Evolution of Quasars into Galaxies and its Implications for the Birth and Evolution of Matter

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In recent years satellite observations have recorded a number of point X□ray sources in the sky. Such sources are overwhelmingly identified with medium to high redshift quasars. These quasars can now be shown to originate in low redshift, active galaxies which eject them along their minor (rotation) axis. It can be empirically demonstrated that this is how galaxies are born and evolve. The observations invalidate the assumptions of Friedmann and Einstein in General Relativity and require a more general, Machian solution of the field equations in flat space-time.

Introduction

Quasars are stellar appearing objects which have large redshifts. They were discovered in 1963 and interpreted as having high recessional velocities which required them to be out near the limits of the visible universe. Already in 1966, however, evidence started to accumulate that quasars were in fact ejected from the nuclei of nearby galaxies and that their redshifts were due to some intrinsic cause, *not* translational velocity.

Evidence for nearby quasars continued over the years to come from many different kinds of observations. The observations also included young galaxies which had physical continuity with quasars and which also showed non–velocity redshifts. This data, up to about 1987, is discussed in *Quasars, Redshifts and Controversies*' (Interstellar Media). In the following decade X–ray observations have picked out quasars with increasing efficiency and massively confirmed the previous association of young higher redshift objects with nearby, low redshift parent galaxies.

X-ray Sources around Seyfert Galaxies

In 1996 H. Arp and H.-D. Radecke analyzed archival X–ray fields around a nearby complete sample of Seyfert Galaxies. These galaxies had been investigated by many different observers because their nuclei were strong sources of high energy emission, including X-rays. In the surrounding areas, however, the results showed an excess of point–like X-ray sources around these Seyferts (Radecke 1997). The results for 24 fields are shown here in Fig. 1. The X-ray sources were obviously physically associated with the central galaxy and almost all of those identified turned out to be quasars (Arp 1997).

The associated X-ray quasars confirmed strongly the pairing and alignment across the ejecting galaxy which had first been observed in 1966. (Radio sources, of which quasars are a sub class, had been accepted since the 1950's as being ejected from the nuclei of active galaxies.) Fig. 2 here shows one example of a pair of bright X-ray quasars across a bright, active Seyfert Galaxy, NGC 4235.

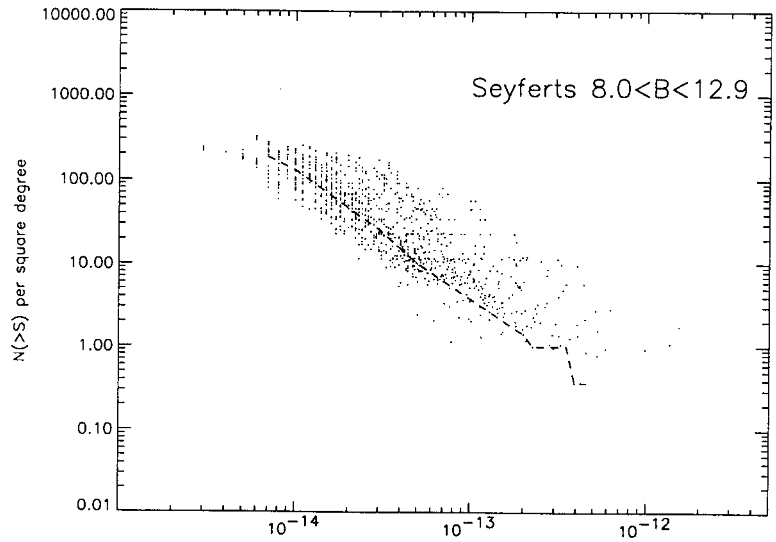


Figure 1. The density of X–ray sources greater than a given brightness *S*, for X–ray fields around 24 bright Seyfert galaxies. The dashed line represents the average relation from 14 high latitude control fields.

This example illustrates a number of properties of the configurations which cannot be due to chance arrangement of background objects. The chance of accidental arrangement for *each one* of the many examples runs from between one in a million to one in ten million. The configuration aspects which are repeated in all the examples however, furnish the data which leads to understanding the physical processes involved.

