al., 1987) and Mg_2 indices (Davies et al. (1987); no Mg_2 is available for NGC 3384). The conclusion again is that the Leo I early-type objects have normal stellar populations.

2.3.2. Reddening

The normal colors of the Leo I ellipticals (Fig. 2) can also be interpreted as evidence that the Galactic reddening is well determined and that any internal reddening must be extremely small. The agreement of the distance ratios derived in the three photometric bands B, V, and K also indicates that the reddening is correct.

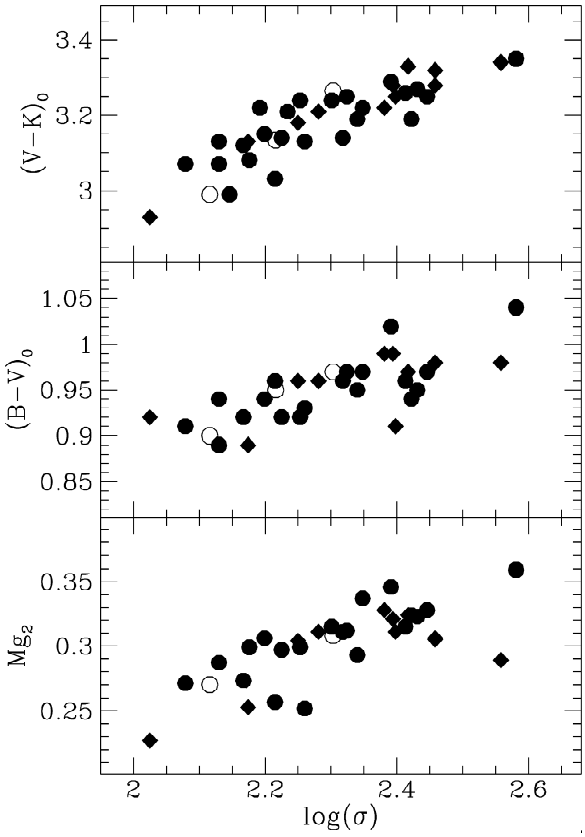

Fig. 2. Comparisons of V − K, B − V, and Mg_2 as a function of $\log(\sigma)$ for Coma, Virgo, and the Leo I early-type galaxies. Symbols as in Fig. 1. The Leo I galaxies have typical colors and Mg_2 strength compared to ellipticals in the other clusters.

3. The distance to the Leo I group and the Hubble constant

Using the Coma–Leo I distance ratio, a value for

the Hubble constant can be derived by adopting an absolute distance to the Leo I group and a cosmic recession velocity for Coma in the microwave background frame. Estimates of the Coma recession velocity are generally in good agreement at approximately 7200 $km\,s^{-1}$ (Faber et al., 1989; van den Bergh, 1996). Following Tanvir et al. (1995), an uncertainty of 300 $km\,s^{-1}$ is adopted to allow for the possibility of a sizable peculiar velocity for the entire Coma cluster.

There are currently 4 methods which give distances to the Leo I group with quoted errors of 10% or less: Cepheids (to two spirals, M96 and M95), surface brightness fluctuations, planetary nebulae luminosity functions, and the location of the red giant branch tip luminosity. The distances and resultant Hubble constants are summarized in Table 2; distance estimates to the Coma cluster are also included. The latter values amount to zero-point calibrations of the D–σ relations of the Coma cluster based on the other indicators. The error from the relative Coma–Leo I distance is combined in quadrature with the published error for each method to give the final uncertainties listed in Table 2.

3.1. Surface brightness fluctuations

Tonry et al. (1997) present a compilation of recalibrated SBF distance estimates to various nearby groups and clusters. The SBF Leo I group distance is 10.67±0.30 Mpc, based on observations of 5 member galaxies: the 3 early-type galaxies used in the D–σ relation plus another S0, NGC 3412, and the bulge of M96. This implies a value of $H_o = 76\pm4\ km\,s^{-1}\,Mpc^{-1}$.

3.2. Planetary nebulae luminosity function

Ciardullo et al. (1993) list PNLF distances to the the 3 Leo I early-type galaxies used here to derive the distance ratio with Coma. The weighted mean is 10.33±0.30 Mpc, implying $H_o = 79\pm5\ km\,s^{-1}\,Mpc^{-1}$. This is consistent at the 1σ level with the SBF result. Ciardullo et al. (1993) point out that SBF and PNLF distances can always be brought into agreement by adjusting the reddening since reddening affects the distances derived by the two techniques in opposite ways. For the Leo I early-type galaxies, the small difference can be eliminated if A_V is reduced to approximately zero; given the good agreement, however, and other possible sources of error, this is perhaps best taken as additional evidence that the Galactic reddening towards Leo I is indeed low.

