Early Science from the LWA Phase II: A Target List

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1. Introduction

As described in Taylor et al. (2006), the LWA Phase I will consist of a single LWA station near the center of the VLA and another station at a distance similar to that of the Pie Town station. Phase II (the Long Wavelength Intermediate Array or LWIA) will expand this system by adding another seven stations even farther out to create an array with a maximum baseline of between 150 to 200 km. These nine antennas can be used alone or, when observing at 74 MHz, they can be used in combination with the 27 VLA antennas.

The LWIA will be a sparse array that likely will not be capable of ionospheric calibration across the full field of view. Therefore it will operate mainly to observe sources that dominate the flux density in their field of view, for which simple self-calibration is sufficient. In this memo, we have examined the 74 MHz VLSS catalog to determine a list of sources that are bright enough and isolated enough that they can be imaged with self-calibration alone. We describe our methodology and present a final source list along with a description of the types of objects in this list. We find that 362 sources meet this criteria. When the effects of bandpass smearing are included, which suppress the signals of outlying sources, this list increases dramatically to 4,824.

2. Determining the Criteria for Self-Calibration

Only sources that dominate the flux density within their field of view can be imaged successfully with self-calibration. That is because if other sources have significant relative brightness, they must also be included in the calibration model. At the resolution and frequency of the LWA, these other sources will certainly lie outside the isoplanatic patch of the central source, and therefore full-field ionospheric calibration will be necessary. Therefore, in order for self-calibration to work, we must be able to obtain reliable gain solutions by comparing the measured visibilities to a source model that contains only the central source and not any outlying sources. Our experience with VLA data indicates that self-calibration is successful when a model can fit the data with a signal-to-noise ratio of at least 3:1. If we treat the signals from the outlying sources as "noise", this means that the outlier contibution to the average visibility signal must be no more than 1/3 that of the signal from the central source.

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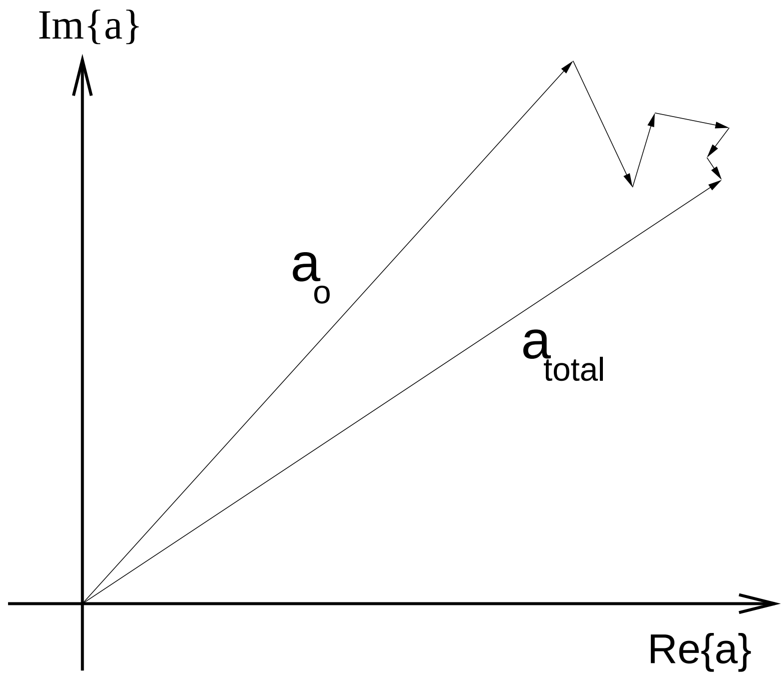

Fig. 1.— The total visibility, a_{total}, is a complex sum of the visibilities of the brightest source, a_o, and that of all other sources in field of view. The difference between a_{total} and a_o is a "random walk" sum, which has average magnitude equal to the quadratic sum of the magnitudes of all other source contributions.

To investigate what this means, consider the visibility signal, a, from a given baseline at a given time. Because a visibility has both magnitude and phase, a is a complex number. If there are N outlier sources, we can break down a into a sum of contributions from the central source, a_o, and the contributions from the outlier sources: a_1, a_2, ... a_N. The difference between a_{total} and a_o is the sum of all other source contributions:

$$a_{total} - a_o = \sum_{i=1}^{N} a_i. \tag{1}$$

Because this is a sum of complex numbers with uncorrelated phases (Figure 1), the average magnitude of the sum will be the quadratic sum of the magnitudes of each of the a_i, just as in the case of a random walk:

$$\langle |a_{total} - a_o| \rangle_{mean} = \left(\sum_{i=1}^{N} |a_i|^2 \right)^{1/2}. \tag{2}$$

The original criteria that the average visibility magnitude from all other sources be no more than

1/3 that from the central source requires that:

$$a_o > 3 \times \left(\sum_{i=1}^{N} |a_i|^2 \right)^{1/2} \tag{3}$$

This equation can be related to source flux densities if we assume that the magnitude of a source visibility contribution, a_i, is proportional to the flux density of that source, S_i, multiplied the primary beam attenuation $\rho(\theta_i)$ which is a function of the angular distance θ_i of source i from the pointing center. This assumption is true for the case of sources being unresolved or, on average, resolved to the same degree on the average baseline. It would fail for the case of a central source that was significantly more extended than the average outlier source. However, this could be avoided somewhat by only calibrating to the shorter baselines. Proceeding with this assumption results in the following criteria for sources we expect to image with self-calibration alone:

$$S_o > 3 \times \left(\sum_{i=1}^{N} (\rho(\theta_i)\, S_i)^2 \right)^{1/2} \tag{4}$$

3. Determining the Source List

To determine how many such sources there are at 74 MHz, we can use the nearly completed VLSS survey (`http://lwa.nrl.navy.mil/VLSS`). Using the catalog from that survey, we consider each source in comparison to all its surrounding sources. Treating the station as a uniformly illuminated aperature, the field of view FWHM is $1.02\,\lambda/D$. Assuming a station diameter of 100m and a frequency of 73.8 MHz ($\lambda = 4.06$m) this results in a FWHM of $2.37°$, which determines the value of $\rho(\theta_i)$ in Equation 4 as a Gaussian with this half power diameter. For each source, we consider all outlier sources within a 5 degree radius, and sources that meet the requirement of Equation 4 are included in the final source list.

The resulting list includes 362 target sources. These sources are listed in Table 1 along with their identifications which are discussed in Section 4. We note that these targets were selected as candidates solely on the basis of the VLSS survey which has a resolution of 80 arcseconds. It is possible that some of the more diffuse candidates may not have a sufficiently high peak flux density at a resolution of a few arcseconds to be used for self-calibration. Higher resolution observations of the targets from the VLA archive could be used further select from the target list in Table 1.

4. Target Identifications

The source list obtained from the VLSS catalog search was passed through batch jobs to both the NASA Extragalactic Database (NED) and the CDS SIMBAD astronomical database for source identification. The source searches were carried out within a search radius of 3 arcminutes for NED and 5 arcminutes for SIMBAD around the VLSS source positions. Source matches within 18 arcseconds of the VLSS search position were generally selected as the candidate identification of the target. All candidate sources that showed no identification within 18 arcseconds and/or candidate sources that had very little available information in the literature were followed up with visual identifications by overlaying VLSS radio contours on NVSS images. All sources with large positional offsets (up to 2 arcminutes) have been identified through this process as extended sources.

