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A Review of Anomalous Redshift Data

Hilton Ratcliffe
Climate and Solar Science Institute, 625 Broadway, Suite A, Cape Girardeau, MO 63701 USA
email: hilton@hiltonratcliffe.com

Abstract. One of the greatest challenges facing astrophysics is derivation of remoteness in cosmological objects. At large scales, it is almost entirely dependent upon the well-established Hubble relationship in spectral redshift. The comparison of galactic redshifts with distances arrived at by other means has yielded a useable curve to an acceptable confidence level, and the assumption of scale invariance allows the adoption of redshift as a standard calibration of cosmological distance. However, there have been several fields of study in observational astronomy that consistently give apparently anomalous results from ever-larger statistical samples, and would thus seem to require further careful investigation. This paper presents a review summary of recent independent work, primarily (for galaxies and proto-galaxies) by teams led by, respectively, D. G. Russell, M. Lopez-Corredoira, and H. C. Arp, and for galaxy clusters and large-scale structures, those of N. A. Bahcall, and J.C. Jackson. Included also are several other important contributions that will be fully cited in the text. The observational evidence is presented here *per se* without attempting theoretical conclusions or extrapolating the data to cosmology.

1. Introduction

The first question that needs to be answered in a review of anomalous redshift data is, "What is the statistical significance of the samples being cited?" Put another way: Are anomalous redshift associations not in fact just extremely rare events that can be written off to chance alignments and optical illusion? "*Fulton & Arp have analyzed the positions, redshifts, and magnitudes of ∼118,000 galaxies and∼25,000 quasars in the 2dF deep field. The examination of individual samples revealed concentrations of high z galaxies and quasars near galaxies. A natural extension of the analysis was to determine the average densities of objects over the survey area as a whole.*" (Arp & Fulton 2008)

2. The Redshift

Redshift is an extremely important quantity in astrophysics, and supports a large body of theory. In cosmology, it gives us the radial calibration along line-of-sight that determines almost exclusively the depth in 3-D representation of structure. In 1929, Edwin Hubble discovered that for galaxies in his field of view, that is, fairly local, the fainter they are, the higher the redshift. From the outset, data patterns were indistinct and tenuous. Hubble's original redshift data were described by Weinberg (1977) as leaving him "*perplexed how he (Hubble) could reach such a conclusion — galactic velocities seem almost uncorrelated with* *their distance, with only a mild tendency for velocity to increase with distance.*" Hubble himself remained unconvinced that the Doppler effect correctly explained his observations. In Hoyle, Burbidge, and Narlikar, in "A Different Approach to Cosmology" (Hoyle, Burbidge, & Narlikar 2000), (pages 32-33), we learn that, "*In the case of the redshifts it had been accepted that they must be corrected for solar motion with respect to the centroid of the Local Group, since it had been realised since 1936 that the systematic redshift does not operate within the Local Group.*" The crucial implication of this was that it was impossible to test redshift-expansion against parallax distance measures, the most reliable method for quantifying celestial remoteness, albeit within the limits of achievable baseline scale. Given that uncertainty increases dramatically with remoteness on all axes, it would appear that *the Hubble relationship fits best where it is tested least.*

The Sloan Digital Sky Survey (SDSS) and the Centre for Astrophysics (CfA) survey, as two examples of modern works, have given us 3-dimensional interpretations of pie slices of the universe that rest, or fall, with redshift distance. All these mentioned surveys produced peculiar patterns when arranged spatially according to redshift, and even more obvious anomalies where resolution permitted detection of material connections between bright objects.

In the words of Arp and Fulton, "*The resulting collection of objects can be analyzed to obtain the average numbers of galaxies and quasars per square degree as shown in Table 1. The subject count records the occurrence of galaxies and quasars inside a circle of radius 30′ around each galaxy and the background count records the occurrence of galaxies and quasars in a concentric annulus of equal area enclosing the subject circle.*" (Arp & Fulton 2008)

3. Anomalous Redshifts

Anomalous redshifts are defined as quantities significantly at variance with the Hubble Law. To assess whether the arrangement in an apparent system is or is not anomalous, we would look for "*properties of nearness, alignment, disturbances, connections*" (Arp, Burbidge, & Burbidge 2004). Quasars present an unusual defining characteristic: Redshifts significantly higher than other objects seen on the sky. This creates difficulties for physical theory because at their redshift-implied remoteness, they would by known physics be impossibly bright. If one plots quasars' redshift against apparent brightness, as Hubble did for galaxies, one gets a wide scatter, as compared with a smooth curve for the same plot done for galaxies. This seems to indicate that quasars do not follow the Hubble law, and there is no direct indication that they are at their proposed redshift distance. In fact, it is argued if Hubble had been given the plot for quasars first, he and other astronomers would not have concluded the Universe was expanding.

