CHAPTER VII

THE NON-STANDARD APPROACH

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OBSERVATIONS REQUIRING A NON-STANDARD APPROACH

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ABSTRACT. Extragalactic astronomy rests on the assumption that redshifts are always equal to velocities and that large velocities are unambiguous distance indicators. There are now many observations which disprove this fundamental assumption. We here review the evidence which has been accumulating for 20 years with particular emphasis on the most recent developments.

I. QUASARS

Since quasars are stellar appearing, high energy-density objects their large redshifts cannot automatically be interpreted as measures of their distances as is customarily done for galaxies. In fact since quasars do not exhibit a redshift-apparent magnitude relation there is no direct evidence that they obey a redshift-distance relation. We now cite evidence of six different kinds that quasars are much closer than their redshift distances. Each kind of evidence is conclusive in its own category but is supported by other evidence for non-velocity redshifts in both quasars and galaxies.

1. Multiple Quasars Associated With Nearby Galaxies

Figure 1 shows the four galaxies now known which appear to have more than one quasar closely associated. Table 1 lists the data for these associations. The chance for accidental proximity in each of these systems is:

a) $\sim 10^{-5}$ for NGC 622. This was discovered in a UV excess search which included approximately 30 such galaxies. Note straight filament leading from galaxy to HII region adjacent to quasar.

b) $\sim 10^{-5}$ for NGC 470. The quasars were discovered in a UV excess survey which included about 5 galaxies this bright. In the disk of the spiral galaxy are seen irregularly shaped nebulosities which appear to be interacting with the quasar images.

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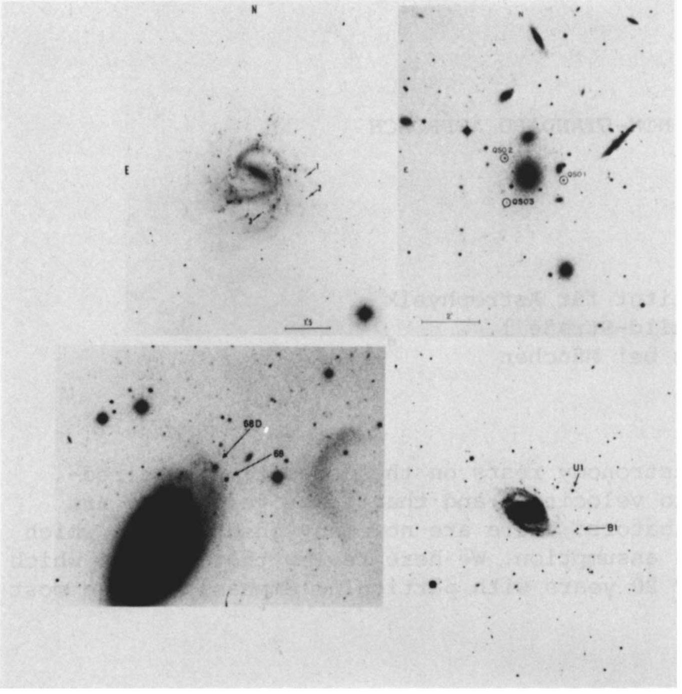

Figure 1. Multiple quasars close to galaxies. Clockwise from upper left: NGC 1073, NGC 3842, NGC 622, NGC 470

Table 1

Galaxy		Quasar				
Name	redshift	name	dist. (arc sec)	mag.	redshift	probability
NGC 622	0.018	UB1	71	18.5	0.91	0.001
		BSO1	73	20.2	1.46	0.02
NGC 470	0.009	68	95	19.9	1.88	0.015
		68D	85	18.2	1.53	0.002
NGC 1073	0.004	BSO1	104	19.8	1.94	0.01
		BSO2	117	18.9	0.60	0.006
		RSO	84	20.0	1.40	0.02
NGC 3842	0.020	QSO1	73	19.0	0.34	0.003
		QSO2	59	19.0	0.95	0.002
		QSO3 (radio)	73	21.0	2.20	0.01

c) $\sim 10^{-6}$ for NGC 1073. Quasars were searched for in this system because of the discovery of a compact radio source (RSO). The galaxy is so bright that it is one of the only 176 in the Hubble Atlas and one of the 1246 in the Shapley Ames Catalog. Three clumps of hydrogen in the disk, if rotated forward by $\sim$20 degrees, correspond to the positions of the three quasars.

d) $\sim 10^{-7}$ for NGC 3842. The two brightest quasars form a pair of X-ray sources across the galaxy. The galaxy is one of the two brightest in an unusual cluster of galaxies which, like Virgo, has individual galaxies as X-ray sources.

It is usually not appreciated how close these quasars fall to low redshift galaxies. The vast majority of bright galaxies have not been inspected but the compound probability of finding two or three quasars in those that have is so small that only a few such cases are required to give a certain proof of the association of high redshift quasars with low redshift galaxies.

A more detailed review and source references can be found in [1].

2. Quantization of Quasar Redshifts

When the first quasar redshifts began to accumulate, Geoffrey Burbidge pointed out that there was a significant excess around the value z=1.95. In 1968 [2] he also identified peaks at z=0.06, 0.30 and 0.60. In 1971 and again in 1977 [3], K.G. Karlsson showed the quasar redshift distribution had broad peaks given by: $\Delta\log(1+z)=0.089$. This has been most lately confirmed for all quasars known through 1984 by Depaquit, Vigier and Pecker [3]. The positions of the peaks described by this formula (using z=0.30 as a zero point) are listed in Table 2.