Table 1 lists the 362 sources in our list with the VLSS source Name (Column 1) and an alternative name from the NED/SIMBAD source identification (Column 2). The source type (Column 3) is given as one of the following: QSO - quasar, G - galaxy, GCl - galaxy cluster, RS - radio source (no other type found), SNR - supernova remnant, Sy2 - Syfert 2 galaxy, Grp - galaxy group, relic - galaxy cluster radio relic, halo - galaxy cluster radio halo, MH - radio mini-halo in cluster core, GTrpl - triple galaxy system, GPair - double galaxy system, HCG - Hickson Compact Group, GRG - Giant Radio Galaxy. The other columns give: distance between target and candidate ID in arcminutes (Column 4), Right Ascension from the VLSS catalog in J2000 (Column 5), Declination from the VLSS catalog in J2000 (Column 6), integrated VLSS 74 MHz flux of the source in Jy (Column 7), and the ratio of the target flux density to the quadratic sum of the other sources in the LWA FOV (Column 8).

The majority of the targets are extragalactic (98.6%) with only 5 source identified as Galactic SNRs (3C58, Crab, Kepler, W49B, and Cas A). All sources within 3 arcminutes of a galaxy pair, galaxy triple galaxy group or cluster of galaxies were followed up with a literature search to determine if the candidate source is associated with AGN emission or if it is related to a halo/relic source. Of the 26 sources associated with a galaxy cluster, 1 is a radio halo (Abell 1914), 2 are radio relics (Abell 85, Abell 566), 2 are mini halos in cooling core clusters (Perseus A, Abell 2199), and 8 are central radio galaxies in cooling core systems (Perseus A, Hydra A, Virgo A, Abell 2052, Abell 2199, Cygnus A, Abell 2597, & Abell 4059). Thus the source list of Table 1 contains sources which are interesting in a large variety of scientific ways, indicating the great scientific potential of even the earliest stages of the LWA.

5. Effects of Bandwidth Smearing

Averaging across a nonzero bandwidth will cause radial smearing in sources. This bandwidth smearing increases with distance from the phase center. Normally this is considered a problem, however it actually can aid the efforts to self-calibrate as it suppresses the effects of outlying sources on visibilities relative to the central source of interest.

Bandwidth smearing becomes significant when the distance from the image center in units of the synthesized beam-width times the fractional bandwidth approaches unity. For a bandwidth of about 1 MHz, and a central frequency of 74 MHz and an array size of 150 km, this occurs at an angular distance of only about 7 arcminutes from the image center. This is a small fraction of the radius of the field of view, which is roughly 75 arcminutes. Therefore, even for a modest bandwidth, this will be a very significant effect across most of the field of view.

To quantify the effect of bandwidth smearing on self-calibration for an entire data set, we first consider the effect of bandwidth smearing on the visibility contribution of single point source to a single visibility. If source i is a point source with flux density S_i, the magnitude of its visibility contribution, $|a_i|$, is simply equal to its observed flux density attenuated by the primary beam shape: $\rho(\theta_i)\, S_i$. Bandwidth smearing will reduce this magnitude by an additional attenuation factor w_i where:

$$w_i = \text{sinc}\left(\pi\,\theta_i\,\frac{\Delta\nu}{\nu}\,\frac{B\cos\phi}{\lambda}\right) \tag{5}$$

where the sinc function is defined as $\text{sinc}(x) = \sin(x)/x$, θ_i is again the angular distance of source i from the phase center, $\Delta\nu/\nu$ is the fractional bandwidth, B is the projected baseline length, ϕ is the angle between the projected baseline and the direction from the phase center to the source, and λ is the observing wavelength at the central frequency. The relevant figure for self-calibration is the visibility contribution averaged over all baselines. To average w_i for all ϕ involves an integral with no analytical solution, but in the case where

$$\theta_i\,\frac{\Delta\nu}{\nu}\,\frac{B}{\lambda} >> 1 \tag{6}$$

we can approximate the average w_i over all ϕ, (from 0 to 360°) as:

$$< w_i >_\phi \approx \frac{1}{\pi\,\theta_i}\,\frac{\nu}{\Delta\nu}\,\frac{\lambda}{B}. \tag{7}$$

Now, we would like to average over the baseline lengths, B. However, this depends on the distribution of baselines, which is uncertain. Therefore, we conservatively take the value of $< w_i >_\phi$ at one fifth the maximum baseline length, B_{max}. Longer baselines will have more attenuation, and shorter baselines will have less. However, it is safe to take this value because even if the shorter baselines with less bandwidth attenuation pose a problem, the calibration can simply be done on baselines longer than this, which should be numerous enough to attain solutions. Therefore, if we plug in $B = B_{max}/5$ and use the relation $\nu\,\lambda = c$, we get the average bandwidth attentuation over all baselines, $\bar{w}$, which can now be written as a function of θ_i:

$$\bar{w}(\theta_i) = \frac{5\,c}{\pi\,\theta_i\,\Delta\nu\,B_{max}}. \tag{8}$$

To determine a list of source that can be self-calibrated using the effects of bandwidth smearing, we use the criteria of Equation 4 adjusted to reflect the bandwidth smearing attenuation of outlier sources. This gives:

$$S_o > 3 \times \left(\sum_{i=1}^{N} (\bar{w}(\theta_i)\,\rho(\theta_i)\,S_i)^2\right)^{1/2} \tag{9}$$

We applied this criteria to the entire VLSS catalog, using a bandwidth of $\Delta\nu$ =1 MHz and a maximum baseline of B_{max} =150 km. This resulted in a much larger list of 4,824 target sources. Because of the size of this sources list, it is not included in the text of this memorandum, but is available in separate links on the LWA Memo Series web site (http://www.ece.vt.edu/swe/lwa/#VTR) as both a PDF file and an ascii text file for machine readability.

6. Conclusion

Full-field ionospheric calibration will require both development of a complete calibration algorithm and the construction of enough LWA stations to fully constrain the problem. However, before this occurs, even a large intermediate array will be capable of observing several hundred of sources simply using self-calibration. If we make use of the effects of bandpass smearing, this list expands to over 4,800. Therefore, even in its early stages, the LWA will be capable of observing many sources at an unprecedented combination of low frequency and high resolution, which can produce a tremendous amount of science even during the initial phases of the LWA.

