RADIO STRUCTURES IN QSO–GALAXY PAIRS

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Abstract

It is now generally agreed that if quasars and nearby low redshift galaxies are associated, then there should be luminous connections between them. However, most of the observational evidence being presented is in the optical domain, whereas such evidence should also exist at radio frequencies. We are, therefore, investigating some QSO–Galaxy pairs at radio frequencies to search for luminous connections and other structural peculiarities. Radio maps of some of these sources are presented.

A focus of current debate in modern astronomy is the apparent lack of consensus in the understanding of the relationship (or lack of it) between quasars and 'host' galaxies, and the controversy surrounding the conventional interpretation of redshifts (e.g Burbidge, 1981; Arp, 1986). Central to this puzzle is whether quasars are active nuclei of distant galaxies– that is whether quasar redshifts are cosmological. The conventional view is that quasars are relatively distant objects as indicated by their redshifts. On the other hand some astronomers believe quite strongly that quasars are comparatively local objects genetically related to galaxies, perhaps compact galaxies ejected from the nearby parent galaxy, the redshift excess being due to local Doppler effects (see Burbidge, *et al.* 1971).

It is therefore believed by the latter group that many quasars and nearby low redshift galaxies are physically related despite having discordant redshifts. Most of these evidence of physical association are presented in the form of optical images. But if such pairs of objects are physicaly related, then there might also be luminous radio connections between them, particularly if both objects are radio–loud. Morever, evidence of association cannot be placed on a firm foundation without supporting results at other wavebands. Such luminous radio connections may be in the form of either diffuse emission or bridges, or higher resolution features like connecting jets or knots. The type of radio connection found may also help to explain the type of relationship between the associated objects and the time–scale of any possible interaction compared with radio source life–times.

But a technical limitation exists since the separation of objects in these pairs is sometimes a few minutes of arc, making it difficult to obtain at high angular resolution a single image containing a pair of objects. Another approach, therefore, to this problem is to investigate the structures of the individual members of the pairs, in order to search for systematic effects or structural peculiarities than can distinguish them from non–pair objects.

In this paper we report the progress in our investigation of radio structures of some suggested quasar–galaxy pairs. Our sample consists of 16 sources chosen from the 3C and 4C catalogues (Table I, see Burbidge 1985 for a more comprehensive list). Each member of the pair is radio–loud. Radio images of the pairs or the dominant rado emitting object is being obtained with the VLA or MERLIN at different wavelegths. The aim is to, without prejudice, search for possible peculiarities of character and luminous connections between these pairs of objects. Radio maps of some of these objects are presented with brief comments on the individual soucres.

0114+074 (4C 07.04): The radio images of the objects have been obtained with the VLA and MERLIN at different wavelengths (Akujor, 1989; Akujor *et al.* 1989). The quasar 0114+074N is a point source (unresolved) at all wavelengths. The radio galaxy (0114+074) is a very asymmetric source with one component having a spectral index of 1.13 (S $\sim \nu^{-\alpha}$) while the other is flat, α=0.45.