Table 2 - Peaks in Quasar Redshift Distribution

z (all quasars from $\Delta\log(1+z)=0.089$)	z (NGC 1073 observed)
0.30	
0.60	0.60
0.96	
1.40	1.40
1.95	1.94

It is clear that the redshifts of the NGC 1073 quasars fit these predicted peaks much too closely to be accidental. The remaining redshifts in Table 1 fit less well but still confirm this average periodicity. It is important to note, however, that each group of quasars fits better with a slightly different constant in the equation $\Delta\log(1+z)=$ const.

For example, Fig. 2 shows that quasars selected by objective prism

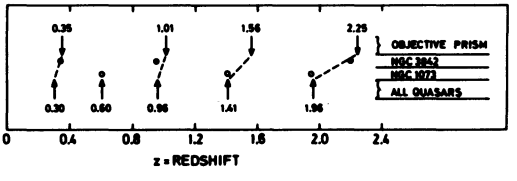

Figure 2. Redshift peaks observed for different groups of quasars

searches (dominated by the Sculptor region) show peaks z=0.35, 1.56 and

2.25 (with an uncertain peak at 1.01) [5]. These latter peaks, on average, fit better the formula with const. ∿0.096. The redshifts in the triple association NGC 3842 fit better with this slightly larger constant as Fig. 2 shows. A group of bright apparent magnitude quasars in the core of the Virgo Cluster fit an equation with const.=0.098 [6].

The adding together of different groups of quasars gives broad peaks as observed in the overall redshift distribution. But the fact that an individual group of quasars such as the NGC 1073 group can fit so exactly a particular value of redshift multiple, confirms that it is one physical group at the same distance despite the huge range in redshift of its quasars.

3. Single Quasars Associated With Nearby Galaxies

A single quasar falling improbably close to a low redshift galaxy is more common than the multiple quasars discussed earlier. In 1972 Burbidge, O'Dell and Strittmatter [7] showed significant associations of such quasar/galaxy pairs. Moreover they showed that the higher the redshift of the galaxy, the closer the quasar appeared in angular separation as if the whole association were viewed a greater distance. Fig. 3 shows this relation with the data available up to 1983 [8].

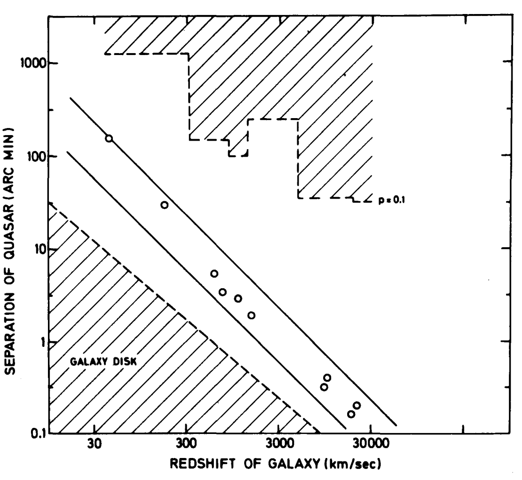

Figure 3. Apparent separation of quasar varies as distance of galaxy

In 1972 Arp began to show that quasars fell particularly close to a class of galaxies which were companions to large spirals [9]. These investigations culminated in 1981 and 1983 when it was shown that quasars were about 20 times more dense around companions to large, low redshift spirals than they were in the general field.[10] This result is shown in Fig. 4 and has a probability of about 7×10^{-16} of ocurring by accident.[1]

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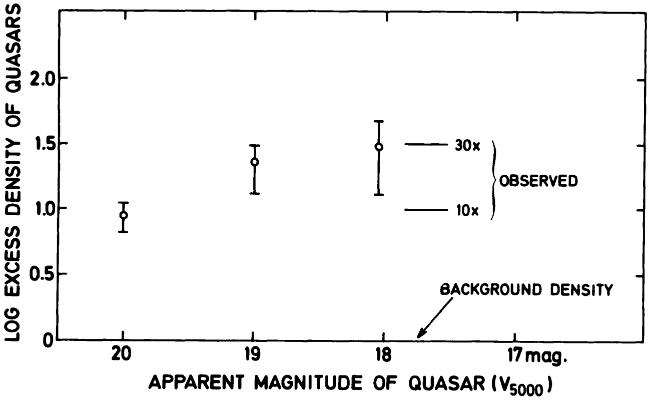

Figure 4. Density of quasars around companion galaxies of large, low redshift spirals

It is generally believed that subsequent criticisms of these probability calculations established that the association were not significant. That is not true, since the last and most elaborate analysis of the statistics obtained only a 0.01 probability for chance association.[11] Though still significant, the reason this improbability is not nearly so small as the one Arp calculated is because it ignores the fact that the galaxies with which the quasars are associated have varying distances from us as shown in Fig. 3. Ignoring the differing galaxy distances still gives a signficant association but not the overwhelming significance which is obtained if this elementary fact of astronomy is taken into account.[1]

4. Quasars Visibly Connected to Galaxies

Arguments about degrees of improbability of chance association seem unnecessary, however, when it has been demonstrated that some quasars are visibly connected to low redshift galaxies. The most famous of these is NGC 4319/Mark 205 in which a luminous filament was detected leading from the quasar (z=21,000 km/sec) back to the galaxy (z=1,700 km/sec). Long debate about the reality of this connection has finally led to the acknowledgement of its reality.[12] The only remaining escape is to have the luminous filament arise from a quasar in the background and to have it only accidentally project toward the galaxy, mimicking a true connection. This possibility is ruled out, however, by the image processing done by J.W. Sulentic on CCD, KPNO 4 meter images of the center of NGC 4319. As shown in Fig. 5 the maximum intensity in the center of the galaxy proceeds at an angle to the major axis directly into the luminous connection which leads to Mark 205.