REFERENCES

G. Taylor et al. "LWA Overview", Long Wavelength Array Memo #56, September 22, 2006.

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Table 1. Isolated Sources

VLSS Name	Other Name	Type	D arcmin	RA (J2000) h m s	Dec (J2000) ° m s	S_{74} Jy	Ratio
J0000.3+5539	TXS 2357+553	RS	0.0	00 00 20.45	+55 39 06.1	15.92	7.82
J0001.3+4153	4C +41.47	RS	0.1	00 01 19.77	+41 53 06.4	12.39	4.04
J0006.3−0004	3C 002	QSO	0.0	00 06 22.63	−00 04 26.4	28.85	4.11
J0014.8+6117	4C +60.01	RS	0.1	00 14 48.83	+61 17 37.7	14.24	4.02
J0020.4+1540	3C 009	QSO	0.1	00 20 25.51	+15 40 52.0	37.49	5.29
J0024.5−2928	PKS J0024−2928	QSO	0.1	00 24 30.30	−29 28 50.7	30.76	6.74
J0035.1−2003	PKS J0035−2003	QSO	0.1	00 35 09.14	−20 03 57.7	20.70	3.09
J0036.1+1838	3C 014	QSO	0.0	00 36 06.45	+18 38 00.6	22.65	3.74
J0036.1+5855	4C +58.02	RS	0.1	00 36 08.06	+58 55 49.4	40.52	3.27
J0037.7+1319	3C 016	RS	0.1	00 37 44.87	+13 19 58.4	23.61	3.35
J0040.8+1003	3C 018	G	0.1	00 40 50.44	+10 03 25.9	35.86	3.20
J0041.5−0922	ABELL 0085:[SDG98] A0	GCl/relic	0.2	00 41 31.10	−09 22 13.3	34.66	4.43
J0043.1+5203	3C 020	G	0.1	00 43 09.14	+52 03 27.3	73.51	5.20
J0055.8+2624	3C 028	G	0.1	00 55 49.88	+26 24 39.0	38.20	3.25
J0055.9+6822	3C 027	G	0.2	00 55 59.85	+68 22 19.0	48.72	3.34
J0057.5−0123	3C 029	G	0.1	00 57 34.70	−01 23 24.3	28.71	3.16
J0108.2−1604	3C 032	G	0.1	01 08 17.23	−16 04 22.3	44.24	6.50
J0109.7+7312	3C 033.1	G	0.1	01 09 43.87	+73 12 02.9	33.33	3.54
J0110.3+3147	3C 034	G/GCl	0.1	01 10 18.54	+31 47 17.0	30.82	3.33
J0117.9+4536	3C 036	G	0.1	01 17 59.72	+45 36 24.2	16.47	3.35
J0120.4−1520	3C 038	G	0.0	01 20 27.14	−15 20 15.4	30.62	3.16
J0127.5−1402	PKS 0125−14	G	0.0	01 27 30.24	−14 02 56.7	22.32	3.02
J0128.5+2902	3C 042	G	0.1	01 28 30.44	+29 02 60.0	22.78	3.38
J0131.3+0623	3C 044	GCl	0.1	01 31 21.54	+06 23 40.7	17.88	3.15
J0135.4+3754	3C 046	GRG	0.1	01 35 27.92	+37 54 01.5	19.33	3.87
J0136.4+2057	3C 047	QSO	0.1	01 36 24.32	+20 57 20.7	66.70	11.96
J0137.6+3309	3C 048	QSO	0.1	01 37 41.48	+33 09 37.7	70.70	8.79
J0139.4+3957	4C +39.04	GRG	0.2	01 39 29.27	+39 57 01.1	18.03	3.46
J0148.4+5332	3C 052	G	0.1	01 48 29.32	+53 32 32.6	22.46	4.03
J0153.3−0333	3C 053	RS	0.1	01 53 24.00	−03 33 55.2	12.52	5.40
J0155.4+4345	3C 054	G	0.0	01 55 29.99	+43 45 53.7	20.08	3.78
J0157.1+2851	3C 055	G	0.1	01 57 10.83	+28 51 38.4	31.84	4.44
J0200.2−3053	PKS J0200−3053	QSO	0.1	02 00 12.43	−30 53 24.7	29.80	4.23
J0205.5+6449	3C 058/AD1181	SNR	0.3	02 05 32.60	+64 49 41.0	27.43	3.51
J0220.9−0156	3C 063	G	0.1	02 20 54.43	−01 56 49.0	42.09	5.84
J0222.0+0826	3C 064	G	0.9	02 22 01.66	+08 26 41.4	13.76	4.21
J0222.8+8618	3C 061.1	QSO	0.3	02 22 52.14	+86 18 59.1	70.99	17.84
J0234.3+3134	3C 068.2	G	0.0	02 34 23.81	+31 34 17.0	29.33	3.04
J0235.5+2908	4C +28.06	RS	0.1	02 35 35.07	+29 08 56.0	20.64	3.28
J0237.7−1932	PKS J0237−1932	G	0.1	02 37 43.68	−19 32 32.6	37.60	6.12

Table 1—Continued

VLSS Name	Other Name	Type	D arcmin	RA (J2000) h m s	Dec (J2000) ° m s	S_{74} Jy	Ratio
J0238.0+5911	3C 069	G	0.1	02 38 02.55	+59 11 55.4	43.52	7.71
J0242.6−0000	MESSIER 077	G	0.0	02 42 40.83	−00 00 45.5	27.04	5.19
J0243.7+5009	4C +49.08	RS	0.0	02 43 42.40	+50 09 30.7	12.61	4.71
J0249.5+4305	4C +42.08	G	0.2	02 49 30.37	+43 05 23.4	18.16	3.72
J0249.9+3332	4C +33.05	RS	0.1	02 49 56.87	+33 32 41.5	6.98	3.32
J0251.7+1550	4C +15.09	QSO?	0.8	02 51 43.50	+15 50 14.3	8.74	3.58
J0307.5−2225	PKS J0307−2225	G	0.1	03 07 31.80	−22 25 21.5	15.52	3.05
J0308.4+0406	NGC 1218	G	0.2	03 08 26.10	+04 06 50.4	30.93	3.40
J0309.9+1705	3C 079	G	0.0	03 09 59.95	+17 05 58.0	61.42	7.77
J0312.6+2423	3C 83	RS	0.0	03 12 36.05	+24 23 30.4	12.27	3.04
J0315.3+1012	4C +10.10	G	0.1	03 15 21.07	+10 12 40.2	13.63	3.40
J0319.8+4130	Perseus A	G/GCl/MH	0.0	03 19 48.06	+41 30 42.5	137.88	5.21
J0324.6−0324	4C −03.12	RS	0.5	03 24 41.00	−03 24 19.9	16.83	4.23
J0327.9+0234	3C 088	G	1.2	03 27 58.81	+02 34 03.9	28.42	6.80
J0330.0−1638	PKS J0330−1638	G(ld)	0.1	03 30 04.76	−16 38 50.8	15.85	3.33
J0334.2−0111	3C 089	G/GCl	0.5	03 34 14.30	−01 11 19.3	43.72	6.17
J0337.7+5045	3C 091	G	0.1	03 37 44.17	+50 45 53.4	25.60	3.39
J0343.4+0457	3C 093	QSO	0.0	03 43 29.86	+04 57 47.2	25.92	3.12
J0351.4−1429	3C 095	QSO	0.5	03 51 29.27	−14 29 36.4	50.95	5.67
J0351.8+5753	4C +57.08	RS	0.8	03 51 52.32	+57 53 30.4	15.87	3.81
J0352.0+2624	4C +26.12	RS	0.1	03 52 04.15	+26 24 13.5	13.13	3.64
J0352.5−0711	3C 094	QSO	0.3	03 52 31.70	−07 11 03.9	37.70	5.17
J0353.1+3826	4C +38.11	RS	0.1	03 53 11.31	+38 26 39.4	10.88	3.51
J0400.2−1610	PKS 0357−16	G	0.0	04 00 16.57	−16 10 14.0	19.69	3.10
J0401.1+0036	3C 099	G	0.0	04 01 07.75	+00 36 34.0	14.45	3.02
J0408.0+4300	3C 103	G	0.1	04 08 03.24	+43 00 18.7	63.73	10.43
J0411.6+1714	4C +17.23	QSO	0.0	04 11 40.73	+17 14 04.9	12.27	3.61
J0412.3−0059	3C 107	G	0.0	04 12 22.56	−00 59 32.0	23.00	3.16
J0413.6+1112	3C 109	G	0.1	04 13 40.47	+11 12 21.2	42.62	10.74
J0414.4+1416	4C +14.11	G	0.0	04 14 29.97	+14 16 23.1	17.95	4.35
J0418.4+3802	3C 111	G	1.7	04 18 28.75	+38 02 21.2	142.26	19.82
J0420.3+1753	3C 114	G	0.3	04 20 22.08	+17 53 55.1	16.58	4.88
J0420.8+2526	4C +25.14	QSO	0.1	04 20 49.62	+25 26 27.2	13.31	4.15
J0423.8+3451	3C 115	RS	0.1	04 23 52.97	+34 51 43.4	10.42	3.59
J0434.4+7229	4C +72.07	RS	0.1	04 34 27.17	+72 29 11.5	24.05	4.78
J0437.0+2940	3C 123	G	0.1	04 37 04.71	+29 40 15.5	454.09	49.37
J0444.6−2809	PKS J0444−2809	G	0.1	04 44 37.28	−28 09 51.7	69.16	5.40
J0446.3+3945	3C 125	RS	0.1	04 46 18.02	+39 45 06.9	31.04	6.50
J0453.3+3129	3C 131	RS	0.0	04 53 23.25	+31 29 26.3	37.19	3.66
J0454.3+5757	4C +57.11	RS	0.1	04 54 20.32	+57 57 42.7	15.07	3.43