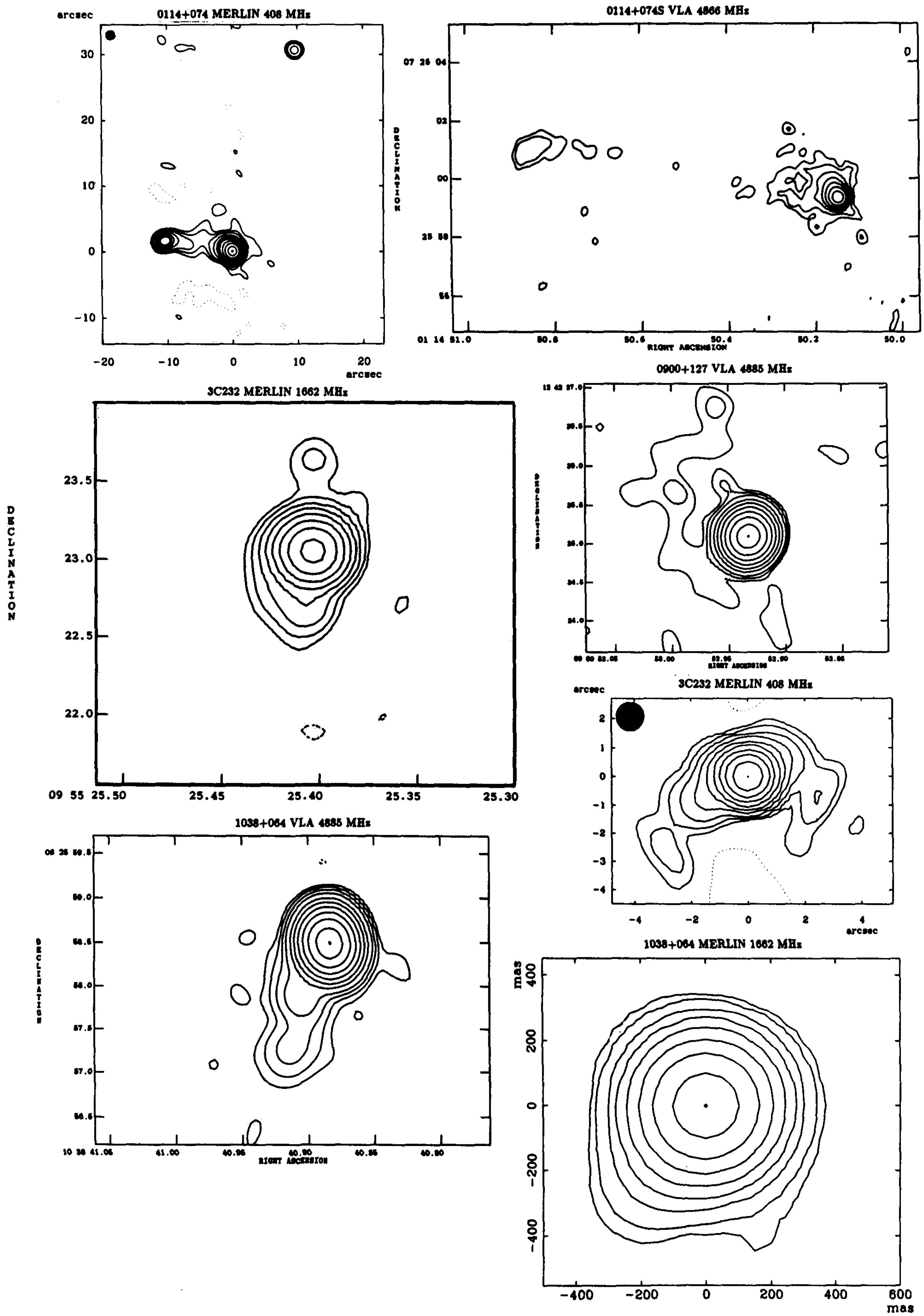
0900+127 (4C 12.33): The VLA radio image is presented. The radio quasar has a steep spectrum source and is unresolved with the VLA at 5 GHz but there are indications of a surrounding fuzzy structure. The companion is a symmetric double radio galaxy.

0955+327 (3C232): The first ever radio images of this quasar are presented. Both Perley (1982) and Rogora et al (1986) had failed to detect extended emission with the VLA. The 408 MHz map shows a –two sided emission, while at 1.6 GHz there is a jet that points soutwards in the direction of the companion galaxy. It is interesting that the position angle of this jet corresponds to that seen in the recent HI observations of Carilli *et al* (1989).

1038+064 (4C 06.04): The maps of this radio quasar have been obtained with the VLA, MERLIN and VLBI (Akujor & McGruder, In preparation). The quasar has a flat radio spectrum with a core–jet structure. Akujor & McGruder do show that the changes in the position angle of the jet with increasing resolution imply that the jet, and hence the core may be rotating. The dominant companion radio galaxy (1037+067) has a possible tailed structure, but there are at least 5 other radio objects with $S_{327MHz} \geq$50 mJy within 2 arcmin of the radio quasar. Some of these objects probably belong to a cluster as suggested by Burns et al (1981).

1206+439 (3C268.4): This is a powerful quasar with a triple structure and a characteristic double hotspot in the southerly lobe (Lonsdale & Barthel, 1986). There is another weak radio source ~4 mJy SE of this source.

1218+339 (3C270.1): The MERLIN image of this source confirms the non–collinear structure usually refered to as 'dog–leg structure' (Stocke *et al*, 1985). Hintzen & Scott (1978) suggest that such quasars are members of galaxy clusters, while Stocke *et al* (1985) propose that the non–collinearity could arise from collisions of the radio lobes with nearby galaxy halo or an intergalactic cloud.