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Figure 5. Image processing of NGC 4319 showing central spine leading to Mark 205

Another remarkable development in the analysis of NGC 4319 is shown in Fig. 6. Then the VLA radio map by J.W. Sulentic shows radio

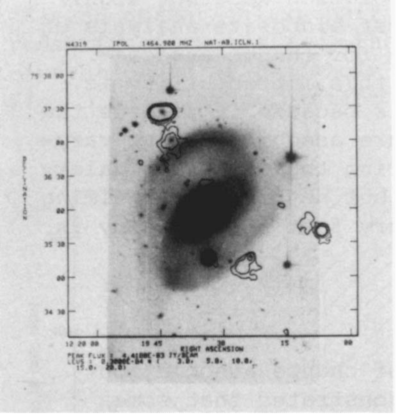

Figure 6. Map at 20 cm with VLA by J.W. Sulentic showing radio lobes across NGC 4319

lobes ejected in either direction from the nucleus of NGC 4319. Radio lobes across a spiral galaxy are unprecedented. These could only have come from the explosion that disintegrated the spiral arms at their roots and cleared out the Hα from the disk of NGC 4319 leaving only shock excited [NII] emission.[13] It was originally concluded that Mark 205 had been ejected from NGC 4319. We now see that the radio source Mark 205 is aligned approximately along the direction of the ejected radio lobes. Both the unusual optical and radio properties support the physical association of the quasar with the galaxy.

An even more straightforward example of a quasar connected to a galaxy is shown in Fig. 7. The galaxy, MCG 03-34-085, is chaotic, possesses a jet and exhibits an unusual spectrum.[14] The quasar has a luminous filament which emerges most strongly on one side of its stellar image and leads back to the base of the jet. The connection was discovered in 1984 on two independent, IIIa-J, U.K.schmidt, survey plates. It is being published for the first time only now.[1]

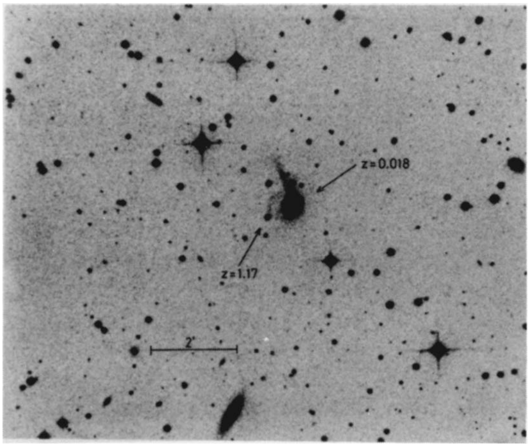

Figure 7. The quasar PKS 1327-206 connected to a low red-shift, disturbed galaxy by a luminous filament

As an example of a quasar connected to a galaxy by a radio filament we show in Fig. 8. In the northern lobe of the radio galaxy 0844+31 there is a hot spot only 5 arc sec distant from a high red-shift, bright apparent magnitude quasar. The chance of a quasar this

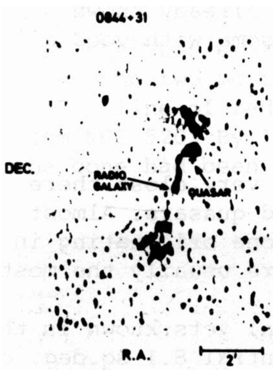

Figure 8. Radio map of ±2402 and quasar with z=1.83

bright falling this close to the hot spot is only 3×10^{-6}. Even if we take the significant distance to be from the quasar to the center of the lobe, a distance of 19 arc sec, the chance is only 4×10^{-5}.

Another well-known example, 3C 303, is listed in Table 3. The observations of P. Kronberg, E.M. Burbidge, H.E. Smith and R.G. Strom [15] show the radio jet from the galaxy terminates near three ultra-violet objects, two quasars and one peculiar extended object. The improbability of finding just the one quasar with measured redshift is $<10^{-4}$.

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Table 3 - Quasars Connected to Galaxies or Close to Radio Lobes

Galaxy Name	Galaxy redshift	Quasar Name	distance (arc sec)	mag	z	probability
N6C 4319	1,700 km/sec	Mark 205	40	14.5	0.07	∿0
MCG 03-34-085	5,400	PKS 1327-206	38	17.0	1.17	∿0
N6C 5296	2,500	BSO #1	55	19.3	0.96	$<<10^{-3}$
3C 303	42,000	UV #C	20+	20	1.57	$<10^{-4}$
I 2402	20,000	0844+31	70+	18.0	1.83	$\sim10^{-5}$
0924+30	8,000	Compact source	497+	21.5	2.02	$\sim10^{-5}$

+ Distance from galaxy; quasar is much closer to hot spot or radio lobe.