Table 1—Continued

VLSS Name	Other Name	Type	D arcmin	RA (J2000) h m s	Dec (J2000) ° m s	S_{74} Jy	Ratio
J0502.9+2516	3C 133	G	0.0	05 02 58.41	+25 16 22.6	44.41	7.58
J0504.7+3806	3C 134	G	0.1	05 04 42.67	+38 06 12.7	191.21	30.44
J0510.5−1838	PKS J0510−1838	G	0.3	05 10 32.31	−18 38 40.1	47.22	8.87
J0515.8+2459	3C 136.1	G	2.5	05 15 52.64	+24 59 09.4	26.23	3.07
J0521.1+1638	3C 138	QSO	0.2	05 21 10.46	+16 38 25.9	14.06	3.72
J0521.8−0613	4C −06.11	RS	0.2	05 21 49.96	−06 13 02.0	8.80	3.03
J0524.4+2812	3C 139.2	RS	0.1	05 24 26.92	+28 12 54.1	35.42	3.13
J0526.2+1140	3C 140	G	0.2	05 26 14.52	+11 40 25.6	11.81	4.46
J0526.7+3250	3C 141	G	0.4	05 26 43.54	+32 50 01.9	31.46	3.98
J0528.9+1519	4C +15.16	RS	0.1	05 28 58.90	+15 19 18.4	9.82	3.18
J0531.4+0630	3C 142.1	G	0.0	05 31 29.51	+06 30 26.7	39.15	6.68
J0534.5+2202	Crab Nebula	SNR	1.4	05 34 30.56	+22 02 14.1	1883.43	195.30
J0542.6+4951	3C 147	QSO	0.0	05 42 36.18	+49 51 06.6	54.68	5.74
J0543.1−2421	PKS J0543−2420	G	0.0	05 43 07.75	−24 21 03.5	17.31	3.01
J0547.5+6357	4C +63.08	RS	1.1	05 47 31.17	+63 57 35.4	19.36	3.18
J0548.7+2636	4C +26.18	RS	0.4	05 48 44.51	+26 36 01.3	11.13	3.22
J0551.5+3725	4C +37.14	RS	0.1	05 51 32.76	+37 25 29.7	12.61	3.00
J0555.4+0632	4C +06.25	RS	0.0	05 55 29.90	+06 32 55.9	8.10	3.49
J0604.4+2021	3C 152	RS	0.0	06 04 28.45	+20 21 21.3	23.08	3.78
J0606.4+6444	4C +64.07	RS	0.0	06 06 25.62	+64 44 42.6	19.09	3.14
J0609.5+4804	3C 153	G	0.1	06 09 32.87	+48 04 13.6	26.81	3.60
J0613.8+2604	3C 154	QSO	0.1	06 13 49.49	+26 04 36.1	60.61	6.37
J0621.6+1432	3C 158	RS	0.0	06 21 41.15	+14 32 10.8	37.68	3.19
J0622.7−0232	4C −02.25	RS	0.0	06 22 42.26	−02 32 37.0	15.69	3.42
J0627.1−0553	3C 161	RS	0.1	06 27 09.81	−05 53 11.1	99.45	13.73
J0631.4+2500	3C 162	G	0.9	06 31 26.22	+25 00 47.7	21.09	4.05
J0636.0+0432	4C +04.25	RS	0.1	06 36 05.29	+04 32 36.8	7.93	4.56
J0643.1+2319	3C 165	G	0.0	06 43 07.25	+23 19 02.7	30.49	3.13
J0645.2+0531	3C 167	RS	0.1	06 45 17.18	+05 31 36.1	13.70	3.47
J0645.4+2121	3C 166	G	0.1	06 45 24.19	+21 21 48.3	40.70	3.20
J0651.2+4509	3C 169.1	G	0.0	06 51 15.35	+45 09 28.7	17.24	3.31
J0655.2+5408	3C 171	G	0.0	06 55 14.62	+54 08 59.3	41.17	3.06
J0658.9−2417	PKS J0658−2417	RS	0.1	06 58 57.64	−24 17 25.3	57.87	5.11
J0702.1+2514	3C 172	G	0.8	07 02 09.10	+25 14 30.1	31.99	5.05
J0702.8+4431	4C +44.15	RS	0.0	07 02 53.86	+44 31 13.7	12.34	3.16
J0704.4+6318	4C +63.10/Abell 566	GCl/relic?	1.0	07 04 26.62	+63 18 26.2	18.52	3.75
J0707.8−0759	3C 174	RS	0.1	07 07 50.06	−07 59 43.3	17.21	3.54
J0709.2+7449	3C 173.1	G	0.1	07 09 17.65	+74 49 27.1	27.56	4.67
J0710.0+0617	4C +06.28	RS	0.1	07 10 05.23	+06 17 02.3	6.87	3.80
J0711.7−2043	PKS J0711−2043	RS	0.1	07 11 47.30	−20 43 09.3	30.41	3.18

