Redshifts of New Galaxies

Halton ARP

Max-Planck-Institut für Astrophysik
Karl-Schwarzschild-Str. 1
85740 Garching, Germany

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Abstract

Observations increasingly demonstrate the spatial association of high redshift objects with larger, low redshift galaxies. These companion objects show a continuous range of physical properties - from very compact, high redshift quasars, through smaller active galaxies and finally to only slightly smaller companion galaxies of slightly higher redshift. The shift in energy distribution from high to low makes it clear that are seeing an empirical evolution from newly created to older, more normal galaxies.

In order to account for the evolution of intrinsic redshift we must conclude that matter is initially born with low mass particles whose mass increase with time (age). This requires a physics which is non-local (Machian) and which is therefore more applicable to the cosmos than the Big Bang extrapolation of local physics. Ambartsumian's "superfluid" foresaw some of the properties of the new, low particle mass, protogalactic plasma which is required, demonstrating again the age-old lesson that open minded observation is much more powerful than theoretical assumptions.

Since the ejected plasma, which preferentially emerges along the minor axis of the parent galaxy, develops into an entire galaxy, accretion disks cannot supply sufficient material. New matter must be created within a "white hole" rather than bouncing old matter off a "black hole".

1   Introduction

Evidence for the association of high redshift objects with low redshift galaxies emerged in 1966 with completion of the systematic study in the Atlas of Peculiar Galaxies. For the most recent summary of the evidence to date see Arp (1998b). In the present report, however, we concentrate on the most recent observations and those which summarize best the empirical properties which characterize the associations. These latest discoveries reinforce a picture of empirical evolution which progresses from newly born, high redshift protogalaxies (quasars) to older, more normal, low redshifts galaxies.

2 The Quasars around NGC5985

Fig. 1 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 (Markarian et al. 1986) had a quasar of redshift z = .81 only 2.4 arcsec from its nucleus (Reimers and Hagen 1998). Even multiplying by 3 x 104 galaxies of this apparent magnitude or brighter in their survey they estimated only a chance proximity of 10^{-3}. (Nevertheless they took this as proof that it was a chance projection! Also it was not referenced that G.Burbidge, in 1996 in the same Journal, had published extensive list of other quasars improbably close to low redshift galaxies).
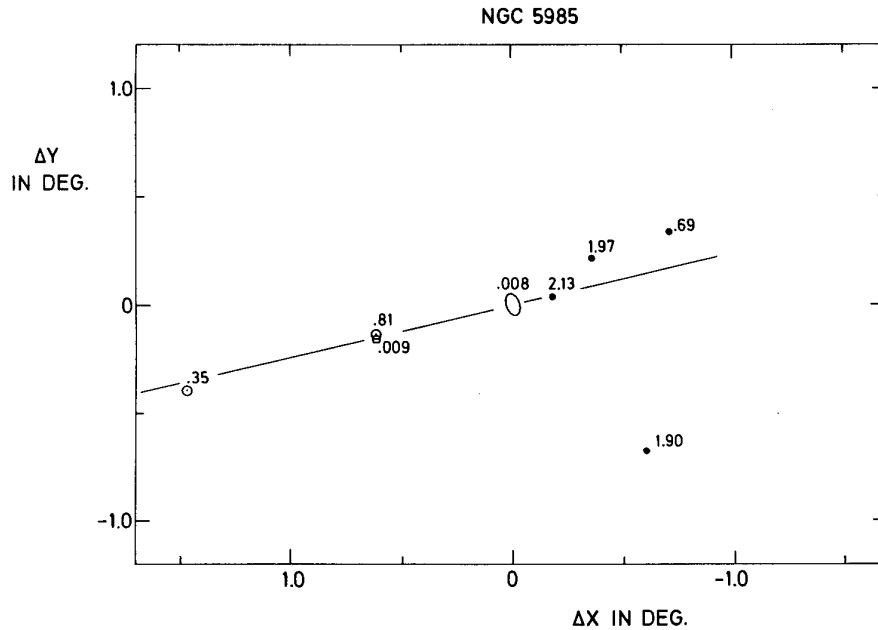

Figure 1: All catalogued active galaxies and quasars within the pictured area are plotted.Redshifts are labeled. The dwarf spiral 2.4 arcsec from the z = .81 quasar has z = .009 which marks it as a companion of the Seyfert NGC5985 at z = .008. The line represents the position of the minor axis of NGC5985.