Even more onerous was the precision measurement of radial expansion rate by very long baseline radio interferometry. Quasars appeared to be expanding at up to ten times the speed of light, with obviously serious implications for underlying theory and Einsteinian physics. All of these quandaries about quasars were real only at their redshift-implied remoteness, and would tend to disappear if the objects were in fact closer to our point of observation. It was clear that

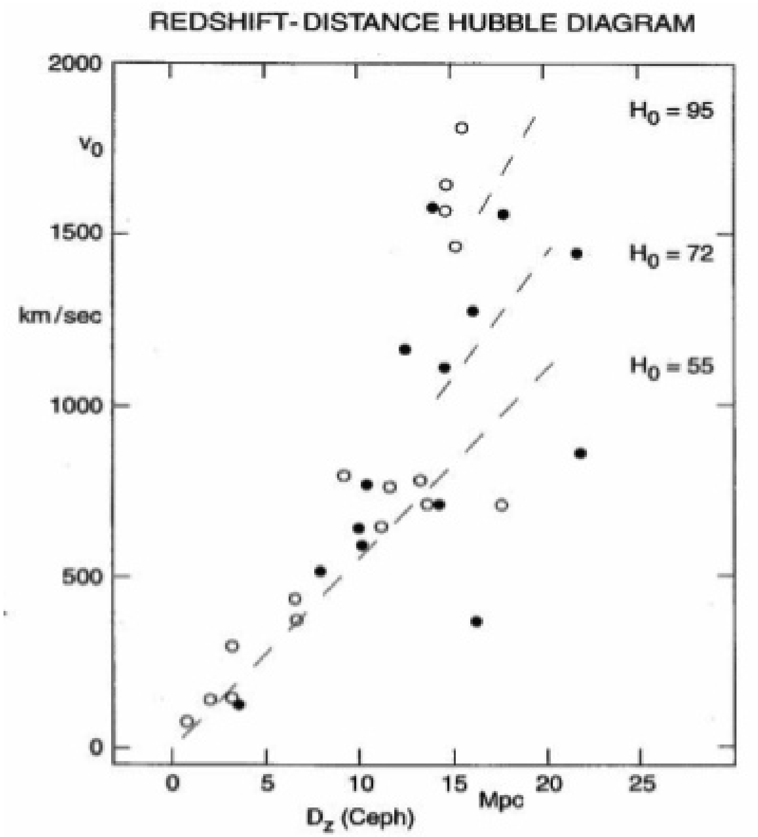

Figure 1. Using Cepheid variables as lighthouses reveals many galaxies much closer than their redshift distances, Sb (filled) and Sc (open circles) define $H_0 = 55 km/sec/Mpc$ with small spread in peculiar velocity. The deviation for higher redshifts cannot be due to peculiar velocity. (Data for diagram by kind permission of Halton Arp)

quasars were peculiar enough to warrant further investigation to establish observationally what they actually were in the scheme of things, and where they might be located in space.

Halton Arp and colleagues found that three aspects of quasar distribution were anomalous: Their distribution amongst other objects, that is, the 2-D density of quasars on the sky, showed an inordinate prevalence of quasars paired in close (angular) proximity across Active Galactic Nuclei; objects apparently physically associated in space had significantly varying redshifts; and the asymmetrical concentrations of isophotes on AGN/quasar maps indicated that the quasars were moving away from the AGN, suggesting ejection. In 1997, Arp, together with a team of Chinese astronomers, published a landmark paper: "Quasars around the Seyfert Galaxy NGC3516" (Chu et al. 1997) Arp has described this system as the "Rosetta Stone" of Intrinsic Redshift. He says, "*We report redshift measurements of 5 X-ray emitting blue stellar objects (BSOs) lo-*

cated less than 12 arc min from the X-ray Seyfert galaxy, NGC 3516. We find these quasars to be distributed along the minor axis of the galaxy and to show a very good correlation between their redshift and their angular distance from NGC 3516. All of the properties of the high redshift X-ray objects in the NGC 3516 field confirm the body of earlier results on quasars associated with active galaxies. We conclude that because of the number of objects in this one group, the evidence has been greatly strengthened that quasars are ejected from nearby active galaxies and exhibit intrinsic redshifts."