Table 1—Continued

VLSS Name	Other Name	Type	D arcmin	RA (J2000) h m s	Dec (J2000) ° m s	S_{74} Jy	Ratio
J0713.0+1146	3C 175	QSO	0.0	07 13 02.49	+11 46 13.3	47.21	6.68
J0714.0+1436	3C 175.1	G	0.0	07 14 04.67	+14 36 23.0	16.78	3.94
J0717.2−2504	PKS J0717−2504	RS	0.1	07 17 17.85	−25 04 52.4	28.10	4.59
J0722.1−1848	PKS J0722−1848	RS	0.0	07 22 09.36	−18 48 27.8	25.04	3.57
J0723.9+1904	4C +19.29	G	0.0	07 23 56.54	+19 04 59.3	16.51	3.88
J0724.9−0939	3C 178	G	0.0	07 24 55.07	−09 39 55.7	18.10	4.24
J0727.0−0204	3C 180	G	0.1	07 27 04.95	−02 04 41.6	32.52	3.75
J0728.1+6748	3C 179	QSO	0.1	07 28 11.51	+67 48 46.2	17.72	3.03
J0729.4+2436	TXS 0726+247	Sy2	0.1	07 29 28.01	+24 36 20.2	21.74	3.06
J0733.9+0202	4C +02.20	RS	0.0	07 33 54.72	+02 02 20.9	14.16	3.82
J0739.4+7023	3C 184	G/GCl	0.0	07 39 24.55	+70 23 12.8	23.50	3.90
J0743.1+8025	3C 184.1	G	0.9	07 43 10.29	+80 25 39.5	28.95	6.38
J0744.2+3753	3C 186	QSO	0.0	07 44 17.38	+37 53 16.0	32.39	3.15
J0745.0+0159	3C 187	G	0.9	07 45 05.50	+01 59 18.8	28.21	6.07
J0745.7+3142	4C +31.30	QSO	0.2	07 45 42.75	+31 42 51.7	13.82	3.60
J0801.5+1414	3C 190	QSO	0.0	08 01 33.40	+14 14 44.6	33.19	4.77
J0804.8+1015	3C 191	QSO	0.0	08 04 48.06	+10 15 23.6	29.78	4.30
J0805.5+2409	3C 192	G	0.1	08 05 35.18	+24 09 52.1	49.73	9.42
J0810.0+4228	3C 194	G	0.0	08 10 03.58	+42 28 05.0	17.82	3.24
J0813.6+4813	3C 196	QSO	0.1	08 13 36.33	+48 13 01.1	135.96	12.11
J0814.7+1258	4C +13.37	G	0.1	08 14 43.60	+12 58 12.8	11.28	3.11
J0815.4−0308	3C 196.1	G	0.0	08 15 27.93	−03 08 26.2	46.81	5.48
J0819.7+5232	4C +52.18	G	0.0	08 19 47.52	+52 32 32.5	13.85	4.32
J0820.7+0946	4C +09.28	RS	0.0	08 20 43.60	+09 46 56.6	13.16	3.58
J0827.2−2026	PKS J0827−2026	QSO	0.1	08 27 17.20	−20 26 20.3	25.74	3.67
J0827.4+2918	3C 200	G	0.0	08 27 25.37	+29 18 45.1	26.64	4.46
J0837.7+6513	3C 204	QSO	0.0	08 37 44.79	+65 13 35.8	26.44	4.18
J0839.1+5754	3C 205	QSO	0.0	08 39 06.61	+57 54 16.1	26.71	4.46
J0840.7+1312	3C 207	QSO	0.1	08 40 47.84	+13 12 25.4	25.46	3.79
J0857.2+0948	4C +09.32	RS	0.0	08 57 17.16	+09 48 29.6	13.99	3.44
J0857.6+3404	3C 211	G	0.0	08 57 40.54	+34 04 08.5	20.64	3.35
J0858.1+2750	3C 210	GCl	0.0	08 58 10.14	+27 50 53.0	24.28	3.59
J0901.7−2555	PKS J0901−2555	G	0.1	09 01 47.43	−25 55 15.7	62.16	7.67
J0909.5+4253	3C 216	QSO	0.0	09 09 33.52	+42 53 45.8	40.30	3.02
J0918.0−1205	Hydra A	G/GCl	0.9	09 18 03.63	−12 05 02.1	578.16	74.36
J0921.0+4538	3C 219	QSO/Grp	0.8	09 21 05.98	+45 38 20.4	77.34	18.72
J0932.6+7906	3C 220.1	G	0.0	09 32 40.23	+79 06 31.1	32.32	3.50
J0936.5+0422	3C 222	G	0.1	09 36 32.26	+04 22 11.6	22.63	3.68
J0939.3+8315	3C 220.3	G	0.0	09 39 23.60	+83 15 23.9	37.21	5.02
J0944.2+0946	3C 226	G	0.0	09 44 16.26	+09 46 20.7	39.53	3.13

Table 1—Continued

VLSS Name	Other Name	Type	D arcmin	RA (J2000) h m s	Dec (J2000) ° m s	S_{74} Jy	Ratio
J0947.8+0725	3C 227	G	1.1	09 47 49.72	+07 25 15.1	77.18	6.23
J0949.8−2511	PKS J0949−2511	G	0.2	09 49 53.66	−25 11 30.3	24.01	3.57
J0950.1+1419	3C 228	G	0.0	09 50 10.65	+14 19 59.7	36.77	4.15
J1001.8+2847	3C 234	G	0.3	10 01 48.38	+28 47 06.1	70.55	13.34
J1005.1−2144	MRC 1002−215	G	0.1	10 05 11.71	−21 44 49.9	37.91	4.53
J1011.7+4628	3C 239	G	0.1	10 11 45.58	+46 28 16.1	31.37	4.27
J1021.9+2159	3C 241	G	0.0	10 21 54.53	+21 59 32.9	17.67	3.25
J1022.1+2523	4C +25.32	QSO	0.1	10 22 09.73	+25 23 13.1	6.88	3.49
J1025.4+4257	4C +43.19	RS	0.1	10 25 29.96	+42 57 45.3	9.60	3.41
J1027.2+4603	4C +46.21	G	0.1	10 27 15.00	+46 03 01.4	12.33	4.44
J1033.5+5814	3C 244.1	G	0.1	10 33 33.90	+58 14 32.9	44.98	7.04
J1034.0+1112	MRC 1031+114	RS	0.1	10 34 04.87	+11 12 27.1	14.08	3.74
J1042.7+1203	3C 245	QSO	0.1	10 42 44.51	+12 03 34.3	31.29	6.36
J1046.3+5458	4C +55.21	RS	0.0	10 46 20.76	+54 58 50.1	16.21	3.46
J1051.5−0918	3C 246	QSO	0.1	10 51 30.12	−09 18 13.8	20.50	3.85
J1058.9+4301	3C 247	G	0.0	10 58 58.93	+43 01 24.5	18.25	3.94
J1102.0−0116	3C 249	QSO	0.1	11 02 04.03	−01 16 14.1	32.86	3.64
J1104.2+7659	3C 249.1	QSO	0.1	11 04 13.15	+76 59 01.4	23.98	3.34
J1106.3−2109	PKS J1106−2109	G	0.0	11 06 22.16	−21 09 01.2	22.95	3.08
J1108.8+2500	3C 250	G	0.1	11 08 51.81	+25 00 52.5	24.77	4.03
J1111.5+3540	3C 252	G	0.2	11 11 31.95	+35 40 43.7	31.27	3.76
J1112.6+4326	[HB89] 1109+437	QSO	0.2	11 12 39.06	+43 26 01.1	16.24	4.09
J1114.6+4037	3C 254	QSO	0.0	11 14 38.68	+40 37 21.0	51.00	3.70
J1116.5+2915	4C +29.41B	GPair	0.2	11 16 34.74	+29 15 22.1	9.65	3.02
J1120.7+2327	3C 256	G	0.1	11 20 42.70	+23 27 54.3	18.23	4.57
J1139.9+6547	3C 263	QSO	0.1	11 39 58.38	+65 47 48.6	29.93	3.27
J1140.8−2629	PKS J1140−2628	G	0.1	11 40 48.47	−26 29 09.0	25.56	3.42
J1145.1+1937	3C 264/ABELL 1367	G/GCl	0.0	11 45 06.47	+19 37 03.8	35.03	4.09
J1145.4+3133	3C 265	G	0.1	11 45 29.32	+31 33 42.8	46.15	6.83
J1149.9+1247	3C 267	G	0.0	11 49 56.67	+12 47 18.8	28.51	4.40
J1155.2+5452	MCG +09−20−031	GPair	2.9	11 55 13.31	+54 52 47.2	25.38	3.27
J1200.3+7300	3C 268.1	G	0.1	12 00 21.97	+73 00 46.2	30.70	3.26
J1202.2−1040	PKS 1159−10	G	0.1	12 02 12.56	−10 40 49.3	15.76	3.29
J1204.8+2930	4C +29.46	RS	0.6	12 04 53.14	+29 30 05.2	12.93	3.30
J1208.6−3403	PKS J1208−3403	G	0.1	12 08 39.63	−34 03 04.2	22.65	3.47
J1209.2+4339	3C 268.4	QSO	0.0	12 09 13.42	+43 39 19.7	21.60	4.11
J1215.5+5335	[HB89] 1213+538	QSO	0.1	12 15 30.00	+53 35 52.2	18.54	3.28
J1218.5−1018	PKS J1218−1019	RG	2.0	12 18 34.65	−10 18 45.9	28.06	3.28
J1220.5+3343	3C 270.1	QSO	0.0	12 20 33.92	+33 43 09.8	30.59	5.68
J1229.0+0202	3C 273	QSO	0.3	12 29 05.93	+02 02 55.9	149.73	21.13