3.3. RGB tip luminosity

Sakai et al. (1996) have detected the tip of the red giant branch in NGC 3379 from deep F814W (I-band) images from HST. This yields a distance of 11.4±0.8 Mpc to Leo I, implying a distance of 101±8 Mpc to Coma and $H_o = 71\pm6\ km\,s^{-1}\,Mpc^{-1}$.

3.4. Cepheids in M96 and M95

Based on observations of 7 Cepheids in the HST F555W (V) and F814W (I) bands, Tanvir et al. (1995) derive a distance to M96 of 11.6±0.9 Mpc, leading to a Hubble constant of 72±7. Graham et al. (1997) report discovery of 49 Cepheids in NGC

Table 2
Distances to Leo I and Coma and the implied Hubble constant

Method	D Leo (Mpc)	D Coma (Mpc)	H_o ($km\,s^{-1}\,Mpc^{-1}$)	Reference
Cepheids M95	10.05±0.88	88.8±8.1	81±8	Graham et al. (1997)
PNLF	10.33±0.30	91.3±3.6	79±5	Ciardullo et al. (1993)
SBF	10.67±0.30	94.3±3.6	76±4	Tonry et al. (1997)
RGB tip	11.4 ±0.8	100.8±7.5	71±6	Sakai et al. (1996)
Cepheids M96	11.6 ±0.8	102.5±7.6	70±6	Tanvir et al. (1995)
unweighted mean	10.8 ±0.7	95.5±6	75±6	

3351, also using HST F555W and F814W images, deriving a distance of 10.05±0.88 Mpc. Combined with the Coma–Leo I distance ratio of 8.84, this yields $H_o = 81 \pm 8$.

3.5. Other distance estimators

The distance to Leo I has also been estimated using the globular cluster luminosity function approach (Harris, 1990), based on a combined sample of clusters from NGC 3377 and 3379, as 10.7±2.2 Mpc. The uncertainty is large because of the small number of globulars found and more than spans the total range of more precise distance estimates, and so provides no additional distance information.

The Tully–Fisher (TF) method can be applied to M96, but its inclination is 47°, making the distance uncertain by ~1 magnitude (Willick 1996, private communication). Even with a more favorable inclination, the TF uncertainty would still be sizable; various estimates for the TF distance to M96 range from 11.0 Mpc (Bottinelli et al., 1985), to 14.1 (Federspiel et al., 1996), both from B-band photometry, with uncertainties approaching 20% magnitudes. An H-band TF distance can be derived for M96 based on the re-calibration of the extensive Aaronson database that has been carried out by Tormen & Burstein (1995) and Willick et al. (1996). The present author's approximate absolute calibration of the Willick et al. data set results in a distance modulus of 11.0±1.7. These distances and error bars span the total range of the other estimates for Leo I and, once again, there is no additional distance information.

4. Discussion

The above various distance estimates to Leo I and resultant values for the Hubble constant are illustrated graphically in Fig. 3. The right ordinate scale displays the implied Hubble constant for each distance, adopting a Coma–Leo I distance ratio of 8.84. The error bars indicate the published uncertainties

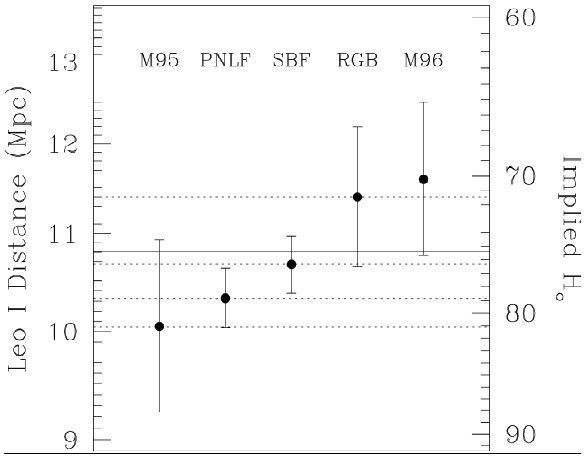

Fig. 3. Graphical comparison of the best available distance estimates to the Leo I group and the implied values of the Hubble constant using the Coma–Leo I distance ratio of 8.84±0.23 from Section 2.2. The points labeled M96 and M95 are Cepheid distances from Tanvir et al. (1995) and Graham et al. (1997), respectively.

for each of the distances; these are not determined consistently from one to another. The Cepheid distance estimates have attempted to include known possible systematic effects and hence their error bars are larger.