How many chances do we have to find such close associations of quasars with radio jets? The most recent compilation of jets in galaxies with z<0.2 by Bridle and Perley [16] list only 75 examples. In addition to the two associations listed next to last in Table 3, my casual inspection of list of radio jets reveals as many as 11 associations at about the improbability level of 0.01 with already known active objects of higher redshift in the vicinity, some with good alignments to the radio jets.

5. Galaxies With Many Associated Quasars

In addition to galaxies with one, two or three very close there are a few galaxies with larger numbers of associated quasars. Almost always these quasars are distributed on a line or cone originating in the nucleus of the galaxy. The galaxies of origin are usually the most disturbed and disrupted of any known.

The galaxy with the longest, straightest optical jets known is the hot-spot nucleus spiral, NGC 1097. Search of the central 8.1 sq.deg. of an objective prism schmidt plate by X.T. He produced 43 candidate quasars around NGC 1097. Slit spectra of 33 showed these candidates were 94% true quasars. The concentration of quasars to the position of this ejecting galaxy is obvious.[17] The concentration builds up from expected background density at the edge of the field and reaches a maximum of greater than 20 times normal just north of NGC 1097 between the two strongest optical jets.

Fig. 9 shows that the radio and X-ray material extends from the galaxy nucleus out along the line of the jets. The six quasars near the strong northern jet are associated with individual patches of X-ray emission. Since the X-ray material is continuous with material in the active nucleus of the galaxy and has obviously been ejected, the X-ray quasars must also have been ejected.

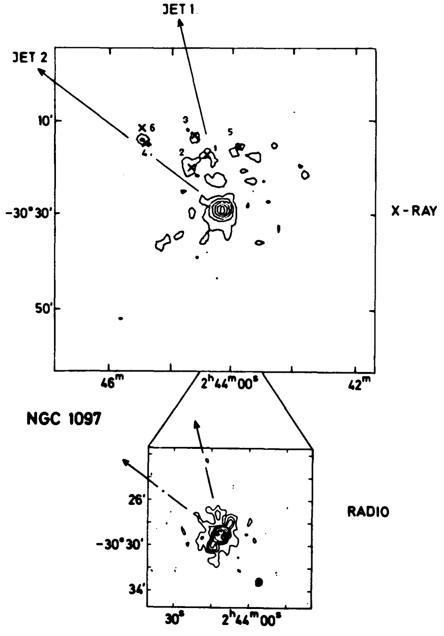

Figure 9. Relation of X-ray and radio material to jets in NGC 1097. Quasars in densest region numbered 1-6

In the Shapley-Ames Catalog of the brightest apparent magnitude galaxies the two most disrupted are M82 and NGC 520. Fig. 10 shows that in 1967 a line of radio sources was identified emerging NE and a cone SW from NGC 520. By 1970 a line of radio bright quasar along one edge of the cone had been discovered. In 1983 a double independent search of

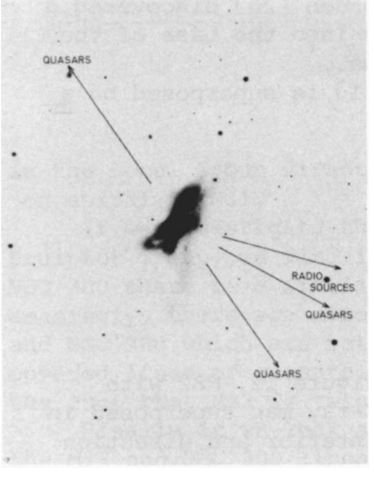

Figure 10. NGC 520 with lines of quasars and radio sources indicated

the area around NGC 520 revealed a line of six quasars with $V_{5000}<19.0$ mag. emerging from the galaxy.[18] The outer X-ray material around

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NGC 520 is also roughly aligned along the direction of the quasars and the radio material. The density, concentration and alignment of these various objects around NGC 520 has a negligible chance of being accidental.

The brightest, very disturbed galaxy in the sky is M82. Fig. 11 shows that a unique group of quasars fall very close to it. Three of

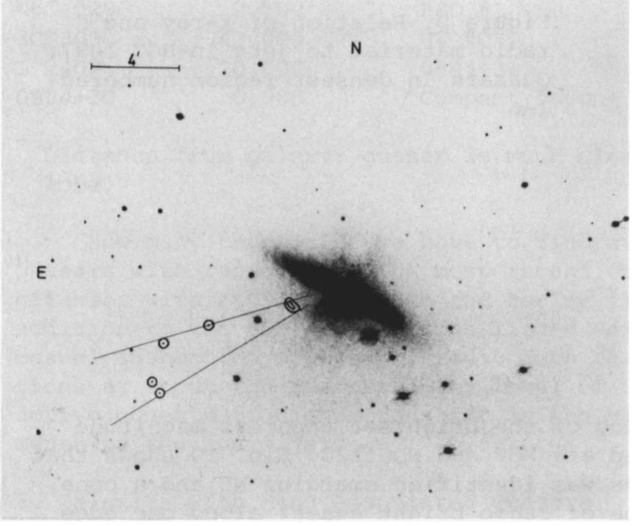

Figure 11. M82 with four quasars and a slightly extended radio source emerging in a cone from a notch in its disturbed outline

them have redshifts of z=2.048, 2.054 and 2.040.[19] Together with a fourth quasar [10] these objects define an ejection cone leading back to the disturbed center of M82. Recently J.J. Condon [20] discovered a radio source on the edge of M82. It fits exactly into the base of the previously defined ejection cone as Fig. 11 shows.