AM 2230-284 large quasar family is a striking example of a family of 14 quasars gathered around the central galaxy AM 2230-284 is examined in one of Arp's most recent studies (Arp & Fulton 2008). The peculiarity of this system typically extends also to the rate at which it expands intrinsically. Radial expansion at 3600 $km\ s^{-1}$ is measured, which includes a significant ejection component. We may then check to see if it matches the expansion rate expected if it really were at its redshift-supposed distance. Arp says, "*the cluster should be expanding with 9,955 km/s. But only 3,600 km/s is measured and most, if not all, of that is deemed ejection velocity. At the conventional redshift distance, however, just the expansion of space should imprint nearly 3 times as much front to back expansion velocity than actually measured for this quasar cluster.*"

Halton Arp in Redshifts of New Galaxies (Arp 1998) "*(The Quasar family around NGC5985) shows one of the most exact alignments of quasars and galaxies known. Attention was drawn to this region when it was discovered that a very blue galaxy in the second Byurakan Survey had a quasar of redshift z = 0.81 only 2.4 arcsecs from its nucleus. Even multiplying by 3 x 10^4 galaxies of this apparent magnitude or brighter in their survey they estimated only a chance proximity of 10^{-3}. A combined numerical probability of the configuration gives a chance of around 10^{-9} to 10^{-10} of being accidental.*"

Meanwhile, the original observations catalogued by Dr. Arp had prompted open enquiry by a number of astronomers in various fields of study. At the Instituto de Astrofísica de Canarias, Martín López-Corredoira and Carlos Gutierrez (hereafter L-C & G), both professional astronomers, studied individual systems to try to establish the presence of evidence supporting or refuting physical associations and material connections between objects in apparent proximity incompatible with their respective redshifts.

The classic case, featured on the covers of all Arp's books, is the famous "invisible" bridge linking NGC 4319 and the quasar Mrk 205. In the early 1980s, Dr. Jack Sulentic soundly debunked two much-cited papers that claimed the observed bridge simply did not exist, and in 2007, he reacted again to similar claims, this time in a press release from Hubble Heritage. In the HST image, Sulentic says, "*You can see the narrow core in the connection, which HST is able to detect because of its excellent resolution. It is seen exactly where we found it in the earlier studies . . . Hubble Space Telescope has in fact, confirmed our earlier work.*"

NGC 7603 is particularly interesting because it is one of the cases where filamentary connections appear between objects of different redshift. In "Research on candidates for non-cosmological redshifts" (López-Corredoira & Gutierrez 2006) the authors presented new evidence concerning two knots in the filament connecting NGC 7603 ($z = 0.029$) and NGC 7603B ($z = 0.057$). "*The angular proximity of both galaxies and the apparently luminous connection between them* *makes the system an important example of a possible anomalous redshift association . . . it seems extremely unlikely that objects 1-4 at different distances can, by chance, give a projection in the way these figures show up.*"

In 2004, Margaret Burbidge presented to the annual meeting of the American Astronomical Society a paper (Galianni et al. 2004) called "The Discovery of a High Redshift X-Ray Emitting QSO Very Close to the Nucleus of NGC 7319." In it, the authors presented observational evidence that a strong X-ray source (an Ultraluminous X-ray Source or ULX) with relatively high redshift ($z = 2.114$) lay in the foreground of NGC 7319, an active galaxy with relatively low redshift ($z = 0.022$). Several tests were conducted to determine whether or not it lay in the foreground, for if it were, beyond reasonable doubt, the case would be conclusive. Is the QSO behind the galaxy? "*One obvious question suggests itself, namely: Does the color of the QSO indicate that it is inordinately reddened and therefore obscured as if it were a background object? . . . We find that it is about 0.1 to 0.2 mag. bluer than average.*"

Dr. Arp and the Doctors Burbidge 2004: "The Double Radio Source 3C343.1: A galaxy-QSO pair with very different redshifts." (Arp, Burbidge, & Burbidge 2004) They summarise the case as follows: "*The strong radio source 3C343.1 consists of a galaxy and a QSO separated by no more than about 0.25″. The chance of this being an accidental superposition is conservatively* $\sim 1 \times 10^{-8}$*. The* $z = 0.344$ *galaxy is connected to the* $z = 0.750$ *QSO by a radio bridge. The numerical relation between the two redshifts is that predicted from previous associations. This pair is an extreme example of many similar physical associations of QSOs and galaxies with very different redshifts.*"

NEQ 3 is a system of 3 compact objects with angular spread <6 arcsecs, aligned with the minor axis of a lenticular galaxy at ~ 17 arcsecs. In "QSO + Galaxy association & discrepant redshifts in NEQ3" (Gutierrez & López-Corredoira 2004), L-C & G state: "*A filament is situated along the optical line connecting the main galaxy and the three compact objects . . . again, as in NGC 7603, we have seen that the system is even more anomalous than previously thought: we now have three different redshifts instead of two. Also as in NGC 7603, the origin of the filament is a mystery; it is supposed to be due to the interaction of the pair 1,2 with some other galaxy to the south-west. Where is this object? It seems that object 4 is the galaxy concerned, and this would imply anomalous redshift.*"

David G Russell is engaged in an ongoing, novel study of spiral galaxies in the Virgo Cluster, using the Tully-Fisher Relationship (TFR) to identify those galaxies that were physically bound in the cluster, and then comparing their mean redshift values. TFR describes an empirically derived correlation between the spin rate and luminosity of certain classes of spiral galaxy.