Table 1—Continued

VLSS Name	Other Name	Type	D arcmin	RA (J2000) h m s	Dec (J2000) ° m s	S_{74} Jy	Ratio
J1230.8+1223	MESSIER 087	G/GCl	0.3	12 30 48.62	+12 23 15.6	1234.17	4.11
J1235.4+2120	3C 274.1	G	0.1	12 35 26.40	+21 20 31.2	29.11	6.61
J1235.6−2511	PKS J1235−2512	QSO	0.3	12 35 37.44	−25 11 60.0	24.69	3.04
J1242.3−0446	3C 275	G	0.0	12 42 19.65	−04 46 22.4	25.91	4.37
J1243.9+1622	3C 275.1	QSO	0.0	12 43 57.68	+16 22 50.6	32.57	4.23
J1251.7+5034	3C 277	G	0.4	12 51 45.91	+50 34 31.1	15.13	3.21
J1252.1+5245	4C +52.26	RS	0.0	12 52 08.46	+52 45 28.0	14.43	3.45
J1253.5+1542	3C 277.2	GCl	0.0	12 53 32.94	+15 42 29.6	20.09	3.80
J1254.1+2737	Coma A	G	0.0	12 54 11.63	+27 37 31.5	16.15	3.09
J1254.6−1233	NGC 4783	G	0.2	12 54 37.39	−12 33 33.6	56.36	4.36
J1256.1−0547	3C 279	QSO	0.0	12 56 11.28	−05 47 23.4	30.48	6.49
J1256.9+4720	3C 280	G	0.1	12 56 57.38	+47 20 21.6	51.56	3.11
J1300.5+4009	3C 280.1	QSO	0.1	13 00 32.88	+40 09 09.5	22.83	3.99
J1305.5+0855	4C +09.45	G	0.1	13 05 35.82	+08 55 15.0	24.30	4.06
J1311.1+2727	3C 284	G/GCl	0.8	13 11 08.37	+27 27 55.5	27.10	5.10
J1311.6−2216	3C 283	G	0.1	13 11 39.51	−22 16 43.0	58.20	7.49
J1321.3+1106	4C +11.45	QSO	0.1	13 21 19.25	+11 06 52.1	15.68	5.98
J1321.3+4235	3C 285	Grp	0.2	13 21 18.40	+42 35 04.7	21.60	3.45
J1331.1+3030	3C 286	QSO	0.0	13 31 08.28	+30 30 32.6	30.03	3.01
J1332.9+0200	3C 287.1	QSO	0.4	13 32 54.61	+02 00 52.5	18.26	3.28
J1338.1−0627	4C −06.35	QSO	0.0	13 38 07.97	−06 27 08.4	32.89	3.30
J1338.8+3851	3C 288	G	0.1	13 38 49.42	+38 51 12.1	41.12	4.60
J1344.3+1409	4C +14.49	RS	0.0	13 44 23.76	+14 09 14.1	11.30	3.15
J1345.4+4946	3C 289	G	0.1	13 45 25.98	+49 46 30.9	26.19	4.24
J1347.0−0803	PKS J1347−0803	G	0.0	13 47 01.56	−08 03 23.8	22.82	3.78
J1349.6+2107	3C 291	RS	0.1	13 49 39.16	+21 07 27.8	17.95	3.60
J1350.6+6430	3C 292	G	0.8	13 50 39.29	+64 30 17.9	23.92	3.56
J1406.7+3411	3C 294	G	0.0	14 06 44.22	+34 11 25.7	30.80	3.92
J1411.3+5212	3C 295	G/GCl	0.1	14 11 20.30	+52 12 03.9	120.01	16.04
J1416.7+4802	4C +48.38	G	0.0	14 16 44.42	+48 02 50.1	13.63	4.03
J1419.1+0628	3C 298	QSO	0.0	14 19 08.33	+06 28 34.3	99.38	7.94
J1421.0+4144	3C 299	G	0.0	14 21 05.61	+41 44 50.8	24.76	4.48
J1422.8−2727	PKS J1422−2727	QSO	0.1	14 22 49.56	−27 27 57.8	40.21	3.74
J1426.0+3749	ABELL 1914	GCl/halo	0.7	14 26 05.66	+37 49 03.9	18.57	3.63
J1427.6−1203	PKS J1427−1203	QSO	0.0	14 27 38.11	−12 03 52.1	23.99	5.53
J1435.2+3140	3C 301	RS	0.1	14 35 15.01	+31 40 51.6	12.35	3.38
J1443.0+5201	3C 303/3C303C	G/QSO	0.1/0.2	14 43 01.96	+52 01 37.1	23.04	3.93
J1446.5−0845	PKS 1443−085	GPair	0.4	14 46 34.75	−08 45 46.6	12.19	3.06
J1449.3+6316	3C 305	G	0.1	14 49 22.27	+63 16 13.1	32.95	3.55
J1455.0−0420	3C 306.1	G	0.1	14 55 01.89	−04 20 59.0	26.29	3.08

