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Selecting stable extragalactic compact radio sources from the permanent astrogeodetic VLBI program

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Abstract. A set of stable compact radio sources is proposed, based on the analysis of VLBI-derived time series of right ascensions and declinations from mid-1989 through May 2002. Five selection schemes are tested, that are based on the usual and Allan standard deviations and on apparent drifts. The efficiency of the selection schemes is characterized by the ability of the sources to support the maintenance of the direction of the axes of the celestial reference frame that they materialize. When compared with the current set of ICRF defining sources, the best performing selection scheme keeps 199 sources and lowers the medium-term frame instability from 28 to 6 microarcseconds. [*]

Key words. Quasars – Astrometry – Reference systems

1. Introduction

The permanent astrogeodetic VLBI observing program started in the 1980s as a joint effort of several institutions, sponsored mainly by the US National Aeronautical and Space Administration (NASA) and National Oceanic and Atmospheric Administration (NOAA). After undergoing development and international extension, it is now managed by the IVS (International VLBI Service for Geodesy and Astrometry). Astrogeodetic VLBI is currently the only available technique to monitor the irregular Earth's rotation at the required level of accuracy. It will stay so in the foreseable future, as no competing technique is proposed. This program provides the basis for the monitoring of the IAU-recommended International Celestial Reference Frame (ICRF, Ma et al. (1998); see also IERS (1999) for the ICRF-Ext.1) to which other celestial reference frames, e.g. the Hipparcos catalogue, are referred.

At the end of 2002, over three million observations of more than 700 compact extragalactic radio sources have been accumulated. This data set includes extremely uneven observation rates. However, about half of the objects are well enough monitored so that the medium and long term stability of their directions can be investigated.

The observed objects are selected by the IVS among quasars and galaxy nuclei that are compact when observed in the X-band (4 cm) and S-band (13 cm) with baseline lengths extending to several thousands kilometers. However, when observed at the current level of precision (a fraction of milliarcsecond, mas), no object is really pointlike. Apparent motions, if existing, may be related to the existence of jets originating in the sources. While the background source structure is assumed to stay fixed, quasi periodical oscillations may exist, as well as apparent drifts that are unlikely to continue indefinitely, but with time characteristics that are not well known.

This observational situation may come into contradiction with the basic assumption that, *globally*, the set of selected object has a no net rotation relative to the quasi inertial space. However, little is presently known about the actual behaviour of these hundreds of sources, so that the solution to solve this difficulty appears to be the selection of sources that best match the no-motion model, in order to minimize the uncontrolled global rotation. The authors of the ICRF (Ma et al. 1998) set up three classes of sources, using qualitative and quantitative criteria, such as apparent drift, formal uncertainty of the global coordinates over 1980-1995, source stucture index. They used only the sources they considered as the most reliable (the *defining* sources) for the definition of the ICRF orientation. A second set of apparently reliable sources that had not been well enough observed in 1995 were considered as *candidates*. Finally, the remaining sources, considered as unstable, were labelled *other* sources.

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[*] Table 6 is only available on-line @EDP

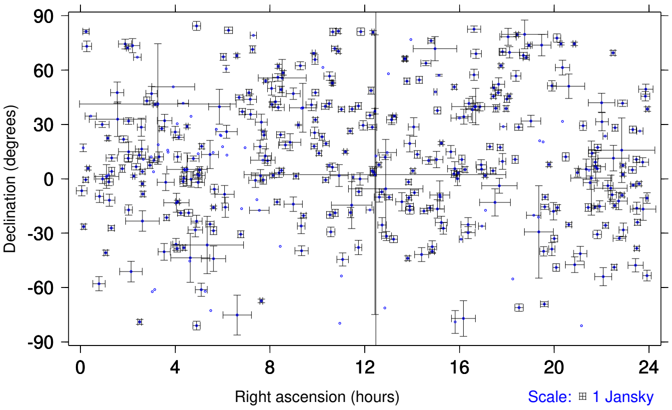

Fig. 1. The most observed ICRF radio sources. Total flux at wavelengths 6 cm (vertical bars), and 11 cm or 15 cm (horizontal bars) are shown when available.

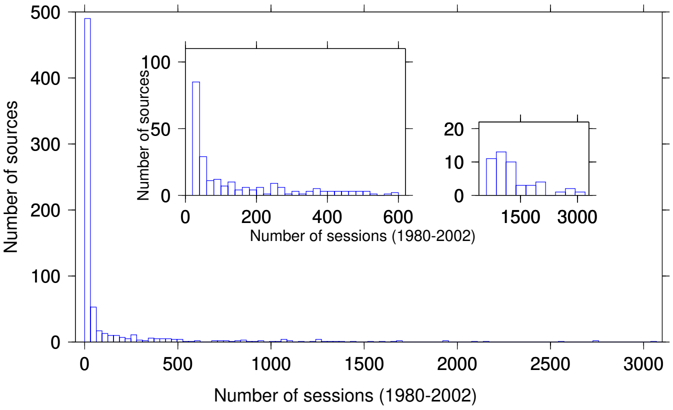

Fig. 2. Observation rates. Number of sessions in which a given source is observed. The leftmost abscissae limit in the right insert is equal to 600

In this paper, we study statistical schemes to detect the most stable sources in the available data, that would be used for the maintenance of the ICRF and the monitoring of the Earth's rotation. The study is entirely based on the series of individual source coordinates derived by Fey (2002) over 1979-2002. We extract from this data set the data over 1989.5-2002.4, i.e. 3.1 million observations of 707 sources, representing 87% of the total observations.

2. The observations

The observations consist of time series derived from a set of three analyses of the existing VLBI observing sessions up to May 2002. Each analysis results in time series of coordinates per session for one third of the sources ("arc" sources), the coordinates of the other sources being treated as "global", i.e. they are assumed to stay fixed in time and are estimated globally. Each analysis includes a no-net-rotation (NNR) condition with respect to the ICRF based on the ICRF defining sources.

To avoid inconsistencies due to the NNR condition realization in the three analyses, and that reach the level of 50 microarcseconds (μas), we consider here for each source the time series of its coordinate differences with their global weighted mean.

Figure 1 gives the sky distribution of the most observed ICRF radio sources. The mean flux at 6 cm and 11 or 15 cm is shown when available at the IERS Celestial Reference System Product Center (2002). The observation rates histogram are shown on figure 2 for the 707 sources.

If the source structure is extended or not circular, its apparent direction may change as a function of the length and orientation of the baselines. Most of the known activity of quasars takes the form of jets, i.e., aligned emissive structures that cause an apparent motion of the observed phase center relative to a fixed background. Therefore, the source structure often changes with time. In principle it is possible to accurately correct this effect, provided that repeated maps of the sources are available (Charlot and Sovers 1997).

However, although series of source maps are routinely derived for the northern hemisphere (Fey and Charlot 1997), the source structure correction is not implemented in the existing astrogeodetic analysis software. As a result, most objects exhibit time variations of their position in some preferred direction.

3. Selection schemes

An earlier study (Gontier et al. 2001) has shown that the improvements in VLBI technology, the development of the observing network and the extension of the set of observed objects that took place in operational VLBI, brought the astrometric results to its current precision towards the end of the first decade. Starting about 1990, individual time series of source coordinates stabilize. Therefore, the selection schemes under study are applied to data after 1989.5. Note that values and plots of yearly averages for sources observed since 1984 are available (IERS 2003).

A set of stable sources is selected in a two-step process, based on series of one-year coordinates, obtained as the mean of the sessions's coordinates weighted according to the corresponding uncertainties:

1. A first selection is made on the basis of continuity criteria for one-year weighted average coordinates.
   (a) Length of observation period longer than five years.
   (b) Not less than two observations of the source in a given session.
   (c) One-year average coordinates based on at least three observations. As this number may be considered as too small, a test was made for comparison with one-year average coordinates based on at least twelve observations.
   (d) Not more than three successive years with no observations, conditions (b) and (c) being met.
   (e) At least half of the one-year averages available over the source observation span.

   This first screening keeps 362 sources for the years centered at 1990.0 through 2002.0. These include 141 defining sources, 130 candidates, 87 other and 4 new sources, i.e. 67% of the defining sources, 44% of the candidates and 85% of the others.