But the galaxy was a dwarfish spiral, showing no active nucleus from which the quasar could have emerged. Proceeding on the by now overwhelming evidence that Seyfert galaxies eject quasars (Radecke 1997; Arp 1997a) I looked in the vicinity for a Seyfert. There was NGC5985, only 36.9 arcmin away on the sky! The chance of finding a Seyfert as bright as V = 11.0 mag. this close to the z = .81 quasar was less than 10^{-3}.

The next obvious question was: Were there other quasars in the field? Fig. 1 shows that there are 6 catalogued quasars discovered in a uniform search of the area in the Second Byurakan Survey. (P. Veron, in this Symposium, reports 66 - 88 % completeness for this survey - probably typical for quasar surveys). But five of these six quasars fall on a line through the Seyfert, with the dwarf galaxy along the same line. What is the probability that three or four objects

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would accidentally align within a degree or so of as straight line through the Seyfert? Conservatively this can be computed to be of the order of 10^{-4} to 10^{-5}. But the most astonishing result of all is that if one looks up the position of the minor axis in NGC5985 it turns out, as shown in Figs. 1 and 2, to be a line that looks as though it were drawn through the positions of the objects!

Just a simple visual evaluation of Fig. 1 would lead to the conclusion that the configuration was physically significant. A combined numerical probability of the configuration gives a chance of around 10^{-9} to 10^{-10} of being accidental (Arp 1998). Nevertheless several peer reviewers recommended against publication on the grounds that the accidental probability was "greater" than this. But, of course, several dozens of cases of anomalous associations had been reported since 1966 with chance probabilities running from 10^{-4} to 10^{-5}. What is the combined probability of all these previous cases? And what is the motivation to claim each new case is "a posteriori"?

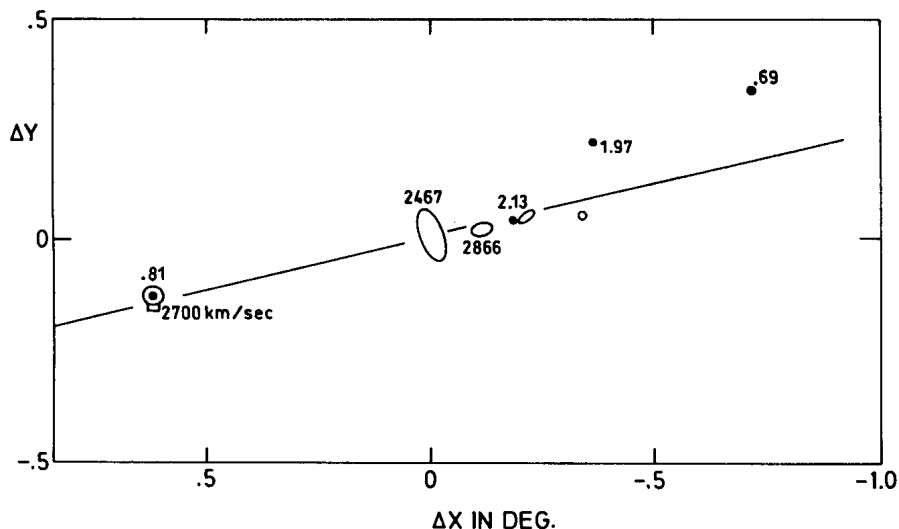## 3   The Companion Galaxies Around NGC5985

Figure 2: The central portion of Fig. 1 is here enlarged and all NGC galaxies are additionally plotted. Three additional companions are seen to lie along the WNW minor axis. The redshifts of the galaxies are now labeled in km/sec and it is seen that the two companions whose redshifts are known have slightly, but significantly, greater redshifts.

We have seen that the quasars are aligned along the minor axis of the central Seyfert. Sections that follow summarize that generally both quasars and companion galaxies are aligned along the minor axes. Is this true of the NGC5985 family? In Fig. 2 I have enlarged the central regions of Fig. 1 and plotted all the bright, NGC galaxies in the region. It is apparent that these NGC galaxies, which are fainter than NGC5985 as companions should be, are almost exactly aligned along the WNW extension of the minor axis! Taken together with the dwarf companion on the other side of the minor axis, this leaves no doubt that in the case of NGC5985 the companion galaxies and quasars are

aligned exactly along the same minor axis. This then constitutes another proof that these objects of variously higher redshift have some physical relation to the low redshift,central galaxy.