The Charasteristic Configuration of X-ray Sources and Parent Galaxy

Fig. 3 shows the average behaviour of physical companions around an active galaxy. The salient characteristics are:

- Quasars emerge as high redshift, low luminosity objects.
- As they travel outward their ejection velocity slows, their luminosities increase and their intrinsic redshifts decrease.
- When they reach maximum extension from the parent galaxy (about 400 kpc) they increasingly behave as BL Lac objects—that is they experience a burst of synchrotron continuum emission which drastically decreases the visibility of emission lines in the spectrum. They readily break up at this stage and exhibit secondary ejection.
- The BL Lac phase begins to show spectral evidence of an underlying stellar population. The quasar is beginning to evolve into a galaxy.
- Subsequent evolution into compact galaxies, blue galaxies and galaxies which are themselves ejecting new generations of objects continues until normal companion galaxies are reached. These companions can be less closely distributed along the line

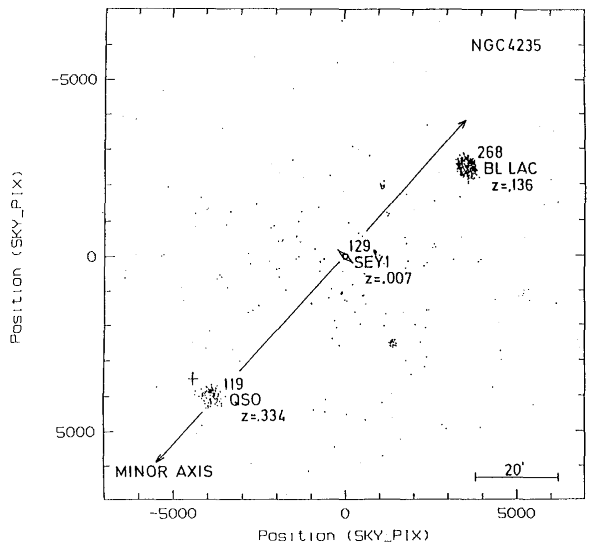


Figure 2. An X-ray map of the area around the Seyfert galaxy NGC 4235. The very bright quasar–like objects of z = .334 and .136 are aligned closely along the minor axis.

back to the original parent galaxy, as if they had experienced some perturbations during their aging. But they never lose all of their excess redshift.

- All galaxies and quasars have quantized redshifts. The quasars are quantized in large steps: z = 1. 96, 1. 41, . 96,. 60,. 30 and. 06. The low redshift galaxies into which they evolve have redshifts quantized in steps of z = .0002 and .0001 (cz = 72 and 37. 5 km/sec).

Confirmation by a Single Example

In April 1997 Prof. Yaoquan Chu communicated to me the sensational result shown in Fig. 4. He had measured the bright X-ray sources around the very active Seyfert NGC 3516. They turned out to be quasars ordered in redshift, culminating in the most distant, a bright optical and X-ray BL Lac type object. All six of these quasars fell within ± 20 degrees of the minor axis of NGC 3516 (a chance, just in this one property, of only 10^{-4} of being accidental). As the bottom of the Figure shows, the redshifts of these six ejecta fit very closely the periodicity which has been known for quasars for more than 20 years.

Evolution of an Intrinsic Property

If high redshift quasars are physically associated with low redshift galaxies ($z \leq .01$), then the redshifts cannot be interpreted as recession velocities. Observations of the high redshift objects rule out gravitational redshifting or "tired light'' effects. If the electrons making the orbital transitions in atoms of the high redshift object are less massive than those of the observer, however, the emitted photon will be redshifted. Can this be reconciled with physics as we know it?

Actually the 1922 Friedmann solution of the Einstein field equations of General Relativity *assume* the particle masses comprising matter are constant. A more *general* solution of the field equation yields:

$$m = at2$$

where m is particle mass, t is cosmic time and a is a constant.

With this one simple solution particle masses grow with time, young objects start with high intrinsic redshifts and evolve to lower redshift as they age. This is exactly what 30 years of empirical evidence has required (Arp 1991, Narlikar and Arp 1993).

For example, Erik Holmberg showed in 1969 that companion galaxies concentrated primarily within ±35 degrees of the minor axis of disk galaxies. Now as Table 1 shows, *quasars* concentrate within about ±20 degrees of the minor axis and reach a 400 kpc extension from the ejecting galaxy *exactly the same extent and alignment as companion galaxies*. As quasars age into companion galaxies they clearly spread more from the line of initial ejection either by axial precession or gravitational perturbations. Whatever causes the quantized steps in their redshifts, they must become smaller, however, as their total redshifts become smaller. So they are also continuous in the property of quantization with age. There should no longer be any reasonable denial that the variable particle mass theory uniquely fits the observations.

Continuous Creation Replaces Big Bang Theory

The variable mass theory is Machian, not a local theory as Einstein ruefully conceded about conventional General Relativity. When a new particle is created it sees a very small universe. As time goes on it exchanges signals within a light sphere which is growing at *c*. As the particle mass increases electron transitions emit higher energy quanta and the intrinsic redshift decreases.