2. The time series of yearly values of $\alpha\cos\delta$ and δ are then analysed in order to derive
   (a) the linear drift (least squares estimation);
   (b) the standard deviation of a single value referred to its global average, and
   (c) the Allan standard deviation for a one-year sampling time. The Allan variance of a time series x_i with N items and sampling time τ is defined as:

$$\sigma_A^2(\tau) = \frac{1}{2N}\sum_i (x_{i+1} - x_i)^2$$

The Allan variance analysis (Allan (1966), see a review of these methods in Rutman (1978)) allows one to characterize the power spectrum of the variability in time series, for sampling times ranging from the initial interval of the series to 1/4 to 1/3 of the data span, in our case one year through four years. This method allows one to identify white noise (spectral density S independent of frequency f), flicker noise (S proportional to f^{-1}), and random walk (S proportional to f^{-2}). Note that one can simulate flicker noise in a time series by introducing steps of random amplitudes at random dates. In the case of a white noise spectrum (an implicit hypothesis in the current ICRF computation strategy), accumulating observations with time eventually leads to the stabilisation of the mean position. In the case of flicker noise, extending the time span of observation does not improve the quality of the mean coordinates. A convenient and rigorous way to relate the Allan variance of a signal to its error spectrum is the interpretation of the Allan graph, which gives the changes of the Allan variance for increasing values of the sampling time τ. In logarithmic scales, slopes -1, 0 and +1 correspond respectively to white noise, flicker noise and random walk noise.

The distributions of the above statistics applied to the 362 preselected sources are shown on figure 3. The normalized linear drift is the absolute value of the least-square derived linear drift divided by its formal uncertainty. This unitless number measures the degree of statistical significance of the estimated velocity. Note that the histograms are quite similar for right ascensions and declinations, except for the standard deviations of the one-year average coordinates, where the declinations tend to be noisier than right ascensions. This may be related to analysis difficulties remaining after the sizeable improvement that was brought to the declination determinations by the adoption of the gradient function correction (McMillan & Ma 1997)

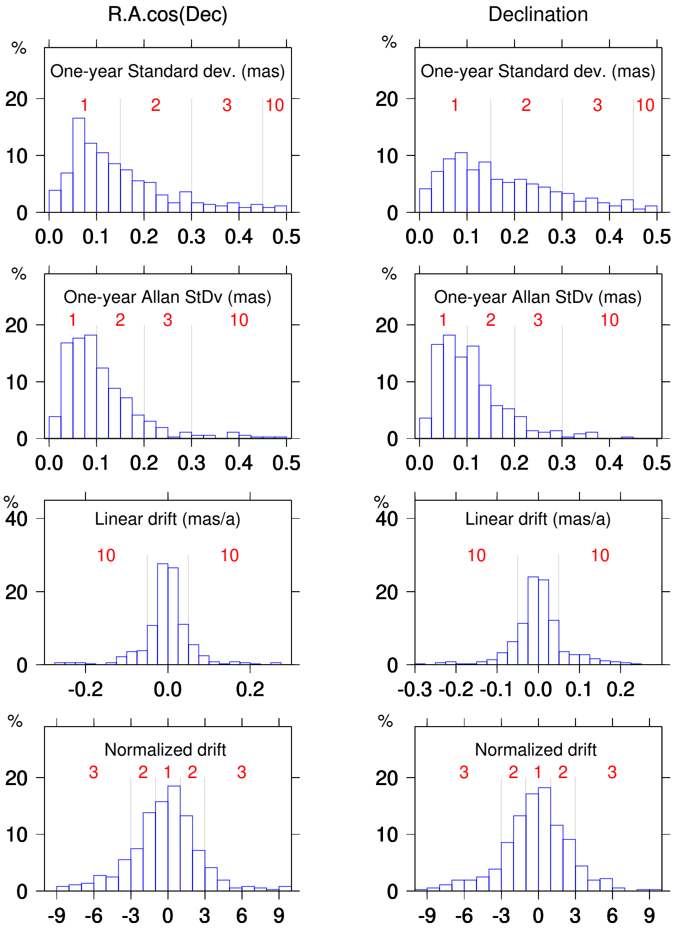

Fig. 3. Distributions of the partial stability criteria for the well observed sources over 1989.5-2002.4. The thresholds and corresponding partial indices listed in Table 1 are shown.

Based on these statistics, rules are set up to derive source stability indices. For each local coordinate ($\alpha\cos\delta$ and δ), three partial indices are defined, as shown in Table 1. The thresholds are set after the distributions of figure 3. The partial stability indices range from 1 (most stable) through 3 (least stable). A rejection value (10) is associated to very large drifts or standard deviations. Given the length of the available time series (up to 13 years), one could consider the Allan standard deviation for sampling times longer than one year (e.g. two or four years). The one-year interval is preferred because its estimation is expected to be more robust than for longer time spans.

The partial stability criteria derived by applying the thresholds of Table 1 are then combined in five different ways, each one representing a different balance in the roles of the standard deviations and the drifts. Fifty sources were found to have apparent drifts larger than 50 μas/year. With at least one partial criterium equal to the rejection value (10), they are excluded a priori in the five options.

The partial indices combinations are as follows.

(a) Usual standard deviation only.
(b) Allan standard deviation only.
(c) Normalized velocity only.
(d) Usual standard deviation and normalized velocity.
(e) Allan standard deviation and normalized velocity.

Table 1. Partial stability criteria. The values range from 1 (best) through 3 (worse), with a rejection value of 10.

Statistics	Threshold	Partial index
Standard deviation (Stdv)		
	Stdv $\leq$ 150 μas	1
	150 μas $\leq$ Stdv $\leq$ 300 μas	2
	300 μas $\leq$ Stdv $\leq$ 450 μas	3
	Stdv $\geq$ 450 μas	10
Allan Standard deviation (AlSd)		
	AlSd $\leq$ 100 μas	1
	100 μas $\leq$ AlSd $\leq$ 200 μas	2
	200 μas $\leq$ AlSd $\leq$ 300 μas	3
	AlSd $\geq$ 300 μas	10
|Drift| (Vel)		
	Vel $\leq$ 10 μas/year	1
	Vel $\geq$ 50 μas/year	10
|Normalized drift| (Nvl)		
	Nvl $\leq$ 1	1
	1 $\leq$ Nvl $\leq$ 3	2
	Nvl $\geq$ 3	3

The global stability index is then defined as the average of the partial indices for $\alpha \cos \delta$ and δ, i.e. two values per source in cases (a), (b) and (c) and four values per source in cases (d) and (e). The stable sources are those which get a stablity index ≤ 2.5.

Combination (a) takes into account the statistical scatter of yearly coordinates, paying no attention to the fact that they belong to a time series. Combination (b) takes this aspect into account in a statistical way, while combination (c) takes it into account in a deterministic way, by modelling an assumed physical phenomenon. Combinations (d) and (e) mix the statistical and deterministic approaches.

4. Testing the source selections

Out of the 362 preselected sources the investigated stability schemes produce between 186 and 208 stable sources, numbers to be compared to the 212 defining sources in the ICRF. To test their efficiency with respect to the maintenance of the axes of the celestial reference frame that they materialize, we consider the 13 yearly differential reference frames (1990.0 - 2002.0) that are formed by the set of stable sources observed in each year. The yearly differential rotation angles $A_1(y)$, $A_2(y)$, $A_3(y)$ around the axes of the equatorial coordinate system for year y are then computed for the 13 years. As the time series of yearly coordinates for each source are referred to the source global average ones, the rotation angles are not affected by the discrepancies between the particular realizations of the no-net-rotation condition attached to the three data treatments that produced the original data used in this work.

Table 2 lists efficiency estimates for the five stability schemes and for the ICRF defining sources. These estimates are the usual standard deviation that characterizes the scattering of the sets of rotation angles, and their Allan standard deviations for one-year and four-year sampling times, that characterize their stability in time. Note that if the time series of the rotation angles have white noise, the four-year Allan standard deviation will be equal to half (square root of one fourth in sampling time) the one-year one. In the case of flicker noise, both values will be equal.

The mixed schemes (d) and (e) keep more stable sources than the single-criterion ones, and yet they insure smaller scattering and better stability. Scheme (e), that takes into account the time series aspect of the data, has slightly better performances that scheme (d), with 5% less sources. As an example, source 2145+067, which shows an abrupt change of coordinates (-0.5 mas from 1998.0 to 1999.0) in a context of moderate drift (22 μas/year), is detected as unstable only by the Allan standard deviation.

The estimated efficiency of the ICRF defining sources is worse than that of selection (e) by nearly a factor of three for the one-year estimates and a factor of five in the longer term. The time series of the yearly rotation angles estimated on the basis of the defining sources have flicker noise at the level of 28 μas. The type of noise of those based on the stable sources (e) is closer to white noise.

5. Discussion

Table 6 (only available in the electronic version of the paper) gives details of the implementation of the selection scheme: number of sessions in which the source was observed, number of yearly points, one-year Allan standard deviation and drift, and four different stability indices. Note that in this table any stability index value larger than 4 is set to this value. For reference, the tables reproduces the values of the source redshifts and fluxes available at the IERS Celestial Reference System Product Center (IERS 2002). The stability indices are are the following ones.