Table 1—Continued

VLSS Name	Other Name	Type	D arcmin	RA (J2000) h m s	Dec (J2000) ° m s	S_{74} Jy	Ratio
J1504.9+2600	3C 310	G/GTrpl	0.5	15 04 59.40	+26 00 46.8	128.97	8.98
J1516.7+0701	3C 317/A2052	G/GCl	0.1	15 16 44.38	+07 01 19.2	121.21	3.02
J1520.0+2016	3C 318	QSO	0.0	15 20 05.53	+20 16 04.6	20.17	3.68
J1524.0+5428	3C 319	G	0.1	15 24 05.47	+54 28 17.7	36.83	3.96
J1531.8+2402	MG2 J153151+2403	RS	0.1	15 31 51.02	+24 02 42.2	25.79	3.54
J1541.7+6015	3C 323	G	0.0	15 41 45.45	+60 15 36.3	20.76	3.19
J1548.2+4835	4C +48.39	RS	0.0	15 48 14.61	+48 35 02.7	14.89	3.69
J1549.2+3047	4C +30.29	G	0.0	15 49 12.75	+30 47 13.1	13.98	3.80
J1549.9+6241	3C 325	QSO	0.0	15 49 58.19	+62 41 19.6	30.19	4.95
J1556.6+4257	4C +43.35	G	1.1	15 56 36.36	+42 57 11.9	19.12	4.02
J1604.2+4423	4C +44.27	RS	0.1	16 04 12.19	+44 23 22.4	19.57	3.09
J1605.0−1734	PKS J1605−1734	G	0.1	16 05 02.27	−17 34 19.0	22.30	5.59
J1609.6+6556	3C 330	G	0.0	16 09 36.19	+65 56 42.7	52.76	3.45
J1612.3+2222	3C 331	RS	0.0	16 12 19.01	+22 22 15.1	17.70	3.07
J1620.3+1736	3C 334	QSO/GCl	0.1	16 20 21.68	+17 36 28.1	31.47	4.05
J1628.6+3933	NGC 6166/ABELL 2199	G/GCl	0.1	16 28 38.21	+39 33 02.2	111.99	22.24
J1628.8+4419	3C 337	GCl	0.0	16 28 52.93	+44 19 05.7	24.95	3.48
J1642.9+3948	3C 345	QSO	0.0	16 42 58.97	+39 48 38.2	18.49	3.52
J1643.8+1715	3C 346	GPair	0.0	16 43 48.74	+17 15 51.4	20.58	4.35
J1643.8−1526	PKS J1643−1526	RS	0.0	16 43 49.05	−15 26 26.6	16.46	3.53
J1646.0−2228	PKS J1646−2227	QSO	0.1	16 46 05.18	−22 28 01.2	16.86	3.55
J1651.2+0459	Hercules A	G	0.6	16 51 12.19	+04 59 51.7	1034.04	31.37
J1659.4+4702	3C 349	GTrpl	0.1	16 59 29.33	+47 02 49.2	28.33	3.83
J1700.6+1448	4C +14.68	RS	0.0	17 00 39.17	+14 48 38.4	16.50	4.05
J1704.7+6044	3C 351	QSO	0.3	17 04 42.42	+60 44 44.4	23.35	3.86
J1705.0+3840	3C 350	RS	0.2	17 05 03.53	+38 40 37.2	15.76	3.80
J1710.7+4601	3C 352	RS	0.0	17 10 44.01	+46 01 27.2	24.70	4.84
J1720.1−0701	PKS J1720−0701	RS	0.0	17 20 11.43	−07 01 32.6	17.67	4.07
J1720.5−0058	3C 353	G	0.8	17 20 31.16	−00 58 39.1	454.14	20.16
J1723.0+0718	4C +07.45	RS	0.0	17 23 00.21	+07 18 02.0	19.44	3.18
J1724.3+5057	3C 356	G	0.2	17 24 19.67	+50 57 32.3	28.70	3.66
J1724.9+4705	4C +47.46	G	0.1	17 24 58.43	+47 05 48.2	11.44	3.27
J1725.2+4036	3C 355	RS	0.1	17 25 16.11	+40 36 35.6	11.83	3.56
J1728.3+3146	3C 357	G	0.4	17 28 20.16	+31 46 02.3	16.58	3.32
J1730.3+7949	4C +79.17	RS	0.0	17 30 21.91	+79 49 16.5	18.00	3.83
J1730.6−2128	KEPLER SNR	SNR	0.4	17 30 41.51	−21 28 46.3	87.99	28.62
J1734.7+1600	4C +16.49	QSO	0.1	17 34 42.70	+16 00 34.4	21.18	3.83
J1747.2−1921	PMN J1747−1921	RS	0.3	17 47 15.31	−19 21 13.7	16.38	4.49
J1755.7+3742	3C 364	QSO	0.0	17 55 44.90	+37 42 40.5	11.09	3.20
J1802.8−0207	4C −02.75	RS	0.1	18 02 49.98	−02 07 41.4	13.94	3.52

Table 1—Continued

VLSS Name	Other Name	Type	D arcmin	RA (J2000) h m s	Dec (J2000) ° m s	S_{74} Jy	Ratio
J1805.1+1101	3C 368	G	0.0	18 05 06.37	+11 01 33.3	37.96	4.52
J1807.8+4829	4C +48.45	G	0.0	18 07 48.75	+48 29 23.0	19.61	3.21
J1812.5+2629	4C +26.55	G	0.0	18 12 31.11	+26 29 22.4	16.99	3.13
J1824.5+5744	3C 378	RS	0.0	18 24 32.01	+57 44 43.5	16.85	3.36
J1827.3+0918	4C +09.60	RS	0.1	18 27 22.46	+09 18 40.5	18.62	3.18
J1829.5+4844	3C 380	QSO	0.0	18 29 31.85	+48 44 46.2	125.15	10.29
J1835.1+3242	3C 382	G	1.1	18 35 06.96	+32 42 14.9	41.41	3.62
J1838.4+1711	3C 386	G	0.1	18 38 26.11	+17 11 57.5	38.58	9.83
J1840.0+2402	4C +24.46	RS	0.0	18 40 02.80	+24 02 29.6	13.42	3.35
J1842.5+7945	3C 390.3	G	1.2	18 42 30.58	+79 45 34.0	83.54	16.68
J1844.0+4533	3C 388	G/GCl	0.1	18 44 02.64	+45 33 34.8	39.12	4.88
J1845.6+0953	3C 390	RS	0.0	18 45 37.64	+09 53 44.0	44.23	4.45
J1859.3+1259	3C 394	G	0.0	18 59 23.44	+12 59 10.8	30.31	3.66
J1906.3+2808	4C +28.47	RS	0.1	19 06 19.38	+28 08 45.2	7.35	4.14
J1907.4+0708	3C 397	RS	0.8	19 07 29.81	+07 08 47.7	53.81	4.10
J1911.2+0905	W049B	SNR	1.8	19 11 12.52	+09 05 48.6	52.37	3.76
J1914.3+4350	TXS 1912+437	RS	0.0	19 14 22.92	+43 50 29.2	6.01	4.37
J1915.9+3019	3C 399.1	RS	0.1	19 15 56.82	+30 19 57.0	18.68	3.38
J1918.1−0153	4C −01.47	RS	0.3	19 18 11.15	−01 53 37.2	8.14	3.16
J1923.4+2237	4C +22.54	RS	0.1	19 23 28.78	+22 37 34.2	10.49	4.02
J1929.3+0958	4C +09.65	RS	0.1	19 29 22.36	+09 58 13.1	12.67	3.26
J1931.5−1405	PMN J1931−1406	RS	0.1	19 31 35.73	−14 05 54.3	13.85	4.84
J1933.8+4719	4C +47.52	RS	0.1	19 33 48.80	+47 19 13.8	6.68	3.03
J1934.6+3224	4C +32.60	RS	0.0	19 34 38.55	+32 24 48.5	7.96	4.87
J1935.7+0556	4C +05.75	RS	0.0	19 35 45.23	+05 56 44.1	7.97	3.06
J1936.8−0022	4C −00.75	RS	0.2	19 36 53.76	−00 22 07.1	11.99	3.28
J1939.6+2135	4C 21.53	RS	1.2	19 39 38.91	+21 35 02.0	14.68	3.73
J1940.4+6041	3C 401	G	0.0	19 40 25.26	+60 41 33.2	32.35	7.77
J1941.9+1026	4C +10.58	RS	0.0	19 41 56.02	+10 26 50.0	22.36	4.15
J1952.2+0230	3C 403	G	0.1	19 52 15.48	+02 30 31.0	47.65	4.95
J1952.8+2526	4C +25.55	RS	0.0	19 52 48.24	+25 26 52.6	17.08	3.53
J1956.1−0737	3C 404	G	0.1	19 56 10.89	−07 37 03.1	17.22	4.86
J1959.4+4044	Cygnus A	G/GCl	0.3	19 59 26.91	+40 44 09.1	16598.13	36335.79
J2012.8+4708	MG4 J201248+4708	RS	0.2	20 12 53.61	+47 08 20.9	6.31	3.38
J2014.4+2334	3C 409	RS	0.0	20 14 27.55	+23 34 54.4	152.95	17.33
J2017.2+3345	4C +33.50	RS	0.1	20 17 12.96	+33 45 53.1	10.25	3.09
J2020.1+2942	3C 410	G	0.1	20 20 06.37	+29 42 11.9	68.87	14.11
J2022.1+1001	3C 411	G	0.0	20 22 08.53	+10 01 11.2	30.65	3.10
J2032.7+5345	3C 415.2	RS	0.0	20 32 46.18	+53 45 50.0	21.36	3.14
J2032.8+2552	3C 414	RS	0.1	20 32 50.30	+25 52 20.3	13.02	5.39