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1241+166 (3C275.1): This is another 'dog–leg' (Stocke *et al* 1985) radio quasar. Our VLA map is broadly consistent with the higher resolution map of Stocke *et al.* Hintzen & Romanishin (1986) have detected a large cloud of line–emitting gas surrounding this quasar (see also Hintzen & Stocke 1986)

1441+522 (3C303): Our high resolution map shows clearly the compact features of this source– a bright core identified with a galaxy and a knotty jet that points to the western hotspot complex. The nearby quasar (Z=1.570) is south (~7 arcsec) of this hotspot complex, but is enclosed by an extended halo detected in low resolution maps (Kronberg *et al.* 1977). A recent VLA map by Perley (1988) reveals the extent of this halo and the presence of a compact hotspot East of the core.

1458+718 (3C309.1): This is compact source with a steep radio spectrum. Our MERLIN map shows an asymmetric structure, while high resolution maps by Wilkinson *et al* (1984) reveals a highly distorted structure on parsec scales. It has been suggested that such distorted structures in steep spectrum compact cores could arise from interaction of radio beams with ambient gas.

It is probably premature to look for systematic effects since we have not reduced all the data. But we note that a majority of the radio quasars have distorted structure. However, it is not yet clear whether this can be ascribed to any factors that are common to them.

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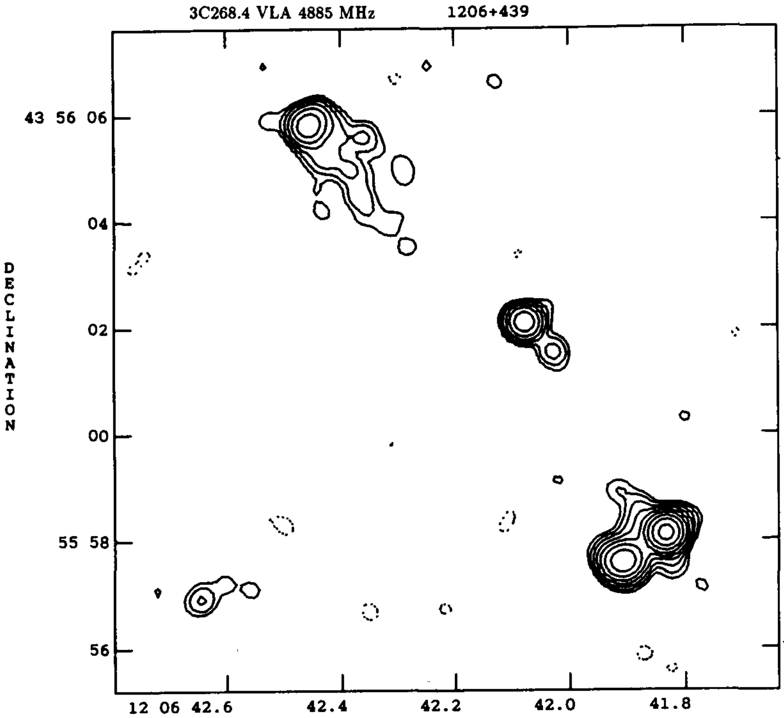