Perhaps somewhat unexpectedly, the two Cepheid distance estimates bracket the other distance estimates to Leo I. The other three techniques derive distances directly to the early-type galaxies used in the D–σ relations; however, using the Cepheid distances to M95 and M96 to calibrate the D–σ relations relies on the assumption that the spirals are at the same distance as the early-type members, a possible source of systematic error. Based on detailed dynamical analysis and modeling of the intergalactic hydrogen ring in the Leo I group, Schneider (1989) makes strong arguments in favor of the early-type galaxies NGC 3377, NGC 3379, NGC 3384, and NGC 3412, and the spirals M96 and M95 being in close physical proximity, probably all within 0.5 Mpc or less of each other. Schneider's data show that M96, in particular, appears to be directly interacting with the HI which is orbiting the close

pair NGC 3379 and 3384. M95 is 1°.5 away from the NGC 3379/3384 pair; the evidence linking it to the early-type galaxies is more tenuous. But if M95 is really 1.3 Mpc closer than M96, as the Cepheid results indicate, then the Leo I group is extended along the line-of-sight by 15%, pointing almost directly towards us.

From Schneider's analysis, however, it is unlikely that both M96 and M95 could be at distances much different than the early-type galaxies in Leo I. The spread in the above cited distances determinations to Leo I can be interpreted simply as the real uncertainty in present distance estimates. Since possible systematic effects are difficult to evaluate, and may enter in common in some of the estimators, perhaps the best estimate of the Hubble constant in this instance is a straight unweighted mean of all the methods (the heavy horizontal line in Fig. 3). This yields a distance to Leo I of 10.8 ± 0.7 Mpc, to Coma of 96 ± 7 Mpc, and a Hubble constant of 75 ± 6 km s^{-1} Mpc^{-1}, where the uncertainty is the dispersion of the various estimates about the mean. Because the Cepheid distances of Tanvir et al. (1995) and Graham et al. (1997) bracket the range of distance estimates, consideration of the Cepheids alone does not change this result at all.

This result is additional support for the ''short'' distance scale, consistent with a number of other studies, in particular the HST Key Project on the distance scale (Freedman, 1996). If the Hubble constant is instead close to 50 km s^{-1} Mpc^{-1}, then one or more systematic errors must exist in the arguments or in the data used here. For H_o to be less than 60 km s^{-1} Mpc^{-1}, then the Leo I early-type galaxies would have to be at a distance of ~ 14.5 Mpc, but this is $> 3\sigma$ greater than either the Cepheid distance to M96 (Tanvir et al., 1995) or the RGB tip distance to NGC 3379 (Sakai et al., 1996), the two largest accurate distance estimates to Leo I. Placing both M96 and M95 3–5 Mpc in the foreground of the early-type galaxies in Leo I requires setting aside the dynamical evidence of Schneider (1989) for a direct physical link between M96 and NGC 3379 and also requires that all three of the early-type distance estimates to Leo I (SBF, PNLF, and RGB tip) are seriously in error at the 30–40% level. This must be considered unlikely. The Hubble constant may also be overestimated here if the adopted velocity of the Coma cluster were seriously in error. The mean velocity of the Coma cluster is observationally well established, but if the Coma cluster has a large peculiar velocity directed away from us, then H_o would be lower than estimated here. To bring it below 60 km s^{-1} Mpc^{-1}, however, would require a peculiar velocity for Coma of ~ 1500 km s^{-1}, which must be considered highly unlikely; most studies of peculiar velocity fields yield estimates of a few hundred km s^{-1} and Faber et al. (1989) estimate a peculiar velocity for Coma of only 259 km s^{-1}, directed *towards* us. Finally, the Hubble constant could be pushed as low as 60 km s^{-1} Mpc^{-1} if the Coma–Leo I relative distance were ~ 11 rather than 8.84 ± 0.23 as found here. It is argued above in Section 2.3 that this is unlikely; the most likely systematic effect, a younger age for the early-type galaxies in Coma and Leo I, would work in the opposite direction, causing the relative distance to be overestimated and H_o underestimated.

5. Summary

The main result of this work is that the Coma–Leo I distance ratio is 8.84 ± 0.23 based on the D–σ relations in B, V, and K for three early-type galaxies in the Leo I.

Consideration of the five most precise distance estimates to the Leo I group allows a distance to the Coma cluster to be derived and from that an estimate of the Hubble constant which is free of the problems associated with working in the Virgo cluster. The distance estimates used are based on Cepheids, SBF, PNLF, and RGB tip estimates and span a range from 10.05 to 11.6 Mpc, somewhat surprisingly with the two Cepheid determinations to M96 and M95 bracketing the range. Utilizing the Coma–Leo I distance ratio derived here and adopting a cosmic recession velocity for the Coma cluster of 7200 km/s, the corresponding Hubble constants range from 70 ± 7 to

81 ± 8 km s^{-1} Mpc^{-1} with an unweighted mean of $H_o = 75 \pm 6$.

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