There is confirming evidence in the measured redshifts of these companions. As Fig. 2 shows, the one to the ESE is about +230 km/sec with respect to NGC5985 and the one to the WNW is about +400 km/sec. These redshifts are close enough to that of the parent galaxy to conventionally confirm their status as physical companions. But at the same time they exhibit the systematic excess redshift of younger generation galaxies in groups (See Fig. 1 of preceding paper in this volume and Arp 1997). In the following sections we will interpret this excess redshift as indicating that they have more recently evolved from quasars. Since they are older than the quasars, they have had time to fall back from apgalacticon to within a few diameters of the parent galaxy.

4 The Empirical Model of Ejection and Evolution

As Fig. 3 shows, we can now combine the data from the last 32 years of study of physical groups of extragalactic objects. What results is a sequence of quasars emerging from a large galaxy along its minor axis, increasing in luminosity and
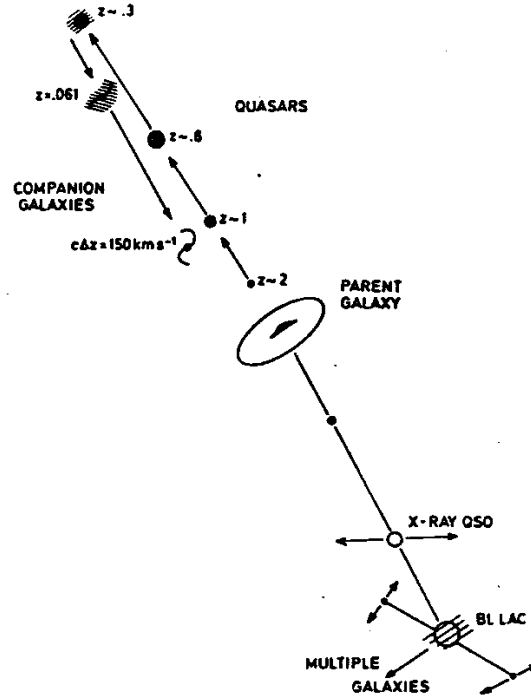

Figure 3: Schematic representation of quasars and companion galaxies found associated with central galaxies from 1966 to present. The progression of characteristics is empirical but is also required by the variable mass theory of Narlikar and Arp (1993).

decreasing in redshift as they move outward. When they reach a maximum distance of about 500 kpc they have started to turn into compact, active galaxies. As they age further into more normal galaxies they may fall back toward the parent galaxy. In that case they fall back along the minor axis because they emerged with little or no angular momentum component. *They move on plunging orbits.*

Ambartsumian (1958) noted that companion galaxies seemed to be ejected from larger galaxies. Arp (1967;1968) showed evidence that quasars were also ejected from galaxies. The astronomer most knowledgeable about disk galaxies, Erik Holmberg (1969), showed companion galaxies aligned along minor axes. He concluded they must be formed from gas ejected from the nucleus. Burbidge and Burbidge (1997) showed gas ejected along the minor axis of the strong Seyfert, NGC4258. Arp (1997b) showed a number of pairs of X-ray quasars ejected closely along the minor axis of Seyferts (e.g. NGC4235, NGC2639).

These observational results are now summarized in Fig. 4. It is seen that the quasars preferentially come out in a cone angle of about $\pm 20^o$. The companion galaxies are preferrentially confined within about $\pm 35^o$. This difference is in the expected direction because as the quasars reach their maximum extension and slow down, they are vulnerable to perturbation by objects at that distance and
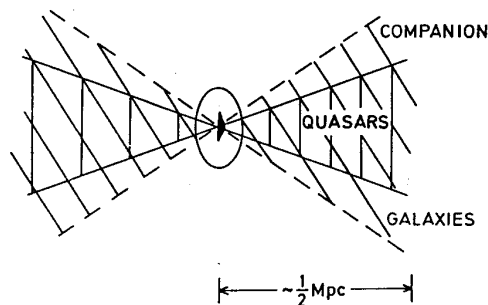

Figure 4: Schematic representation of distribution of companion galaxies along minor axes of disk galaxies ($\pm 35^o$ from Holmberg 1969; Sulentic et al. 1978; Zaritsky et al. 1997). Quasars are observed $\pm 20^o$ from minor axis (Arp 1998a).

hence will fall in again along slightly deviated orbits. Also since the companions are older, the more recent ejection axes of quasars in some cases have moved because of precession of the galaxy or the spin axis of the nucleus.