New matter is created with near zero mass, therefore it is travelling with nearly the signal speed of the medium, namely the velocity of light. As the particle mass grows, however, its translational velocity drops in order to conserve momentum. It finally comes to rest near the observed 400 kpc maximum extension shown in Table 1. This is the same maximum extension quantitatively predicted

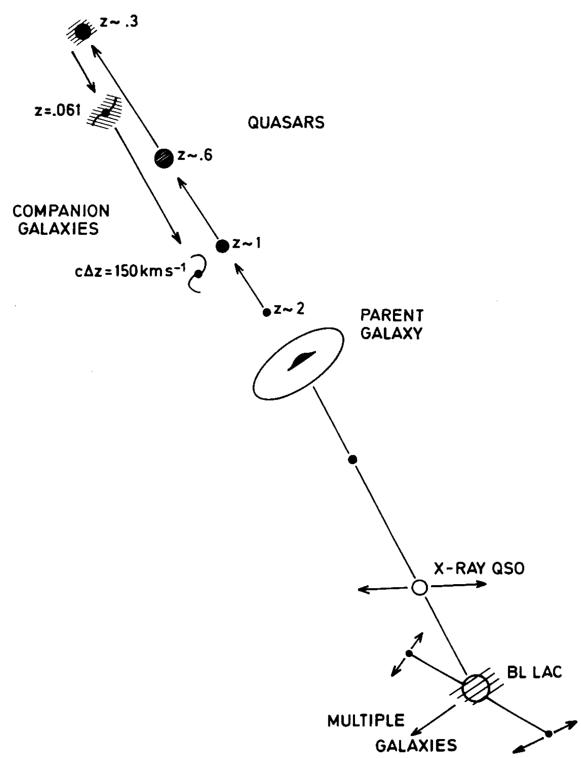
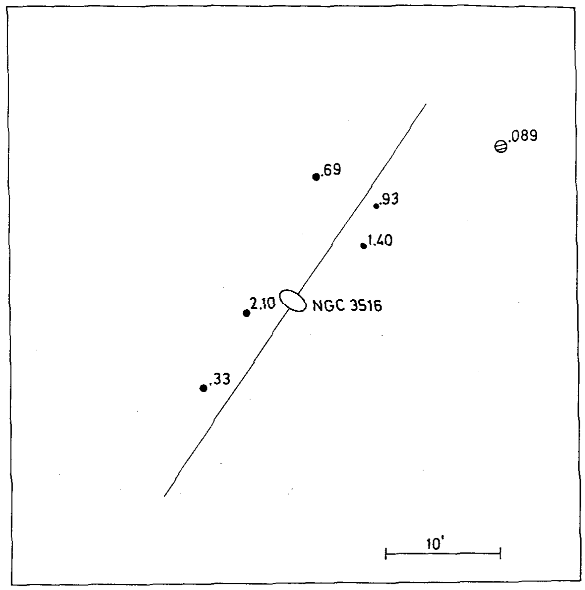


Figure 3. Summarizing the empirical data for low redshift ejecting galaxies and their associated quasars and companion galaxies since 1966. The high redshift quasars lose their intrinsic redshifts as they travel out and eventually evolve into companion galaxies of only slightly higher redshift.



Quantization

observed NGC3516:	z= .089	.33	.69	.93	1.4	2.1
Karlsson formula:	z= .061	.30	.60	.96	1.41	1.96

Figure 4. All bright X-ray objects arround the very active Seyfert galaxy NGC 3516 have had their redshifts measured by Y. Chu. Redshifts decline as they separate from the ejecting galaxy.

by Narlikar and Das (1980).

Moreover, the random velocities within a young plasma must diminish as the particles gain mass and therefore its temperature drops. We have the ideal explanation for how a hot plasmoid ejected from an active galaxy can cool and condense into a quasar and eventually evolve into a normal galaxy. The synchrotron "knots'' observed leaving the nucleus of M87, for example, could never make the transition into the older galaxies observed to be aligned along the direction of the jet. In a conventional plasma the large particle masses would contain too much energy and consequently blow the plasmoid apart before it could cool. What we now have with the low particle mass plasma is Viktor Ambartsumian's "superfluid'' which he intuitively described just from looking at a photograph of new galaxies being formed in ejections from other galaxies in 1957.

Where the Friedmann/Einstein Expanding Universe Fails

Fig. 5 shows that the conventional solution of the field equations leads to expanding spatial coordinates and redshifts caused by recessional velocity. This violates the observations previously summarized in this paper. The variable mass solution outlined in the right column, however, explains nicely the intrinsic redshifts as due to the creation age of the matter.