In Fig. 12 the X-ray map of the interior [21] is superposed on a

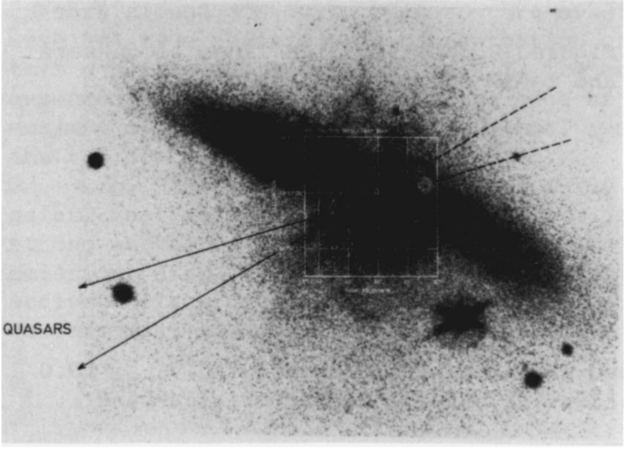

Figure 12. M82 with X-ray map superposed in interior and direction of quasars marked

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photograph of M82. It is seen that some of the X-ray emission coincides with the optical emission filament coming out along the SE minor axis of M82. The main body of the X-ray material, however, is extended out along the line of the ejection cone to the quasars.

In summary, three of the most disturbed bright galaxies we know all have the most numerous, close quasar associations we know. In each case the quasars are aligned in ejection cones originating from the galaxies. In each case radio and X-ray material confirm that these quasars have been ejected out from the disrupted galaxy.

6. Where Do Most Quasars Belong?

The most conspicuous small groupings of quasars on the sky all involve quasars with redshifts predominantly in the range $0.8<z<1.4$.[22] The relatively small scale of their separation indicates they are the most distant and hence the most luminous at a given apparent magnitude. Quasars of different redshift, particularly in the range $1.4<z<2.4$ should be less luminous. Of these, the brightest in apparent magnitude should be closest to us. Plotting all bright, high redshift quasars in the sky shows that in the direction of the Local Group of galaxies they are 3.5 times more numerous than in the opposite direction of the sky towards the Virgo Cluster.[6] Fig. 13 shows the most conspicuous feature

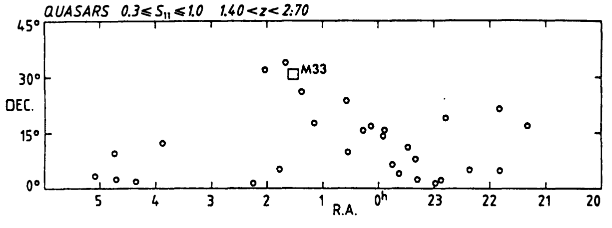

Figure 13. Radio quasars in the direction of the Local Group of galaxies

in the Local Group direction, a line of quasars from M33, the companion spiral to M31.

If we investigate the next nearest group of galaxies to us, the Sculptor Group, we find it contains the bright Sc, NGC 300. From NGC 300 there is a similar line of high redshift quasars.[6] Most amazingly, there are also lines of hydrogen (HI) printing to both M33 and NGC 300 which are rotated only 20 and 25° from the previously discovered lines of quasars. The lines of HI have scales proportional to the fact that M33 is twice as close to us as NGC 300.

Finally if we look at the apparent magnitudes of the quasars in the M33 and NGC 300 lines we find that the latter one is just about 1.5 magnitudes fainter. Again this reflects the fact that NGC 300 is

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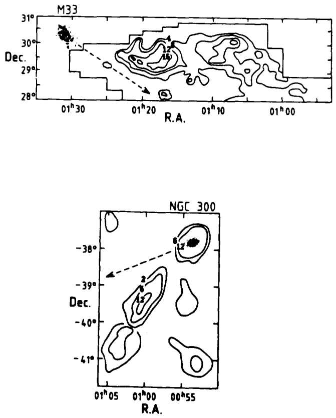

Figure 14. Lines of quasars (dashed) and hydrogen coming from nearest galaxies

just about twice as far away. Fig. 15 also shows that the quasars associated with M82 are fainter than 20^{th} magnitude and hence we should

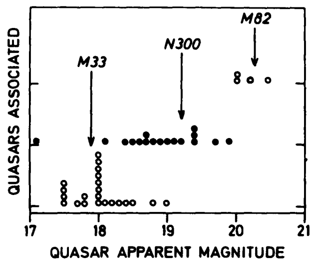

Figure 15. Apparent magnitudes of quasars ($z \sim 2$) become fainter as galaxies become more distant

not generally see, with present surveys, high redshifts quasars at much greater distances than M82.

The answer to the question of where most quasars belong is: Most high redshift quasars belong to very nearby galaxies and are projected at large angular distances around them on the sky. Quasars near $z \sim 1$ are more luminous, are seen to greater distances and form separate, smaller groupings on the sky. The overall distribution of quasars which is observed is a projection on the plane of the sky of nearby, large diameter groups and smaller, more distant groups, all of which contain a range in redshifts.