5 Verification of the Model

The above model combines many cases, each one of which may only contain a few elements. But it is now possible to show in Fig. 5 the active Seyfert NGC3516. This galaxy is exceptional because it confirms the essentials of the model in a single case. The objects are drawn from a complete sample of bright X-ray objects within about 22 arc min of the Seyfert (Chu et al. 1998). Notice there are 5 quasars and a BL Lac-type object, the latter object representing a transition between a quasar and a more normal galaxy. The redshifts of these six objects are strictly ordered with the highest closest to the Seyfert and the lowest furthest away. They define very well the minor axis of the galaxy.
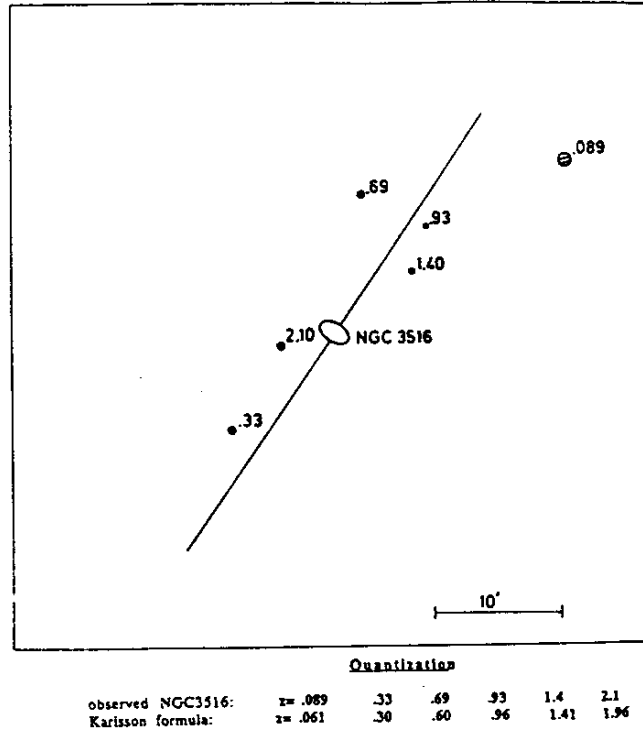
Figure 5: All bright X-ray objects around the very active Seyfert galaxy NGC3516 which have had their redshifts measured by Chu et al. (1998). Redshifts are written to the upper right of each quasar and quasar like object.

As a side note it is clear that each of the six redshifts fits very closely to the quantized redshift peaks observed in quasars in general. Those peaks are: .06, .30, .60, .96, 1.41, 1.96 (Arp et al. 1990). If these redshifts represented Doppler velocities, of course, quantization would be destroyed by random orientations to the line of sight. So quantization is direct proof that extragalactic redshifts are nonvelocity. The intrinsic redshifts are indicated to evolve in discrete steps as the quasars evolve into galaxies. The quantization of redshifts in smaller steps in the companion galaxies further supports their being end products of this evolution.

The NGC5985 case shown in Fig. 2 confirms very well the later stages of smaller redshift where the evolved companion galaxies have fallen back toward the parent galaxy. The very exact alignment of quasars and companion galaxies must mean that the minor axis of NGC5985 has stayed unusually well fixed in space over the time required to evolve from a high redshift quasar to a reasonably normal galaxy, or about 7 x 109 years (Arp 1991). Another case of a very narrow alignment of companion galaxies can be seen around our Local Group center, M31 (Arp 1998a).

The length of the NGC5985 line and the brightness of its components suggests that the group is closer than most Seyferts so far investigated. In particular the distribution of quasars is much closer to NGC3516 which appears to be more distant. It is also clear, however, from the measured ellipticities of the images,

that the minor axis of NGC3516 is tipped much closer to our line of sight than in NGC5985. That accounts for some foreshortening of the NGC3516 line as well as an apparently greater spread off the line relative to the length of the line.