1. The ICRF source status: d = defining, c = candidate, o = other, n = not available in ICRF Ext-1.
2. The source structure index, when available in ICRF-Ext.1. This index (Fey and Charlot 2000) qualifies the level of position disturbance expected as a result of the the source structure (1 for the least disturbed, 4 for the most disturbed)
3. The stability criterion derived in this paper; values 1 and 2 correspond to stable sources, 3 to unstable, and 4 to highly unstable or drifting. The stability indices are rounded off.
4. The same stability criterion as above, but keeping only yearly averages based on at least twelve observations (instead of three).

When imposing a minimum number of twelve observations in the yearly averages instead of three, the difference in stability estimates are as follows.

- 87 sources less as preselected in the first step, 36 because of criterion (d), and 51 because of criterion (e).

Table 2. Efficiency estimates for the tested stability schemes.

Source selection scheme		Nb of sources kept	Std dev. μas	Allan Std dev. 1 year μas	Allan Std dev. 4 years μas
(a)	Stdv	195	11.5	10.1	8.7
(b)	AlSd	186	14.1	8.8	8.9
(c)	Nvl	192	11.3	9.6	5.2
(d)	Stdv+Nvl	208	11.3	9.8	6.7
(e)	AlSd+Nvl	199	10.8	9.4	5.9
ICRF Defining		212	25.6	26.0	27.6

Table 3. Type of noise for the stable and unstable sources as qualified by scheme (e), expressed as the percentage of the types of noise in both categories.

Type of noise	Stable sources R.A.	Stable sources Dec.	Unst. sources R.A	Unst. sources Dec.
White	56%	69%	55%	60%
Flicker	40%	30%	38%	32%
Random walk	4%	1%	7%	8%

Note that 2/3 of these sources are detected as highly unstable or drifting (stability index 4) while most of the reamining ones are detected as highly stable (stability index 1).

- The total number of stable sources drops from 199 to 169.
- The stability diagnoses in the two cases are identical, with very few exceptions.

The source names listed are the 8-character IERS names. The alternate given are those used in the IVS operation. However, most sources have a number of other usual alternate names, the list of which can be found on an ftp site (IERS 2002) or obtained interactively at URL http://hpiers.obspm/fr/icrs-pc/icrf/srcform.html.

Table 3 shows the distribution of the type of noise for the stable and unstable sources as qualified by scheme (e). Sources with white noise are the most frequent globally. They are roughly equally distributed in the stable and unstable sources, as are the less frequent flicker noise sources. The sources with random walk noise are quite few, in particular among the stable sources. Note that these estimations are based on too short time series (13 values at most) to guarantee their robustness. Taking into account the type of noise may be considered for further improvement of the qualifying scheme, when longer time series become available. Table 4 lists the eight stable sources with random walk noise in either right ascension or in declination, i.e. for which the slopes of the Allan graph are close to +1. With the exception of 0119+041 and 2128-123, their Allan standard deviation for a four-year sampling time is small enough to deserve a partial stability index of 2.

Table 4. Stable sources with random walk noise.The table gives the source stability index, the slope of the Allan variance graph and the Allan standard deviation for a four-year sampling time, as well as the type of noise in the direction of maximum variance.

Source	Stb ind	R.A. $\cos(\delta)$ Slope	R.A. $\cos(\delta)$ 4-yr AlSd μas	Declination Slope	Declination 4-yr AlSd μas
0119+041	2	0.8 ± 0.2	350		
0133+476	2			0.7 ± 0.2	103
0229+131	2	1.1 ± 0.1	236		
0234+285	2	1.1 ± 0.4	95		
0552+398	2	0.7 ± 0.1	199		
0919-260	1	1.1 ± 0.1	131		
1611+343	2			0.6 ± 0.1	273
2128-123	2	1.4 ± 0.2	615		

Figure 4 shows the relationship of the ICRF categories with the two components of the source stability index derived in this study for the 312 well observed sources with apparent drifts smaller than 50 μas/year over 1989.5-2002.4. The graphs give the positions of the defining, candidate and other sources as a function of both the one-year Allan standard deviation and the normalized drift. Although a number of defining sources fall in the lower-left zone which correspond to small partial stability indices, some of them are clearly detected as unstable. The candidate sources are globally in the same situation. Conversely, a number of 'other' sources, i.e. considered as having questionable stability in the ICRF work, are detected as stable. Compared to the ICRF selection, the proposed scheme rescues a number of sources that are in fact efficient for maintaining the ICRF axes directions.

Table 5 gives the relationship of the global stability index with two ICRF qualifiers: the source status (defining/candidate/other) and structure index. Again, there is no particular correlation of the instantaneous structure indices with the time stability ones. This finding is of interest in the context of studying the dynamics of the quasars activity. Similarly, there is no clear relationship of the source total fluxes in the X and S bands with their direction time variability. A possible relationship with the flux variability remains to be investigated.

When compared to the current ICRF defining sources, the selection scheme developed in this study achieves improved time stability of yearly reference frames, which implies improved internal consistency. This has consequences not only in astrometric applications, but it may also have bearings in the geophysical interpretation of the Earth's orientation in inertial space. As an example, Dehant et al. (2002) have shown that source instabilities perturb nutation determinations at the level of tens of μas, comparable to that of the excitation of this Earth's rotation axis orientation by diurnal oscillations in the atmosphere.

Table 5. Stability index and ICRF source qualifiers

Stab.	Source status			Structure index		
index	Def.	Can.	Oth.	1	2	3-4
1	33	26	15	46	11	7
2	48	42	34	76	26	6
3	2	1	4	6	2	0
4	58	61	34	70	26	13

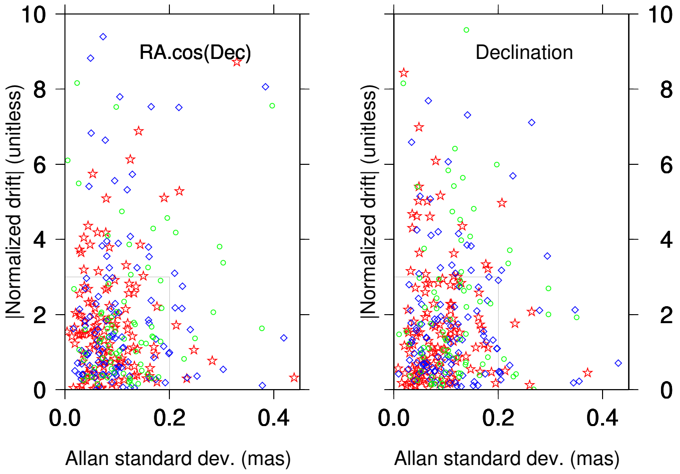

Fig. 4. Partial stability criteria and ICRF source classes: defining (stars), candidate (diamonds) and other (circles). The lower left rectangle includes the sources selected as stable.

Finally, we recommend that the set of selected stable sources be considered on the one hand in any future improvement of the International Celestial Reference Frame, and on the other hand in the scheduling of repeated VLBI sessions for Earth rotation, geodesy and astrometry.

Acknowledgements. The data analysis in this study is entirely based on the time series of coordinates of 707 radio source derived by Alan Fey (USNO) using 3.6 millions of observations accumulated in various US and international programs since 1979.

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Table 6. Stability criteria for 362 well observed extragalactic sources, 1989.5-2002.4. The redshift and the total flux at 6 cm, 11/15 cm are given when available. 'AlSd' is the Allan standard deviation for a one-year sampling time. Stability criterion 1 is the ICRF one (d=defining, c=candidate, o=other). Stability criterion 3 is the one derived in this paper; values 1 and 2 correspond to stable sources, 3 to unstable, and 4 to highly unstable or drifting. Stability criteria 2 and 4: see explanation in the text