One closing note is that there is a subgrouping of quasars in Fig. 13 at the position of the anomalous quasar/galaxy, 3C 120. In 1973

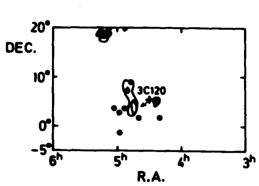

Figure 16. Quasars around 3C 120

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it was concluded that the group of galaxies to which this unusual object belonged was the Local Group. Fig. 16 shows the same kind of high redshift quasars that were associated with M33 are also closely associated with 3C 120. Local Group HI clouds and other anomalous objects are also associated with 3C 120.[23] One consequence of placing 3C 120 in the Local Group rather than at its redshift distance (z=0.033) is that its apparent superluminal expansion is reduced from 6 times the speed of light to about 0.04 the speed of light.

II. GALAXIES WITH EXCESS REDSHIFT

The most common argument rejecting the foregoing evidence that quasars are closer than their redshift distance is: Quasars are physically similar to galaxies and galaxies can only have Doppler, velocity redshifts. We briefly review here the evidence that many galaxies have small, non Doppler components of redshift and that the more a galaxy resembles a quasar, the greater the non-velocity redshift it usually has.

1. Galaxies with Discordant Redshift Companions

The prototype galaxy in this class is shown in Fig. 17. The

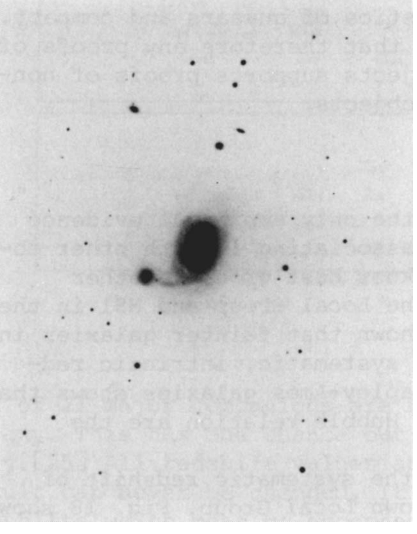

Figure 17. NGC 7603 with companion discrepant by +8,300 km/sec

Seyfert galaxy has one luminous filament connecting it to the companion. The photograph shown here is an image processed composite by N. Sharp of plates taken in 1973 by R. Lynds. Available now, the image best shows the interaction of the companion with the filament from NGC 7603.[1] It has always been clear that a companion running by the main galaxy with a differential velocity of 8,300 km/sec could not gravitationally pull out such a filament of stars. If they are connected the companion must have a large component of intrinsic redshift.

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There are now 38 examples of discordant redshift companions interacting with 24 main galaxies.[24] A sample of these associations is shown in Table 4. It is important to note that the companions with the

Table 4 - Sample of Interacting Galaxies with Large Discordant Redshifts

Main Galaxy	Comparison	Excess Redshift	Type of Spectrum
N6C 7603	comp SE	+ 8,300 km/sec	late absorption
AM 0059-402	comp S	+ 9,695	late absorption
AM 0213-283	comp N	+14,021	strong em. early abs.
AM 0328-222	comp S	+17,925	emission, early abs.
AM 2006-295	KN SW	+22,350	weak em., pec. abs.
NGC 1232	Gal B	+26,210	emission, early abs.
NGC 53	comp N	+32,774	emission, early abs.
AM 2054-221	comp E	+36,460	emission, late abs.

highest discordant redshift are in the same redshift range as the smaller redshift quasars. (The last entry in Table 4 has z=45,000 km/sec or z=0.15. This is comparable to z=0.16 for the famous quasar 3C 273.) But as the redshifts of the discordant companion galaxies approach that of the quasars, their spectra and general morphology do also. (Note 3C 48, a prototypical quasar has strong emission and early type absorption and is in the position of a companion to M33.) This demonstrates that the physical characteristics of quasars and compact, emission line galaxies are continuous and that therefore any proofs of non-velocity redshifts in one class of objects supports proofs of non-velocity redshifts in the other class of objects.

2. Groups of Galaxies

In general we should emphasize that the only empirical evidence for the distance of an object comes from associating it with other objects of known distance. The galaxies we know best group together around dominant S_b galaxies like M31 in the Local Group and M81 in the M81 group. Every investigation made has shown that fainter galaxies in groups like these have varying amounts of systematic, intrinsic redshifts.[25] In fact, close analysis of Shapley-Ames galaxies shows that the only galaxy types which obey a linear Hubble relation are the dominant S_b, non-companion galaxies.[26]

In order to give a vivid example of the systematic redshift of fainter members of groups we turn to our own Local Group. Fig. 18 shows M31 and the companions which classically belong to the group. However, they only represent a spread in redshift from cz_o (M31) = -86 to cz_o (NGC 404) = +142 km/sec. Groups characteristically contain a spread in redshift of about 800 km/sec. Plotting galaxies up to cz_o <700 km/sec in Fig. 18 demonstrates that these less luminous, higher redshift galaxies are members of the Local Group. They even define the line of group members distributed along the M31 minor axis, the M31-M33 line, which extends to Local group members in the region of 3C 120 (Discovered in connection with Figs. 13 and 16).