6 Statistics

From 1966 onward statistical associations of high redshift quasars with low redshift galaxies were reported (Arp 1987). Significances ranged from 16 to greater than 7.5 sigma. We will give only the latest example here as shown in Fig. 6. There it is shown that a nearly complete sample of Seyfert galaxies have a conspicuous excess of bright X-ray point sources within about 50 arcmin radius (Radecke 1997; Arp 1997a). Since these X-ray sources are essentially all quasar or quasar-like one can see at a glance that there are a large number of quasars physically associated with nearby Seyfert galaxies.
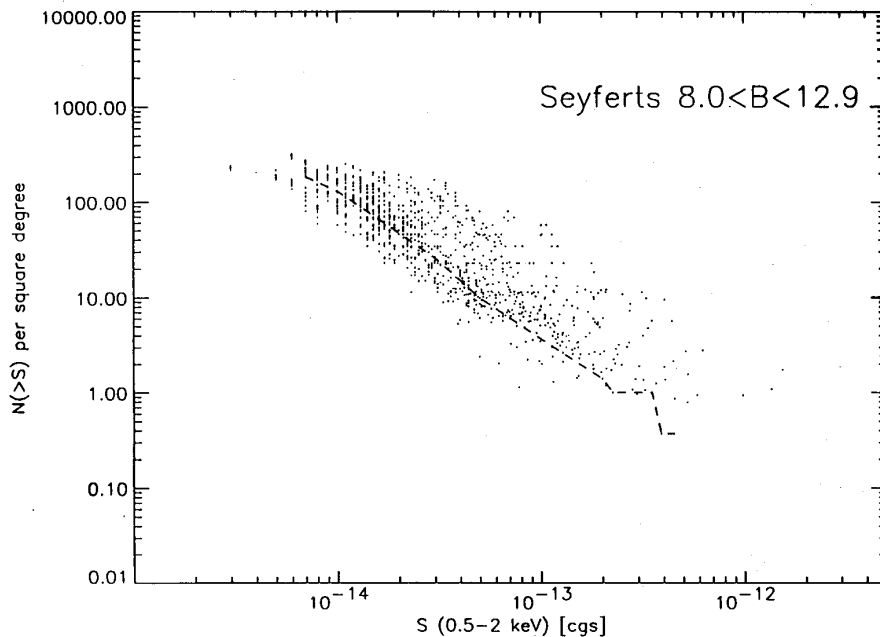

Figure 6: Cumulative number of X-ray sources brighter than strength (S) around a nearly complete sample of bright Seyfert galaxies. Dashed line represents counts in non-galaxy control fields.

7 Theory

What would give an intrinsic (non-velocity) redshift to a galaxy - high when it is first born - and decreasing as it ages? The answer was supplied by Narlikar in 1977. It rests on the fact that the standard solution of the Einstein field equations as made by Friedmann in 1922 made one key assumption. It assumed

that the elementary particles which constitute matter remain forever constant in time. A more general solution, as Narlikar showed, had the mass of particles increasing with time. This would furnish a series of answers to paradoxes which currently falsify the standard Big Bang solution:

1) Episodic creation near zero mass, giving initial outflow at signal speed, c.

2) Condensation into proto galaxies.

3) An intrinsic redshift initially high and decreasing with time.

4) Evolution into normal galaxies moving with small velocities.

5) Possibility of understanding quantized redshifts.

6) Transformation to local physics using local time scales.

The details of this theory are explained in recent publications Arp (1998b). But here it should be emphasized that the observational disproofs of the conventional, singular creation theory can no longer be discarded with the claim that there is no viable alternative theory. The empirical conclusions of Ambartsumian and many others who followed, have now been supported by numerous amplifying observations and a unifying physical theory has been adduced.

It is clear from the experience of the last 40 years that influential astronomers will accept neither the observations which falsify the current beliefs nor the theory which enables these observations to be understood. Therefore it is of the utmost importance for each individual researcher to examine and judge the facts for themselves. The usefulness of each person's career labors and their usefulness to science will depend on their choosing the correct fundamental assumptions.

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