				Flux (Jansky)					R.A. cos(δ)		Declination		Stability			
No	Source	Alter.	Redsh.	6	11	15	Number		AlSd	Drift	AlSd	Drift	criteria			
				cm	cm	cm	sess	pts	μas	μas/year	μas	μas/year	1	2	3	4
1	0003 + 380		.23	.5		.6	12	8	32	-2 ± 20	15	-2 ± 11	d	1	1	1
2	0003 − 066		.35	1.6		1.7	492	12	110	-9 ± 8	177	30 ± 24	c	1	2	2
3	0007 + 171		1.60	1.2	.9		14	7	44	-66 ± 15	41	7 ± 31	d	1	4	
4	0008 − 264		1.09	.8		.6	12	9	19	-50 ± 13	64	101 ± 39	c		4	
5	0013 − 005		1.57	.8	.8		54	11	597	15 ± 4	70	4 ± 10	c	1	4	4
6	0014 + 813		3.39	.6		1.0	449	11	96	-7 ± 4	207	54 ± 11	d	1	4	4
7	0016 + 731		1.78	1.6		1.5	425	12	169	-26 ± 6	134	-15 ± 6	o	1	2	2
8	0019 + 058			.5	.5		27	9	26	-35 ± 6	112	-154 ± 32	o	1	4	
9	0026 + 346		.52			1.8	12	5	98	-393 ± 52	10	38 ± 26	o	4	4	
10	0048 − 097			1.9		1.3	1058	13	83	-5 ± 3	104	-7 ± 7	o	1	1	1
11	0056 − 001		.72	1.4		2.2	12	8	136	-262 ± 51	94	194 ± 90	c	3	4	
12	0059 + 581						932	11	158	2 ± 5	197	-26 ± 4	o	1	2	2
13	0104 − 408		.58	.9	.6		499	13	81	-4 ± 12	71	23 ± 13	o		1	1
14	0106 + 013		2.11	3.7		3.9	1280	13	69	6 ± 5	93	1 ± 9	o	1	1	1
15	0109 + 224			.8	.4		14	9	72	24 ± 25	30	13 ± 13	d	1	1	1
16	0111 + 021		.05				167	12	39	-16 ± 9	39	-3 ± 13	c	1	1	1
17	0112 − 017		1.37	1.2	1.4		49	10	192	68 ±117	79	58 ± 40	c	1	4	4
18	0113 − 118		.67	1.9	1.8		27	9	179	-31 ± 93	117	-313 ± 49	o	2	4	4
19	0119 + 041		.64	1.2		.9	1427	13	192	2 ± 11	161	-1 ± 7	c	1	2	2
20	0119 + 115		.57	1.0		1.8	387	11	45	4 ± 4	179	-34 ± 14	c	1	2	2
21	0133 + 476		.86	3.3		2.1	500	13	136	-14 ± 5	68	-12 ± 4	d	1	2	2
22	0134 + 329	3C48	.37	5.4	9.0		11	5	88	56 ±159	85	-299 ±189	o	4	4	
23	0146 + 056		2.35	1.2	.7		54	10	28	32 ± 15	89	63 ± 28	c	1	4	4
24	0149 + 218		1.32	1.1		1.4	43	9	107	-10 ± 13	104	30 ± 22	d	2	2	2
25	0159 + 723			.3	.3		19	7	37	-7 ± 26	84	-16 ± 41	d	1	1	1
26	0201 + 113		3.61	1.2		1.3	360	13	91	21 ± 7	131	-22 ± 16	c	1	2	2
27	0202 + 149		.41	3.1		3.2	516	13	174	-9 ± 7	228	49 ± 9	c	2	2	2
28	0202 + 319		1.47	1.0		1.6	40	11	55	-19 ± 10	41	-4 ± 11	d	2	1	1
29	0208 − 512		1.00	3.2	3.6		274	13	140	3 ± 17	127	-58 ± 21	o		4	4
30	0212 + 735		2.37	2.2		2.3	1264	12	196	36 ± 8	127	-27 ± 6	o	2	3	3
31	0215 + 015		1.72	.4	.4		23	9	173	34 ± 36	87	11 ± 18	d	1	1	1
32	0221 + 067		.51	1.0		1.4	45	9	85	20 ± 14	29	-44 ± 16	c	2	2	2
33	0224 + 671	4C67.05				1.2	40	7	74	20 ± 32	90	28 ± 37	d	1	1	1
34	0229 + 131		2.07	1.0		2.0	1946	13	105	-23 ± 3	125	-11 ± 4	c	1	2	2
35	0230 − 790		1.07	.8	.6		11	7	70	10 ±170	43	-129 ± 91	d		4	
36	0234 + 285		1.21	2.8	1.2		1085	12	49	11 ± 1	123	-5 ± 3	c	2	2	2
37	0235 + 164		.94	2.8		2.0	442	13	103	1 ± 4	121	-14 ± 5	d	1	2	2
38	0237 + 040		.98	.8		.8	22	8	56	8 ± 18	118	140 ± 45	c	1	4	4
39	0237 − 027		1.12	.6	.4		14	8	174	137 ±102	104	-209 ± 65	c	1	4	4
40	0237 − 233		2.22	3.2	5.3		13	7	52	-20 ± 62	78	22 ±140	o	3	1	
41	0238 − 084	NGC1052	.00	.9	.6		275	10	123	-87 ± 22	138	-38 ± 26	o	2	4	4
42	0239 + 108					1.8	83	12	78	28 ± 11	44	-62 ± 13	d	2	4	4
43	0248 + 430		1.31	1.2	1.0		13	7	84	-47 ± 25	115	122 ± 40	d	2	4	4
44	0256 + 075		.89	1.0		.7	38	8	95	26 ± 32	72	21 ± 55	d	1	1	
45	0300 + 470			2.2	1.8		716	12	166	-15 ± 9	296	36 ± 18	o	1	2	4
46	0302 − 623						18	6	81	59 ± 58	51	-17 ± 60	d		4	4
47	0306 + 102		.86	.7		1.3	30	9	96	40 ± 23	79	-37 ± 22	d	1	2	2
48	0308 − 611						80	8	133	17 ± 45	73	30 ± 26	d		2	2
49	0309 + 411		.14	.5		.6	12	6	13	-12 ± 8	69	22 ± 5	d	2	2	
50	0317 + 188						30	6	32	16 ± 15	56	-27 ± 41	c	1	1	
51	0319 + 121		2.67	1.5		1.4	20	10	35	-5 ± 20	51	40 ± 42	o	3	1	1
52	0332 − 403		1.45	2.6	1.9		11	7	129	-147 ± 30	212	-426 ± 55	o		4	
53	0333 + 321	NRAO140	1.26	2.0		2.3	80	10	72	-11 ± 13	67	-11 ± 10	o	3	1	1
54	0336 − 019	CTA26	.85	2.6		2.7	726	13	160	16 ± 8	279	-25 ± 12	c	1	2	2
55	0338 − 214		.05	.9	.8		29	7	101	-124 ± 77	126	-87 ± 71	o		4	4
56	0341 + 158						22	7	50	-39 ± 6	104	110 ± 82	c	1	4	
57	0342 + 147						32	10	59	-50 ± 11	176	-69 ± 37	d	1	4	4
58	0355 + 508	NRAO150				6.8	470	9	43	6 ± 16	88	-20 ± 28	o	3	1	1
59	0400 + 258		2.11	1.8		1.4	36	9	120	26 ± 15	85	46 ± 16	d	2	2	2
60	0402 − 362		1.42	1.9	1.0		344	13	38	-14 ± 9	57	-18 ± 16	o		2	2

Table 7. Stability criteria for 362 extragalactic sources, 1989.5-2002.4 (Cont.)