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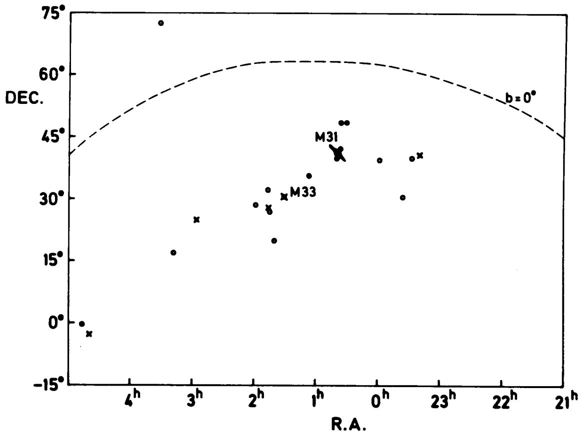

Figure 18. Filled circles are Local Group members. Crosses and open circles are spirals and dwarfs with $300<cz_o<700$ km/sec

Even if we restrict ourselves to just the traditionally accepted members of the Local Group and M81 groups we see from Fig. 19 that 21

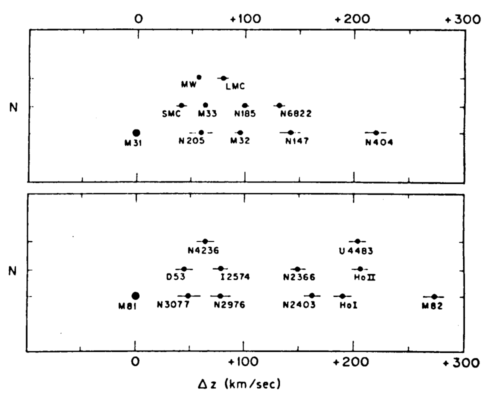

Figure 19. Differential redshifts in M31 and M81 groups

out of 21 major companions are redshifted with respect to the dominant galaxy. This has one chance out of two million of ocurring accidentally.[25] All redshift values and membership are so accurate that this result can never be changed. It is therefore a proof of non-velocity redshifts which must be accepted now.

3. Quantization of Galaxy Redshifts

The existence of systematic, intrinsic redshifts of galaxies has been established from large through small redshift discrepancies by the preceding analyses. If this evidence were not sufficient, there exists the further evidence of quantization of redshifts which is an independent demonstration of their non-velocity nature. Starting in 1976,

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W. Tifft has shown in a number of careful analyses of different pairs and groups of galaxies that their redshifts are quantized, principally in steps of 72 km/sec. This was most recently confirmed by a maximally accurate analysis of an independent sample of galaxies in groups by Arp and Sulentic.[25]

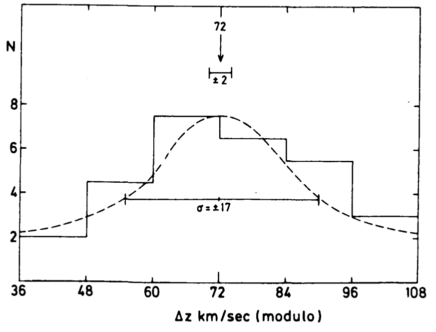

Figure 20. Distribution around multiples of 72 km/sec for M31 and M81 companions

Can we test for quantization in the most nearby galaxies? Yes, if we use a corrected value of solar motion near 250 km/sec instead of the 300 km/sec in current use. The corrected value comes from allowances for non-velocity redshifts in our Local Group of galaxies, an analysis which solves some current enigmas in conventional Local Group motions.[28] Fig. 20 shows that the systematically redshifted companion galaxies in the M31 and M81 groups (as shown in Fig. 19) are quantized around 72 km/sec with an average deviation of only ±17 km/sec.

If we examine members of the closeby M31 and Sculptor Groups, companions that range up to 13 multiples of 72.4 km/sec higher than the dominant galaxies, we see in Fig. 21 that the residuals from modulo

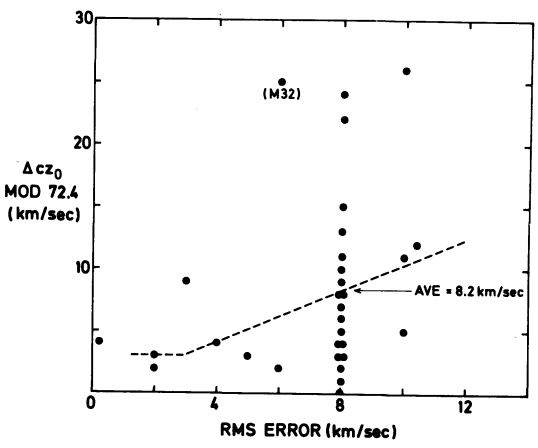

Figure 21. Residual from 72.4 km/sec multiple as a function of accuracy of measures.[27]

72.4 km/sec are only the measuring errors of the redshifts themselves. (An extra decimal place in 72 km/sec is needed because of the high

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order multiples, up to 13. The value 72.46 km/sec was derived by Tifft in 1977 in the Coma Cluster of galaxies - and 72.4 by Arp in the M31 and M81 groups shown in Fig. 21). A few galaxies are indicated in Fig. 21 as having measured redshifts more accurate than ±8 km/sec. They show residuals from modulo 72.4 km/sec of less than ±5 km/sec! This introduces the challenging paradox that there is very little true velocity motion left for orbital or peculiar motion around the central galaxy.