As we have mentioned, the Narlikar (1977) solution is a general solution of what are essentially just energy conservation equations. The general solution, however, is non-local, Machian. It does not require the unrealistic assumption of homogeneity. It avoids the embarassing singularities where physics simply breaks down in the current theory. Instead these singularities become the necessary creation points of "new'' matter. By conformally transforming to our galaxy's time scale (τ) we recover all standard local physics. The continual creation solution takes place in flat (Minkowski) space-time. There is no need for the semantic contradictions of "curved space-time''.

Table 1 Companion Objects around Spiral Galaxies

No.	Companions	$\Delta\Theta_1$ $\Delta\Theta_2$	$r_1 \sim r_2$	Reference
2	quasars across NGC 4258	13° 17°	25-30 kpc	Pietsch *et al.* 1994
2 + (4)	quasars across NGC 2639	0° 13°(31°)	10-400	Fig. 3
2	quasars across NGC 4235	2° 12°	500-600	Fig. 4
4	quasars nearest NGC 1097	~ 20°	100-500	Arp 1987
6	quasars nearest NGC 3516	±20°	100-400	Chu *et al.* 1997
218	$comp^n$s around 174 spirals	~35°	40 kpc	Holmberg 1969
96	distbd. $comp^n$s around 99 sp.	~60°	150	Sulentic *et al.* 1978
115	$comp^n$s around 69 spirals	~35°	500	Zaritsky *et al.* 1997
12	$comp^n$s of M31	~0°	(700)	Arp 1987

Since the large redshifts are predominantly due to young age there is no evidence, and indeed no place for, recessional velocities and no evidence for an expanding universe. It can be argued that the cosmic microwave background is simply the temperature of the intergalactic medium, averaged through the line of sight to obtain the extreme smoothness which is observed. The CMB is therefore likely to be the primary reference frame which is such an anathema to conventional relativity.

References

Arp, H. 1987, *Quasars, Redshifts and Controversies*,' Interstellar Media, Berkeley.

Arp, H. 1991, *Apeiron*, Winter–Spring, 18.

Arp, H. 1997, *Astron. Astrophys*. **319**, 33.

Chu, Y., Wu, J., Hu, J., Zhu, X. and Arp, H. 1997, *Ap. J.* in press.

Holmberg, E. 1969, *Arkiv. of Astron*., Band 5, 305.

Narlikar, J. V. 1977, *Annals of Physics* **107**, 325.

Narlikar, J. V. and Das, P. K. 1980, *Astrophys. J*. **240**, 401.

Narlikar, J. V. and Arp, H. 1993, *Astrophys. J*. **405**, 50.

Pietsch, W. *et al.* 1994, *Astron. Astrophys*. **284**, 386.

Radecke, H. –D. 1997, *Astron. Astrophys*. **319**, 18.

Sulentic, J. W., Arp, H. and di Tullio, G. A. 1978, *Ap. J.* **220**, 47.

Zaritsky, D., Smith, R., Frenk, *C.* S. and White, S. D. M. 1997, *Ap. J.* **478**, L53.

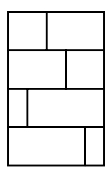
Friedmann (1922)	Narlikar (1977)
Special solution • m =constant $\frac{S(\tau_o)}{S(\tau)} = 1 + z$	**General solution** • $m = m(t)$ $\frac{m_o}{m} = \frac{t_o^2}{t^2} = 1 + z$
$H_o = \frac{\dot{S}}{S}\Big\|_{\tau=\tau_o}$	$H_o = \frac{2}{t_o}$
• Expanding coordinates • Singularities at $m = 0$ $\tau = 0$	• Non expanding Universe (Euclidean) • Creation points at $m = 0$
• $z \equiv$ velocity • distance $\equiv \frac{z}{H_o}$ 	• Quantum ⇔ classical physics • Merging time scales t, τ • Cascading, episodic creation • Indefinitely large, old Universe
$z = z(t)$	

Figure 5. A schematic summary of the Big Bang (left hand side) versus the more general, variable mass solution (right hand side) of the General Relativistic field equations. The conventional assumption that particle mass, *m*, is constant leads to an expanding universe and collision with the brick wall of observation that redshifts are not primarily velocity but intrinsically age related. The Machian solution on the right gives redshift (*z*) as a function of age (*t*), predicts the correct Hubble constant, turns conventional singularities into creation points of “new’’ matter and permits connection with non-local theories such as quantum mechanics.