				Flux (Jansky)					R.A. cos(δ)		Declination		Stability			
No	Source	Alter.	Redsh.	6	11	15	Number		AlSd	Drift	AlSd	Drift	criteria			
				cm	cm	cm	sess	pts	μas	μas/year	μas	μas/year	1	2	3	4
61	0403 − 132		.57	2.9		4.0	11	6	23	-49 ± 6	49	88 ± 29	o	1	4	
62	0405 − 385		1.28	1.1		1.0	73	9	19	13 ± 26	44	97 ± 23	c		4	
63	0406 + 121		1.02	1.6	1.2		32	9	75	-29 ± 40	260	20 ±156	d	1	2	2
64	0406 − 127		1.56	.5	.6		16	7	79	-8 ± 3	159	69 ± 33	c	1	4	
65	0414 − 189		1.54	.8		1.0	11	6	125	113 ± 18	19	-43 ± 5	d	1	4	
66	0420 + 417					1.7	19	8	63	-36 ± 22	39	23 ± 24	c	2	1	
67	0420 − 014		.92	1.6		1.0	1247	11	228	-10 ± 12	222	-45 ± 12	o	1	3	3
68	0422 + 004			1.6		.8	18	8	48	-15 ± 26	98	61 ± 58	d	1	4	4
69	0422 − 380		.78	.8	.5		15	8	28	-29 ± 20	32	89 ± 28	d		4	
70	0425 + 048						16	7	34	52 ± 59	24	174 ± 38	c	3	4	
71	0430 + 052	3C120	.03	5.1		6.4	97	9	183	-50 ± 39	50	-18 ± 10	o	3	4	4
72	0430 + 289			.5	.4		33	5	27	30 ± 28	71	-4 ± 29	n		1	1
73	0434 − 188		2.70	1.1		1.3	92	12	82	56 ± 14	99	17 ± 37	o	1	4	4
74	0440 + 345						30	10	41	15 ± 5	148	72 ± 19	c	1	4	4
75	0440 − 003	NRAO190	.84	2.4	3.5		18	7	40	-61 ± 15	40	-95 ± 37	d	1	4	
76	0451 − 282		2.56	2.2		2.3	11	7	78	-48 ± 63	124	104 ±106	c		4	
77	0454 + 844		≥ 1.34	1.4		1.3	58	11	139	-14 ± 13	116	-25 ± 17	d	1	2	2
78	0454 − 234		1.00	1.9	1.8		1600	13	136	7 ± 7	124	3 ± 6	o	1	2	2
79	0454 − 810		.44	1.4	1.2		20	7	65	-218 ± 85	29	113 ± 26	d		4	
80	0457 + 024		2.38	1.2		1.3	59	11	57	29 ± 19	66	-1 ± 30	d	1	1	1
81	0458 − 020		2.29	1.6		2.0	1256	13	211	-16 ± 7	200	-21 ± 7	c	1	3	3
82	0500 + 019		.58	2.0		2.0	16	9	223	-54 ± 16	317	246 ± 62	o	3	4	4
83	0502 + 049		.95	1.0		.6	11	6	4	9 ± 6	8	-9 ± 15	d	2	1	
84	0507 + 179		.42	.8		.7	42	12	120	-35 ± 22	95	-6 ± 23	d	2	2	2
85	0521 − 365		.05	8.9		11.5	90	11	488	261 ± 82	342	-446 ± 87	d		4	
86	0528 + 134		2.07	4.4	2.7		2546	13	469	-7 ± 8	198	4 ± 4	c	1	4	4
87	0528 − 250		2.77	.8	1.3		16	8	56	-18 ± 31	120	88 ±102	o		4	
88	0530 − 727						55	7	43	-13 ± 29	76	32 ± 47	d		1	1
89	0536 + 145						33	7	96	-18 ± 12	58	-74 ± 20	o	1	4	4
90	0537 − 286		3.10	1.2		1.0	19	9	90	74 ± 35	52	-59 ± 19	d		4	
91	0537 − 441		.90	4.0	3.8		360	13	109	39 ± 8	82	24 ± 11	o	1	2	2
92	0539 − 057		.84	1.5	1.3		12	8	50	63 ± 41	39	32 ± 88	d	1	4	
93	0544 + 273						34	7	70	-17 ± 21	163	-101 ± 39	d	1	4	4
94	0552 + 398		2.36	5.4		3.4	3039	13	129	-8 ± 1	148	-5 ± 2	c	1	2	2
95	0554 + 242						22	5	42	-112 ± 36	173	-99 ± 83	n		4	4
96	0556 + 238						245	12	95	-35 ± 12	131	-75 ± 17	d	1	4	
97	0600 + 177						11	6	100	-22 ± 39	98	-34 ± 42	c	1	1	
98	0602 + 673		1.97	1.1	.8		13	7	85	38 ± 12	66	-48 ± 6	c		2	2
99	0605 − 085		.87	2.7	3.0		27	9	42	-16 ± 17	57	-25 ± 35	c	1	1	1
100	0607 − 157		.32	3.1		1.0	22	9	109	-36 ± 26	63	19 ± 14	c	2	2	4
101	0615 + 820		.71	1.0		1.3	30	8	51	-9 ± 25	60	35 ± 18	d	1	1	1
102	0636 + 680		3.18	.5	.3		34	9	30	15 ± 7	64	-17 ± 8	d	1	2	2
103	0637 − 752		.65	6.2	4.5		277	13	247	-23 ± 21	109	16 ± 10	d		2	2
104	0642 + 449		3.41	.8		1.2	464	12	113	2 ± 6	69	-1 ± 3	d	1	1	1
105	0646 − 306		.46	1.1		.9	11	6	39	170 ± 42	41	172 ± 86	c	2	4	
106	0648 − 165						17	7	109	-30 ± 35	115	192 ± 53	d	1	4	4
107	0650 + 371		1.98	1.0		1.0	30	7	192	-249 ± 45	109	-202 ± 58	c	1	4	4
108	0657 + 172						114	12	88	-14 ± 7	85	-6 ± 7	c	1	1	1
109	0707 + 476		1.29	1.0		.8	13	7	150	-26 ± 8	165	45 ± 26	d	1	2	2
110	0716 + 714			1.1		.7	94	10	38	-12 ± 7	108	-33 ± 15	d	1	2	2
111	0718 + 792	0718+793				1.0	476	10	78	23 ± 5	57	1 ± 4	d	1	2	2
112	0723 − 008		.13	2.3		2.1	27	8	163	45 ± 77	173	-94 ± 77	d	2	4	4
113	0727 − 115						2101	13	159	12 ± 4	165	16 ± 7	o	1	2	2
114	0735 + 178		≥ .42	2.0		2.0	486	12	377	-40 ± 25	180	-10 ± 12	o	1	4	4
115	0736 + 017		.19	1.9		2.9	43	11	234	4 ± 13	35	18 ± 13	c	3	2	2
116	0738 + 313		.63	2.5		1.9	22	9	144	-6 ± 2	80	-15 ± 2	d	1	2	2
117	0742 + 103					3.9	301	12	126	39 ± 13	129	-52 ± 13	o	1	4	4
118	0743 + 259					.6	18	9	176	-14 ± 71	122	122 ± 41	d	1	4	
119	0743 − 006		.99	1.3	1.0		24	9	116	-95 ± 31	289	-412 ± 45	o	1	4	
120	0745 + 241		.41	1.3	.7		111	10	57	-20 ± 9	47	-32 ± 6	d	2	2	2

Table 8. Stability criteria for 362 extragalactic sources, 1989.5-2002.4 (Cont.)