Altogether, however, these results unify the findings from the most extreme quasars through apparently quite normal galaxies. In the quasars all possible empirical tests showed large to intermediate intrinsic redshifts that were quantized. In the physical continuity connecting them to galaxies again we saw all possible tests demonstrating the presence of intermediate to small non-velocity redshifts. In a continuation of the trend from the quasars, these smaller non-velocity redshifts for the galaxies were also quantized but on a smaller scale.

4. Is There a Hubble Relation for Galaxies?

Among bright (Shapley-Ames) galaxies only the Sb's define a linear Hubble relation. The Sc's (which are characteristically companions to Sb's in groups) deviate above the Hubble relation as their apparent magnitudes become fainter.[26] Malmquist bias is an inadequate rationalization for this deviation.

Fig. 22 shows the distance-redshift relation for the Sc's listed by Sandage and Tammann in the Revised Shapley-Ames Catalog. The

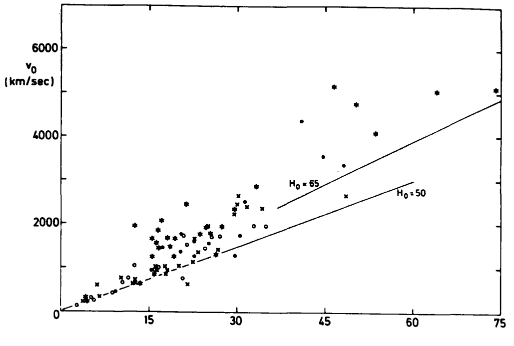

Figure 22. Redshift-distance relation for Sc galaxies. Distances in Mpc from Tully-Fisher relation

distances are derived from the redshift independent, Tully-Fisher criterion. Deviations above the line for H_o=50 km/sec/Mpc cannot be due to streaming motions because they would have to be very large, increase with distance and always be in the receding sense.

The paradoxical result is that the expansion of the universe would have to change from H_o=50 within 15 Mpc to something over H_o=100 at greater distance. This change in H_o as a function of distance was first pointed out by G. de Vaucouleurs in 1972 [29] and reemphasized in a series of papers by E. Giraud [30] (and this symposium).

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The way out of this paradox is the same as for all the contradictory and discrepant results presented in this review. Namely, we must no longer ignore observational evidence which demonstrates that redshifts, from quasars to companion galaxies, contain appreciable components of non-velocity redshifts.

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DISCUSSION

BERGERON: We have obtained deep CCD imaging of the field around the QSO-galaxy pair 1327-206. The existence of a faint east arm from the galaxy is confirmed and further this feature is bending back toward the galaxy and appears more as a loop. The NaI doublet seen in absorption in the QSO spectrum at the redshift of the galaxy (z = 0.018) exhibits a complex velocity structure which indeed agrees with the disturbed morphological structure of the interstellar material.

Finally on the line of sight to the QSO there are also absorbing clouds at much higher redshift (z = 0.853) than that of the galaxy. This second absorbing system is very strong and shows multiple velocity structure.

There is a poster on these observations.

ARP: It is typical of these systems where a high redshift object is associated with a low redshift object, that there are often other systems of radically different redshift also associated. 3C 120 is an example of this. In the case we are discussing here, the alignment of the objects of different redshift is so exact that the probability of them being unrelated objects accidentally in the line of sight is vanishingly small. In addition we have the connection by the luminous filament of the quasar to the low redshift galaxy.

RUBIN: For many years Dr. Arp has been showing us that galaxies can be very peculiar, based on skillful picture processing of beautiful photographic images. Recent CCD images now show that many galaxies formerly thought to be "normal" are instead embedded in low light level envelopes containing streamers, jets, rings, and shells. Such galaxies must not be very rare, but their interpretation is still open to question, and does not necessarily require a non-Hubble interpretation of redshifts.

ARP: The objects which have supplied critical evidence for the physical association of objects of different redshift have all emerged from normal surveys of the sky; Palomar Atlas, radio surveys, etc. It is natural to study these objects with greater resolution and greater sginal-to-noise. In many cases we then find additional, detailed confirmation of the physical association of these objects. But these additional confirmations are always judged in the context of what galaxies normally show under higher resolution and lower surface brightness levels.

It would be completely incorrect to take objects which have gross peculiarities, for example, those in the Atlas of Peculiar

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Galaxies, and imply that they are not peculiar because of anything that happens at very low light levels.

FILIPPENKO: You have shown us some very interesting results concerning NGC 4319 and Mark 205. I should point out, however, that Wallace Sargent and I are conducting a detailed spectroscopic survey of nearby galaxies, and we have found at least a few spirals in which [NII]$\lambda\lambda$6583, 6548 are the only emission lines (other than [OII]λ3727) visible throughout the nuclear region. Thus, NGC 4319 is not an exceptional case. I am not convinced that the [NII] emission is indicative of shocks produced by the ejection of Mark 205.

ARP: Starting with the observational work of the Burbidges, it is well known that strong [NII]/Hα ratios are characteristic of spiral <u>nuclear regions</u>. The point about NGC 4319 is that the [NII] is visible <u>and Hα invisible</u> <u>in regions far from the nucleus</u>. In fact, in the regions of the arms which spectra by V. Rubin and others show are characteristically rich in Hα and weak in NII.

I would doubt that you would argue that in the "few" spirals in which you find only [NII] in the nuclear regions, these nuclear regions were not excited by shocks.

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