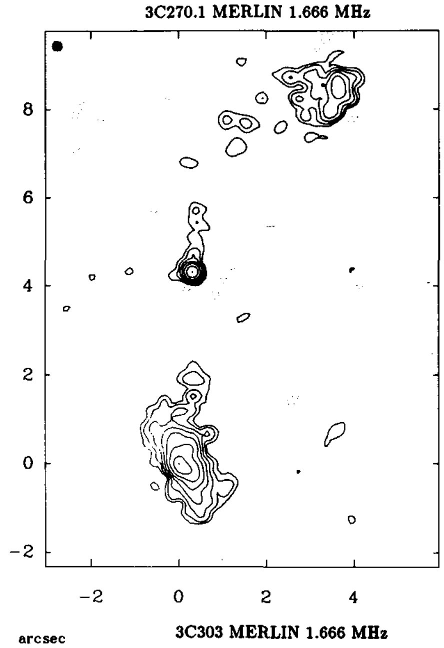

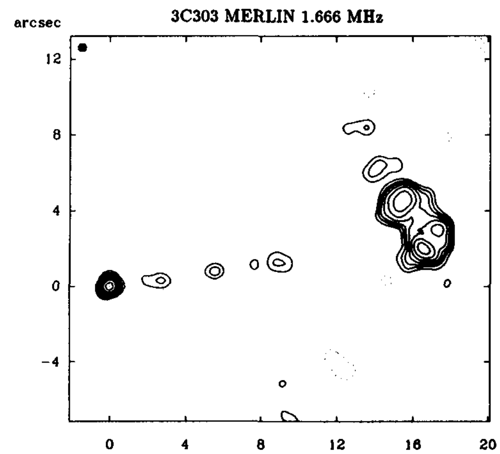

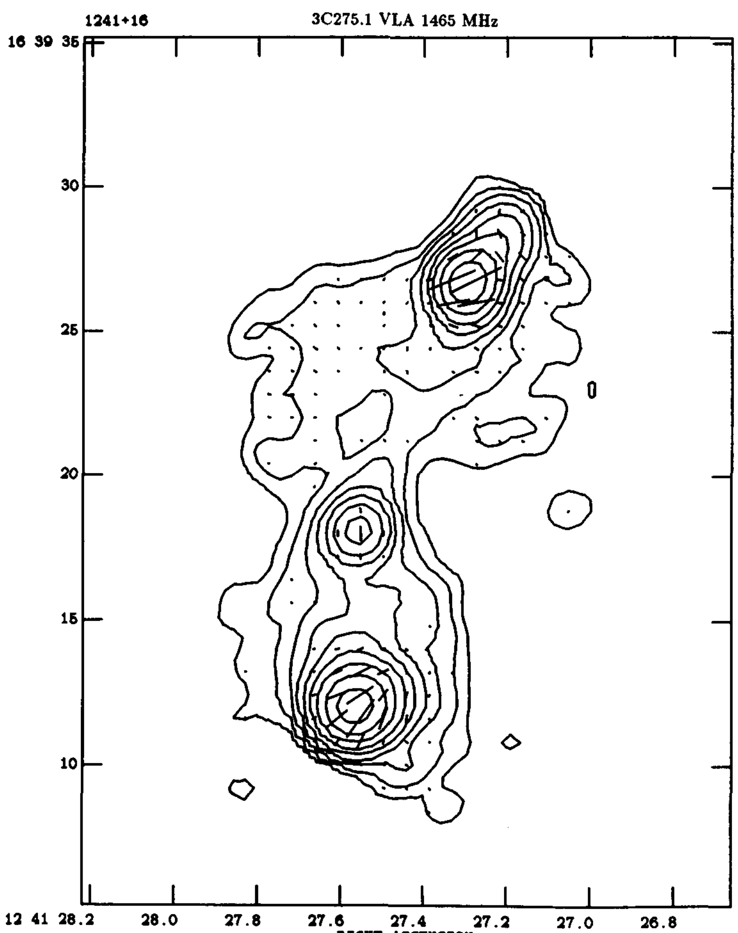

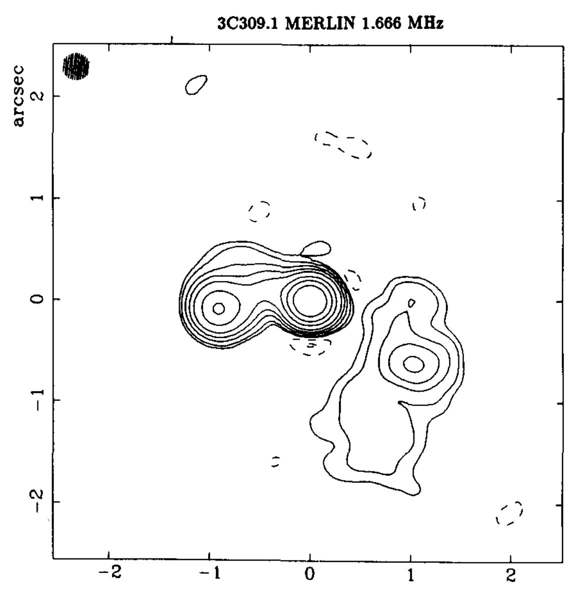

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Table 1

QSO – GALAXY PAIRS

S/No	Name	3C/4C	Z(QSO)
1.	0114+074	4C 07.04	0.861
2.	0219+428	3C66	0.444
3.	0317-023	4C-02.15	2.092
4.	0900+127	4C12.33	-
5.	0955+327	3C232	0.533
6.	1038+064	4C06.04	1.270
7.	1049+616	4C61.20	0.422
8.	1107+036	4C03.21	0.960
9.	1206+439	3C268.4	1.400
10.	1218+339	3C270.1	1.519
11.	1241+166	3C275.1	0.557
12.	1441+522	3C303	1.570
13.	1458+718	3C309.1	0.905
14.	1545+210	3C323.1	0.264
15.	2252+129	3C455	0.543
16.	2305+187	4C18.68	0.313

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