				Flux (Jansky)					R.A. cos(δ)		Declination		Stability criteria			
No	Source	Alter.	Redsh.	6	11	15	Number		AlSd	Drift	AlSd	Drift				
				cm	cm	cm	sess	pts	μas	μas/year	μas	μas/year	1	2	3	4
121	0748 + 126		.89	2.2		2.0	20	7	24	8 ± 11	74	22 ± 38	c	2	1	1
122	0749 + 540		≥ .20	.6	.7		376	12	141	-27 ± 4	96	-4 ± 3	d	1	2	2
123	0754 + 100		.28	1.5	1.0		20	8	27	-28 ± 14	47	-11 ± 21	d	1	1	1
124	0804 + 499		1.43	2.1		1.3	768	13	101	6 ± 3	101	-5 ± 3	d	1	2	2
125	0805 + 410		1.42	.8		.7	240	11	67	-5 ± 7	53	4 ± 5	d	1	1	1
126	0808 + 019			.7		.4	28	8	199	86 ± 25	247	-228 ± 37	c	1	4	4
127	0814 + 425		.26	1.7		1.6	116	11	165	-82 ± 11	75	-11 ± 6	c	1	4	4
128	0818 − 128			.9		.9	18	7	86	29 ± 24	35	-11 ± 20	d	1	1	
129	0820 + 560		1.42	1.2		1.7	53	11	29	52 ± 4	27	4 ± 3	d	1	4	4
130	0821 + 394		1.22	1.0		1.9	14	8	19	-8 ± 6	41	-39 ± 14	d	2	1	1
131	0821 + 621		.54	.6	.3		12	6	218	-261 ± 35	90	38 ± 20	c		4	4
132	0823 + 033		.51	1.4		1.4	785	13	161	-21 ± 6	190	-17 ± 13	c	1	2	2
133	0826 − 373						16	9	53	-77 ± 13	24	-2 ± 22	d		4	
134	0827 + 243		.94	.9		1.3	62	10	108	-8 ± 13	162	47 ± 17	c	2	2	2
135	0828 + 493		.55	1.0		.5	14	8	16	0 ± 11	62	33 ± 44	d	1	1	1
136	0829 + 046		.18	.7		.7	14	7	123	-93 ± 34	133	111 ± 61	d	2	4	4
137	0839 + 187		1.27	1.2		2.2	21	10	140	52 ± 21	363	218 ± 85	d	3	4	4
138	0851 + 202	OJ287	.31	2.6	3.4		2756	13	224	9 ± 4	121	5 ± 3	c	1	2	2
139	0859 − 140		1.34	2.3		2.9	18	7	57	46 ± 31	62	36 ± 26	c	3	2	4
140	0906 + 015		1.02	.9		.8	25	9	55	-18 ± 39	58	-53 ± 79	c	2	4	4
141	0917 + 624		1.45	1.2		1.6	123	10	132	-34 ± 13	129	31 ± 11	d	1	2	2
142	0919 − 260		2.30	2.4		1.2	336	13	62	3 ± 22	137	21 ± 31	o	2	1	1
143	0920 + 390						44	7	95	-91 ± 16	63	-13 ± 21	c		4	4
144	0920 − 397		.59	1.5		2.1	88	12	62	-17 ± 15	140	-227 ± 59	c		4	4
145	0923 + 392	4C39.25	.70	7.6		4.2	2756	13	296	52 ± 3	153	-11 ± 2	o	1	4	4
146	0925 − 203		.35	.7	.8		17	6	47	20 ± 31	44	29 ± 40	c		1	
147	0945 + 408		1.25	1.8		1.7	14	9	64	-17 ± 16	66	-14 ± 11	d	2	2	1
148	0951 + 693	M81		.1		.5	65	9	127	3 ± 25	164	-10 ± 25	o		2	2
149	0952 + 179		1.48	.7		1.0	33	10	64	-38 ± 12	74	39 ± 23	d	3	2	2
150	0953 + 254	OK290	.71	1.8		1.3	530	13	284	38 ± 18	219	49 ± 15	o	1	3	3
151	0954 + 658		.37	1.5		.9	247	12	90	1 ± 8	113	-31 ± 17	d	1	2	2
152	0955 + 326		.53	.7		.7	13	8	70	0 ± 4	126	9 ± 6	d	2	1	1
153	0955 + 476		1.87	1.0		1.1	1049	11	329	-33 ± 4	119	2 ± 2	d	1	4	4
154	1004 + 141		2.71	.7		.8	262	13	145	16 ± 23	98	18 ± 13	o	2	2	2
155	1012 + 232		.56	1.1	.7		13	7	27	27 ± 19	53	13 ± 30	d	1	1	1
156	1014 + 615		2.80				19	7	225	-128 ± 47	50	-43 ± 8	c		4	4
157	1020 + 400		1.25	.9		1.2	15	10	219	-10 ± 2	35	-27 ± 6	d	1	3	2
158	1022 + 194		.83	.6		1.0	22	6	43	-12 ± 13	172	94 ± 61	c	2	4	
159	1030 + 415		1.12	1.1		.8	15	6	58	-122 ± 28	29	-53 ± 20	d	2	4	
160	1032 − 199		2.20	1.0	1.1		11	8	146	305 ± 42	196	-222 ± 76	d		4	
161	1034 − 293		.31	1.5		1.3	1081	13	113	-9 ± 7	138	8 ± 11	o	1	2	2
162	1038 + 064		1.26	1.3		1.6	48	11	74	-58 ± 17	119	125 ± 51	d	1	4	4
163	1038 + 528	1038+52A	.68	.7	.4		162	10	59	-13 ± 10	168	39 ± 24	d		2	2
164	1039 + 811		1.26	1.1	.9		37	11	41	4 ± 10	53	-3 ± 14	d	1	1	1
165	1044 + 719		1.15	.7		1.0	508	12	240	-19 ± 12	204	5 ± 12	c	1	2	2
166	1045 − 188		.60	1.1	.9		12	7	5	-13 ± 2	18	-34 ± 4	o	1	2	
167	1053 + 704		2.49	.7		.6	27	9	111	-1 ± 21	34	-20 ± 3	c	1	2	2
168	1053 + 815		.71	.8		.6	179	12	75	-6 ± 5	114	8 ± 6	d	1	1	1
169	1055 + 018		.89	3.4		2.9	258	12	125	-3 ± 11	95	13 ± 13	o	2	2	2
170	1057 − 797						249	13	120	-11 ± 11	162	-24 ± 12	d		2	2
171	1101 + 384		.03	.7		1.0	209	9	138	-36 ± 11	78	5 ± 11	c	1	2	2
172	1101 − 536						33	8	63	77 ± 8	136	139 ± 47	c		4	4
173	1104 − 445		1.60	2.0	1.8		203	12	122	-119 ± 19	87	70 ± 27	o		4	
174	1111 + 149		.87	.5	.6		20	9	35	-20 ± 21	50	46 ± 30	d	1	1	1
175	1123 + 264		2.34	.8		.7	129	9	71	-9 ± 24	52	6 ± 13	o	1	1	1
176	1124 − 186		1.05	1.6		.6	405	12	64	5 ± 7	52	-8 ± 7	c	1	1	1
177	1127 − 145		1.19	7.3	6.4		28	9	200	-84 ± 85	43	45 ± 27	c	2	4	4
178	1128 + 385		1.73	.8		.9	707	12	85	-13 ± 3	138	6 ± 6	d	1	2	2
179	1130 + 009					.3	28	12	120	43 ± 67	88	-11 ± 73	d	1	1	
180	1144 + 402		1.09	1.0		.9	120	12	88	5 ± 7	129	-40 ± 13	o	1	2	2

Table 9. Stability criteria for 362 extragalactic sources, 1989.5-2002.4 (Cont.)

No	Source	Alter.	Redsh.	Flux (Jansky) 6 cm	11 cm	15 cm	Number sess	pts	R.A. cos(δ) AlSd μas	Drift μas/year	Declination AlSd μas	Drift μas/year	Stability criteria 1	2	3	4
181	1144 − 379		1.05	2.2	1.1		393	13	65	1 ± 8	85	50 ± 12	c		4	2
182	1145 − 071		1.34	1.2		1.0	114	10	64	-27 ± 11	121	-2 ± 19	c	1	2	2
183	1148 − 001		1.98	1.9		2.5	21	9	86	-103 ± 50	74	-119 ± 52	c	3	4	
184	1150 + 812		1.25	1.2		1.2	60	10	75	13 ± 8	110	20 ± 9	d	2	2	
185	1156 + 295		.73	1.5		1.3	589	13	125	-16 ± 4	205	-2 ± 7	c	2	2	2
186	1213 + 350		.86	1.0		1.2	16	8	44	-58 ± 22	21	6 ± 13	d	1	4	4
187	1213 − 172					1.2	18	8	160	36 ± 10	347	-93 ± 44	c	1	4	
188	1216 + 487		1.08	1.1		.7	15	9	28	-1 ± 21	42	-2 ± 23	d	1	1	1
189	1219 + 044		.96	1.4		.6	836	11	32	2 ± 2	157	-10 ± 9	d	1	1	1
190	1219 + 285		.10	.7		1.5	18	9	84	15 ± 37	54	-24 ± 24	c	2	1	
191	1221 + 809			.5	.4		19	10	62	-36 ± 9	35	-18 ± 4	d	1	2	2
192	1222 + 037		.96	1.2		1.0	53	10	71	56 ± 21	56	-82 ± 27	c	2	4	4
193	1226 + 023	3C273B	.16	43.4	41.4		1012	9	101	-227 ± 58	48	-137 ± 21	o		4	
194	1226 + 373		1.51	.9	.2		13	7	162	17 ± 46	180	-69 ± 62	d	1	4	
195	1228 + 126	3C274	.00	71.9			407	12	90	-10 ± 7	118	2 ± 9	c	3	1	1
196	1236 + 077		.40	.7		.6	16	8	58	-1 ± 40	108	157 ± 56	d	1	4	4
197	1237 − 101		.75	1.5		1.6	21	6	31	6 ± 22	104	129 ± 21	c		4	
198	1243 − 072		1.29	.9		.7	31	7	77	-83 ± 12	90	-39 ± 71	c	1	4	
199	1244 − 255		.64	2.3		1.4	76	10	125	2 ± 30	48	-44 ± 14	c		2	4
200	1251 − 713						18	7	53	-51 ± 43	73	-123 ± 51	d		4	
201	1252 + 119		.87	.7		1.8	35	7	37	70 ± 25	32	-5 ± 29	d	1	4	4
202	1253 − 055	3C279	.54	15.3		11.8	223	11	202	195 ± 32	152	-72 ± 33	o	2	4	4
203	1255 − 316		1.92	1.4		1.6	144	11	77	65 ± 24	69	122 ± 23	c		4	4
204	1257 + 145					2.9	14	8	123	-181 ± 80	100	148 ± 74	d	1	4	
205	1300 + 580						197	9	89	-12 ± 6	45	-1 ± 5	o	1	1	1
206	1302 − 102		.29	.8		1.0	48	11	95	83 ± 16	109	120 ± 44	c	1	4	4
207	1308 + 326		1.00	1.5	1.6		1314	13	233	-3 ± 10	232	17 ± 10	d	1	2	2
208	1308 + 328		1.65	1.1			34	7	66	22 ± 17	127	72 ± 25	n		4	4
209	1313 − 333		1.21	1.1		1.2	177	11	35	-4 ± 10	132	-19 ± 50	c	1	1	1
210	1315 + 346	OP326	1.05	.3	.5		21	10	75	7 ± 10	53	-39 ± 17	c	1	1	
211	1334 − 127		.54	2.8		1.9	1670	13	183	-18 ± 6	108	-10 ± 6	o	1	2	2
212	1342 + 663		1.35	.8	.6		39	10	60	5 ± 13	84	-19 ± 17	d	1	1	1
213	1347 + 539		.98	1.0		.9	14	9	117	-117 ± 35	118	-32 ± 19	d	2	4	
214	1349 − 439		.05	.8	.5		21	9	27	-17 ± 42	30	33 ± 42	c		1	
215	1351 − 018		3.71	.8		.8	434	11	121	6 ± 8	111	34 ± 10	c	1	2	2
216	1354 + 195		.72	2.6		1.8	124	12	104	12 ± 12	107	16 ± 18	o	2	2	2
217	1354 − 152		1.89	.8		1.2	91	10	378	-8 ± 68	430	82 ±116	c	1	4	4
218	1357 + 769						861	11	98	-1 ± 3	116	5 ± 2	c	1	1	1
219	1402 + 044		3.21	.7		.6	41	8	253	17 ± 46	201	-34 ± 71	c	1	2	2
220	1404 + 286	OQ208	.08	2.9		1.7	1156	12	39	2 ± 2	139	47 ± 5	o	1	2	2
221	1406 − 076		1.49	.8		1.3	31	10	32	-9 ± 12	33	31 ± 17	c	1	1	
222	1413 + 135		.25	1.2		.9	36	12	81	19 ± 12	59	36 ± 16	o	3	2	2
223	1418 + 546		.15	1.1		1.0	356	12	129	-7 ± 5	109	9 ± 4	d	2	2	2
224	1424 − 418		1.52	2.2		2.2	296	13	82	-23 ± 12	125	-8 ± 23	o		2	2
225	1435 + 638		2.07	.8		1.6	15	8	51	54 ± 23	40	-4 ± 34	d	3	4	4
226	1442 + 101	OQ172	3.54	1.1		2.0	30	9	156	31 ±103	103	9 ± 62	d	3	2	2
227	1448 + 762		.90	.7		1.0	21	8	45	-72 ± 31	89	-41 ± 28	d	1	4	4
228	1451 − 375		.31	1.8		1.4	114	11	103	-34 ± 17	107	-22 ± 49	c		2	2
229	1451 − 400		1.81	.6	.7		27	7	133	-3 ± 57	78	24 ± 49	c		1	1
230	1458 + 718	3C309.1	.90	3.8		6.9	18	9	69	36 ± 18	132	-188 ± 33	o	3	4	4
231	1459 + 480					.5	12	7	20	25 ± 12	20	20 ± 17	d	1	2	2
232	1502 + 106		1.83	2.5		2.0	567	10	132	-25 ± 14	45	17 ± 3	o	1	2	2
233	1504 − 166		.88	2.8		2.2	29	6	90	16 ± 76	80	11 ± 55	c	1	1	1
234	1508 + 572		4.30	.3			51	7	80	-52 ± 15	109	-37 ± 22	c		4	4
235	1510 − 089		.36	4.4		3.1	315	11	166	-4 ± 13	127	-17 ± 12	o	1	2	2
236	1511 − 100		1.51	1.2		.9	19	8	210	-97 ± 31	90	-4 ± 57	c	1	4	
237	1514 + 197		1.07	.5		.5	12	8	37	-8 ± 5	62	28 ± 10	d	1	1	
238	1514 − 241		.05	1.9		1.9	215	10	96	-31 ± 14	69	6 ± 22	c		1	2
239	1519 − 273			1.8		1.0	183	11	112	-11 ± 10	110	-8 ± 11	c		2	2
240	1538 + 149		.61	2.0		1.5	35	8	133	-24 ± 38	165	23 ± 49	d	1	2	2