Table 1—Continued

VLSS Name	Other Name	Type	D arcmin	RA (J2000) h m s	Dec (J2000) ° m s	S_{74} Jy	Ratio
J2041.4+2448	3C 419	RS	1.2	20 41 29.77	+24 48 25.3	6.99	3.97
J2044.6+4037	7C 2042+4027	RS	0.2	20 44 41.78	+40 37 45.5	4.26	3.50
J2047.1−0236	3C 422	QSO	0.1	20 47 10.52	−02 36 20.1	14.23	3.00
J2048.1+0701	3C 424	G	0.0	20 48 12.00	+07 01 14.6	29.26	3.62
J2053.2+2613	4C +26.58	RS	0.5	20 53 17.43	+26 13 23.6	7.33	3.28
J2057.0+3105	4C +30.41	RS?	0.0	20 57 05.98	+31 05 05.8	5.78	3.51
J2104.1+7633	3C 427.1	G	0.1	21 04 07.48	+76 33 10.1	54.92	5.13
J2107.4−2525	NGC 7018/ABELL 3744	G/GTrpl	0.2	21 07 24.44	−25 25 45.8	79.34	7.39
J2116.6−2055	PKS J2116−2055	G	0.1	21 16 36.20	−20 55 49.6	32.86	8.71
J2118.1−3019	PKS J2118−3019	QSO	0.2	21 18 10.34	−30 19 21.0	26.76	4.09
J2118.3+6048	3C 430	G	0.1	21 18 18.78	+60 48 12.7	71.82	5.05
J2118.8+4936	3C 431	RS	0.0	21 18 52.40	+49 36 59.9	51.91	3.08
J2123.0−1627	PKS J2123−1627	G	0.0	21 23 01.65	−16 27 57.9	25.03	3.92
J2123.7+2504	3C 433	G/GPair	0.1	21 23 44.69	+25 04 16.0	112.31	14.39
J2129.0+0732	3C 435B	G	0.1	21 29 05.98	+07 32 52.8	23.52	4.10
J2129.0+4553	4C +45.44	RS	0.1	21 29 00.68	+45 53 04.0	18.10	3.42
J2131.3−3121	PKS J2131−3121	QSO	0.1	21 31 23.13	−31 21 15.6	17.16	4.17
J2132.8+1257	4C +12.73	G	0.1	21 32 53.19	+12 57 53.4	13.54	3.07
J2137.7−1432	PKS J2137−1432	QSO	0.3	21 37 44.08	−14 32 53.0	40.31	6.59
J2144.1+2810	3C 436	G	0.0	21 44 11.84	+28 10 19.2	44.56	7.90
J2155.8+3800	3C 438	G	0.0	21 55 52.40	+38 00 27.2	88.65	10.57
J2156.8−0125	4C −01.57	RS	0.1	21 56 48.88	−01 25 48.9	16.25	3.81
J2203.3+6240	3C 440	RS	0.0	22 03 21.28	+62 40 33.4	24.24	3.33
J2206.0+2929	3C 441	G	0.1	22 06 05.20	+29 29 21.8	27.18	3.26
J2214.4−1701	3C 444/ABELL 3847	RS/GCl	1.4	22 14 25.66	−17 01 41.2	163.66	14.47
J2225.7−0457	3C 446	QSO	0.1	22 25 47.40	−04 57 03.7	25.44	3.50
J2231.3+5409	4C +53.50	RS	0.1	22 31 18.24	+54 09 41.5	18.58	6.98
J2245.8+3941	3C 452	G	0.9	22 45 53.18	+39 41 32.1	129.60	15.45
J2250.7+0702	4C +06.75	GPair	0.1	22 50 46.69	+07 02 01.9	6.95	3.59
J2312.0+1844	3C 457	G	1.2	23 12 04.83	+18 44 37.7	25.69	3.32
J2316.5+0405	3C 459	G/HCG	2.0	23 16 35.27	+04 05 18.1	57.96	3.90
J2321.4+2346	3C 460	G	0.0	23 21 28.56	+23 46 46.6	16.05	3.54
J2323.2+5850	Cas A	SNR	2.6	23 23 12.88	+58 50 40.7	18741.55	512.97
J2325.3−1207	PKS J2325−1207/A2597	G/GCl	0.0	23 25 19.83	−12 07 25.4	28.51	3.76
J2326.9+4048	3C 462	G	0.0	23 26 55.91	+40 48 08.9	14.63	3.03
J2326.9−0202	PKS J2326−0202	G	0.1	23 26 54.28	−02 02 15.2	19.61	3.14
J2336.4+2108	3C464/ABELL 2626	G/GCl/MH	0.2	23 36 29.33	+21 08 41.8	28.01	4.11
J2350.8−2457	PKS J2350−2457	QSO	0.1	23 50 50.13	−24 57 04.3	22.32	3.06
J2350.9+6440	3C 468.1	RS	0.1	23 50 54.90	+64 40 15.0	41.01	4.23
J2355.4+7955	3C 469.1	G	0.1	23 55 24.00	+79 55 15.0	25.12	4.35

Table 1—Continued

VLSS Name	Other Name	Type	D arcmin	RA (J2000) h m s	Dec (J2000) ° m s	S_{74} Jy	Ratio
J2357.0−3445	PKS J2357−3445/A4059	G/GCl	0.1	23 57 00.84	−34 45 30.1	57.27	8.25
J2358.5+4404	3C 470	G	0.1	23 58 35.58	+44 04 37.3	18.46	4.76

Note. — The candidate identification type listed is as follows: QSO - quasar, G - galaxy, GCl - galaxy cluster, RS - radio source (no other type found), SNR - supernova remnant, Sy2 - Syfert 2 galaxy, Grp - galaxy group, relic - galaxy cluster radio relic, halo - galaxy cluster radio halo, MH - radio mini-halo in cluster core, GTrpl - triple galaxy system, GPair - double galaxy system, HCG - Hickson Compact Group, GRG - Giant Radio Galaxy