In his 2003 paper "Intrinsic Redshifts in Normal Spiral Galaxies"(Russell 2003), Russell states, "*The most dramatic result in Table IV is the extreme excess redshifts of the ScI/Seyfert group. Since three of these galaxies (NGC 4321, NGC 4535, NGC 4536) have Cepheid distances it is unlikely that this phenomenon results from inaccurate distances (see also Arp 2002). The result cannot be attributed to the morphological density relation (Dressler 1980) because the redshift excess is systematically positive and the galaxies in question are on both the front and backside of the mean cluster distance. Adopting a strict velocity interpretation of galaxy redshifts requires that as a group the giant Sb* *galaxies are approaching the Milky Way with a mean velocity of -898 km* s^{-1} *while the giant ScI galaxies are receding from the Milky Way with a mean velocity of +824 km* s^{-1}.”

The implication of Russell’s last sentence is crucial — the standard redshift interpretation of velocity would have us believe that galaxies migrate peculiarly by type! The notion of species-dependent universal expansion is an exceptionally strong argument against the Hubble Law.

J. C. Jackson (Jackson 1972) in 1972 found an observational effect in galaxy distribution data that caused clusters of galaxies to appear elongated when expressed in redshift space, taking on the appearance of “fingers” pointing towards Earth. The virial association of high velocities in clusters with their gravitation distorts the Hubble redshift relationship, and consequently, distance measurements are inaccurate, that is, anomalous according to the model. Furthermore, redshift-mapped large structures give anomalous results in terms of the Cosmological Principle, a fundamental requirement of the Standard Model of Cosmology, and the mathematical bedrock of universal expansion theory. In the paper “Large Scale Structure in the Universe Indicated by Galaxy Clusters,” (Bahcall 1988), Neta Bahcall states “*The cosmological principle states that the Universe is homogeneous and isotropic. Observations of galaxies and clusters, however, show inhomogeneities and structure on all scales studied so far . . . When does the Universe become homogeneous? How does the clumpy distribution of luminous matter fit with the highly isotropic distribution of the microwave background radiation on the largest scales? The answers are not known yet.*”

In 1967, Burbidge and Burbidge detected what appeared to be a quirky statistic in the redshifts of quasars: A preferred value of $z = 1.95$. In 1971, by which time the quasar database had expanded significantly, J. G. Karlsson established that quasar redshifts do indeed have preferred peaks, given by the formula $(1 + z_2)/(1 + z_1) = 1.23$, and tend to fall into the series $z = 0.061$, 0.30, 0.60, 0.91, 1.41, and 1.96. This phenomenon was verified by W. G. Tifft in a series of studies from 1976 to 1997. Burbidge and Napier found in 2000 in their paper “The Distribution of Redshifts in New Samples of Quasi-Stellar Objects” (Burbidge & Napier 2000) that, “*The redshift distributions of the samples are found to exhibit distinct peak . . . identical to that claimed in earlier samples but now extended out to higher redshift peaks . . . predicted by the formula but never seen before.*”

4. Discussion & Conclusion

The physical association between objects with different redshifts has been made abundantly clear in observation. In the documentary programme “Universe — the Cosmology Quest,” Geoff Burbidge puts it most succinctly: “*If you see two objects close together with very different redshifts, you only have one of two explanations. One is that a large part of the redshift has nothing to do with distance. The other is that it’s an accident. So the real issue . . . is how frequently do you expect to see accidents?*” (Meyers 2000)

Whichever way we treat quasars in cosmological modelling, they are peculiar. If they are distant, they are too bright to be true, and if they are nearby, they call for extraordinary physics to explain ejection. The holographic map of galaxy clusters in redshift space produces fingers and pancakes that point towards us in a way that exaggerates our significance in the scheme of things, and in any event are unlikely to exist in real space. Additionally, the possibility of super-galactic-scale structure weighs against the Cosmological Principle.

Several arguments have been raised in discussion and in the literature against those made in this review, including that the measured masses of quasars allow the implied intrinsic brightness at redshift distance; that the observed matter bridges are merely spectroscopic artefacts; that clustering of QSOs around AGN is statistically trivial; that the Virgo Cluster is in fact two clusters consisting of exclusive galaxy types migrating in opposite directions; that emission and absorption ratios indicate cosmological remoteness. None of these arguments has been brought to a definite conclusion, and face well supported opposition by the authors cited in this review. There are at the time of writing no grounds to assume from the evidence before us that intrinsic redshift is positively excluded as a factor in the anomalous observations. The anomalies have not been resolved.

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