Table 10. Stability criteria for 362 extragalactic sources, 1989.5-2002.4 (Cont.)

				Flux (Jansky)					R.A. cos(δ)		Declination		Stability			
No	Source	Alter.	Redsh.	6	11	15	Number		AlSd	Drift	AlSd	Drift	criteria			
				cm	cm	cm	sess	pts	μas	μas/year	μas	μas/year	1	2	3	4
241	1546 + 027		.41	1.1		.8	41	11	96	22 ± 16	154	12 ± 57	c	1	2	2
242	1547 + 507		2.17	.7	.7		14	6	28	45 ± 18	28	31 ± 20	d	3	2	1
243	1548 + 056		1.42	2.2		2.3	216	11	83	-33 ± 12	104	125 ± 21	o	2	4	4
244	1557 + 032		3.89	.5	.5		27	6	174	-12 ± 43	355	35 ±152	c		4	4
245	1600 + 335					2.7	16	6	213	21 ± 12	61	38 ± 12	d	1	2	2
246	1604 − 333					.6	20	8	48	56 ± 50	110	22 ± 71	d		4	
247	1606 + 106		1.23	1.4		1.0	1211	13	190	21 ± 4	195	1 ± 5	d	1	2	2
248	1610 − 771		1.71	5.6	3.8		260	13	155	36 ± 29	229	10 ± 28	o		2	2
249	1611 + 343		1.40	2.3	2.4		1055	13	119	-11 ± 2	182	14 ± 5	c	1	2	2
250	1614 + 051		3.22	.9		.6	117	10	72	15 ± 13	104	-25 ± 28	c	1	2	2
251	1622 − 253		.79	2.2	2.3		1246	13	89	-3 ± 5	82	-18 ± 7	o	1	1	1
252	1622 − 297		.81	1.9		2.2	41	9	72	18 ± 43	58	-22 ± 44	c		1	1
253	1624 + 416		2.55	1.6		1.5	31	10	78	7 ± 19	118	-7 ± 30	d	2	1	1
254	1633 + 382	1633+38	1.81	4.1		2.1	433	11	146	15 ± 12	128	5 ± 12	o	1	2	2
255	1637 + 574		.75	1.8		1.4	258	12	102	6 ± 10	123	17 ± 19	d	1	2	2
256	1638 + 398	NRAO512	1.67	1.2		1.1	814	12	169	-11 ± 8	115	23 ± 4	o	1	2	2
257	1641 + 399	3C345	.59	5.7		7.6	1087	10	335	85 ± 44	210	75 ± 9	o	1	4	4
258	1642 + 690		.75	1.4		1.7	146	11	86	4 ± 5	64	23 ± 5	d	2	2	2
259	1652 + 398	DA426	.03	1.3	1.5		207	11	57	-2 ± 6	89	34 ± 10	c	2	2	2
260	1655 + 077		.62	1.6		1.6	18	9	62	-23 ± 18	63	28 ± 38	c	3	1	1
261	1656 + 053		.88	1.4		1.6	45	9	1304	205 ± 45	294	22 ± 6	c	2	4	4
262	1657 − 261					1.1	30	10	39	43 ± 16	97	45 ±106	c		1	
263	1705 + 018		2.58	.5	.5		42	9	48	15 ± 10	48	85 ± 16	d	1	4	4
264	1706 − 174						37	11	66	-49 ± 36	73	-52 ± 53	d	1	4	
265	1717 + 178			.9		1.0	15	8	83	25 ± 21	31	-6 ± 16	o	1	1	1
266	1725 + 044		.29	.9		.8	15	11	81	43 ± 23	147	-41 ± 75	d	1	2	4
267	1726 + 455		.71	.6	.7		755	11	176	-17 ± 7	89	14 ± 3	d	1	2	2
268	1730 − 130	NRAO530	.90	4.2	4.9		599	11	90	20 ± 12	144	71 ± 26	o	2	4	4
269	1732 + 389		.98	1.1	.7		41	7	95	9 ± 4	129	-1 ± 16	c	1	1	4
270	1738 + 476		.32	.9		.9	18	9	46	-41 ± 8	28	5 ± 10	c	1	2	2
271	1739 + 522		1.38	2.0	1.9		1366	13	303	-3 ± 6	344	-1 ± 7	c	1	4	4
272	1741 − 038		1.06	2.3		5.6	2158	13	212	-18 ± 4	146	16 ± 4	o	1	3	3
273	1743 + 173		1.70	.9		.9	29	8	116	-36 ± 17	264	25 ± 12	d	1	2	4
274	1745 + 624		3.89	.6	.6		411	10	138	3 ± 9	103	-10 ± 7	d	2	2	2
275	1749 + 096		.32	2.5		1.1	1545	13	189	5 ± 4	203	-3 ± 6	c	1	2	2
276	1749 + 701		.77	1.1		1.1	20	6	36	63 ± 16	76	-42 ± 18	d	2	4	4
277	1751 + 288					1.1	16	6	17	25 ± 9	24	-45 ± 29	o	1	2	
278	1758 + 388		2.09	.9		.6	24	8	97	10 ± 17	124	-61 ± 15	c		4	4
279	1800 + 440		.66	1.0		.8	12	6	56	-79 ± 23	24	-60 ± 9	d	1	4	
280	1803 + 784		.68	2.6		2.6	1942	13	199	-3 ± 3	152	0 ± 3	c	1	2	2
281	1806 + 456		.83	.7		.5	12	7	92	-77 ± 52	32	-32 ± 15	c		4	
282	1807 + 698	3C371	.05	1.7		3.1	249	13	71	12 ± 3	84	7 ± 4	c	2	2	2
283	1815 − 553						145	13	103	33 ± 39	102	23 ± 24	o		2	2
284	1821 + 107		1.36	1.2	.9		19	8	39	47 ± 26	34	36 ± 29	c	1	2	
285	1823 + 568		.66	1.7		1.6	164	11	98	-1 ± 8	93	23 ± 8	d	1	1	1
286	1830 + 285		.59	1.0		1.3	11	7	62	5 ± 23	27	3 ± 20	d	2	1	1
287	1831 − 711		1.36	1.1	1.3		19	8	102	151 ± 39	9	3 ± 8	c		4	4
288	1842 + 681		.47	.9		1.2	12	8	58	37 ± 22	60	44 ± 17	d	1	2	2
289	1845 + 797	3C390.3	.06	4.5		7.3	29	11	170	65 ± 57	187	26 ± 55	d	2	4	4
290	1849 + 670		.66	.6	.9		121	7	31	-31 ± 8	74	63 ± 6	d	2	4	4
291	1856 + 737	1856+736	.46	.4	.4		13	7	36	37 ± 12	48	-69 ± 10	d	1	4	
292	1901 + 319	3C395	.63	1.8		3.1	28	10	184	-67 ± 28	119	68 ± 25	o	3	4	4
293	1908 − 201					2.3	387	12	60	0 ± 8	172	-25 ± 18	c		2	2
294	1920 − 211						63	10	124	10 ± 26	197	53 ± 49	c		4	2
295	1921 − 293		.35	14.3	4.6		1358	13	123	1 ± 7	185	-37 ± 16	o	1	2	2
296	1923 + 210						97	10	59	-42 ± 18	47	-30 ± 12	c	2	2	2
297	1928 + 738		.30	3.3		3.0	129	11	99	-20 ± 10	170	-11 ± 16	o	2	2	2
298	1933 − 400		.96	1.4	1.2		26	10	33	5 ± 11	34	-33 ± 26	c		1	
299	1936 − 155		1.66	.8		1.3	46	9	66	17 ± 18	109	36 ± 30	c	1	2	2
300	1937 − 101		3.79	.8		.9	16	9	170	-17 ± 20	43	-31 ± 20	c	1	2	2

Table 11. Stability criteria for 362 extragalactic sources, 1989.5-2002.4 (Cont.)

				Flux (Jansky)					R.A. cos(δ)		Declination		Stability			
No	Source	Alter.	Redsh.	6	11	15	Number		AlSd	Drift	AlSd	Drift	criteria			
				cm	cm	cm	sess	pts	μas	μas/year	μas	μas/year	1	2	3	4
301	1947 + 079		2.70	.7		.5	28	6	112	87 ±279	175	935 ±239	n		4	4
302	1954 + 513		1.22	1.6		1.4	43	10	40	3 ± 10	45	-18 ± 12	d	1	1	1
303	1954 − 388		.63	2.0		1.0	373	11	56	12 ± 10	88	-34 ± 20	d		2	2
304	1958 − 179		.65	2.7		1.1	839	13	98	4 ± 4	90	2 ± 6	o	1	1	1
305	2000 − 330		3.78	1.0		1.1	21	9	85	-125 ± 56	107	27 ±155	d		4	
306	2007 + 777		.34	1.3		1.2	241	11	303	45 ± 13	56	3 ± 3	o	1	4	4
307	2008 − 159		1.18	.9		.6	84	11	88	15 ± 15	139	-72 ± 33	o	1	4	
308	2021 + 317						13	8	35	-35 ± 24	42	16 ± 24	d	1	1	
309	2029 + 121		1.22	1.3		1.1	20	8	34	-10 ± 13	38	-54 ± 30	d	1	4	4
310	2037 + 511	3C418	1.69	3.8		5.0	353	12	54	0 ± 3	45	1 ± 3	d	3	1	1
311	2037 − 253		1.57	.7		.9	11	6	66	184 ± 19	63	-149 ± 29	c		4	
312	2052 − 474		1.49	2.5	3.0		70	12	106	-22 ± 31	111	-22 ± 49	d		2	4
313	2059 + 034		1.01	1.4		.6	12	10	48	-32 ± 8	63	-13 ± 20	d	1	2	4
314	2106 − 413		1.05	2.3	2.1		22	9	123	79 ± 28	59	-21 ± 25	d		4	
315	2109 − 811						14	5	18	-50 ± 30	78	152 ±148	d		4	
316	2113 + 293		1.51	1.5		1.1	139	11	61	-8 ± 5	371	15 ± 34	d	1	3	3
317	2121 + 053		1.94	3.2		2.5	851	13	397	78 ± 10	73	-1 ± 3	o	1	4	4
318	2126 − 158		3.28	1.2		.9	180	12	96	6 ± 13	70	-74 ± 15	c	1	4	4
319	2128 − 123		.50	2.0		1.7	700	12	249	37 ± 27	234	20 ± 47	o	2	2	2
320	2131 − 021		1.28	2.1		2.2	15	8	19	-63 ± 4	22	99 ± 16	c	1	4	
321	2134 + 004	2134+00	1.93	11.5		6.5	909	13	70	-38 ± 18	94	-40 ± 26	o	1	2	2
322	2136 + 141		2.43	1.1		1.2	278	12	122	24 ± 9	49	-19 ± 5	d	1	2	2
323	2143 − 156		.70	.5		1.0	18	9	84	17 ± 17	213	-55 ±109	d	2	4	
324	2144 + 092		1.11	1.0		.8	24	9	507	35 ± 9	142	-29 ± 15	c	1	4	
325	2145 + 067		1.00	4.4		3.1	1696	13	439	-5 ± 14	180	22 ± 7	d	1	4	4
326	2149 + 056		.74	1.0		1.1	40	12	419	-72 ± 52	222	-46 ± 70	c	1	4	4
327	2149 − 307	2149-306	2.35	1.3		1.4	16	6	112	-21 ± 50	90	-4 ± 53	o		1	
328	2150 + 173			1.0		1.1	21	6	131	-57 ± 50	82	-30 ± 34	d	2	4	4
329	2155 − 152		.67	1.7		1.8	61	10	231	76 ± 67	166	193 ± 67	o	1	4	4
330	2200 + 420	VR422201	.07	2.9		4.2	955	12	134	-10 ± 6	268	0 ± 10	o	1	2	2
331	2201 + 315		.30	2.8		2.0	305	13	167	11 ± 8	296	32 ± 12	o	1	2	2
332	2209 + 236					.7	18	11	69	42 ± 22	31	15 ± 12	d	1	2	2
333	2210 − 257		1.83	.8		.9	11	6	80	43 ± 11	71	-61 ± 15	c		4	
334	2216 − 038		.90	1.6		1.6	441	12	94	4 ± 8	211	24 ± 30	o	1	2	2
335	2223 − 052	3C446	1.40	4.1		5.2	248	9	165	36 ± 15	206	-73 ± 23	c	3	4	4
336	2227 − 088		1.56	1.4		1.3	61	11	153	52 ± 20	67	-63 ± 19	c	1	4	4
337	2229 + 695			.8	.6		18	9	82	-98 ± 36	59	-12 ± 25	d	1	4	4
338	2230 + 114	CTA102	1.04	4.0	4.9		158	12	185	21 ± 10	77	-18 ± 7	o	2	2	2
339	2232 − 488		.51	.9	.8		13	6	41	116 ± 46	44	-104 ±145	d		4	
340	2233 − 148		≥ .61	.6	.5		18	9	72	77 ± 35	31	-97 ± 36	c	1	4	
341	2234 + 282		.80	1.1		.9	1689	13	384	-73 ± 9	264	-45 ± 6	c	1	4	4
342	2243 − 123		.63	2.7	2.7		369	12	113	26 ± 11	350	-88 ± 46	o	1	4	4
343	2245 − 328		2.27	.6	2.0		31	10	44	70 ± 20	58	-84 ± 45	c		4	
344	2251 + 158	3C454.3	.86	10.0		10.5	1067	10	296	-222 ± 58	73	5 ± 28	o		4	4
345	2253 + 417		1.48	1.0		1.5	40	9	48	-21 ± 11	78	42 ± 23	c	1	2	2
346	2254 + 024		2.09	.5	.5		23	9	116	71 ± 54	87	-118 ± 62	c	1	4	4
347	2254 + 074		.19	.5		.9	20	9	79	-69 ± 14	27	-16 ± 7	d	1	4	
348	2255 − 282		.93	2.1	1.4		886	13	124	-3 ± 9	100	-15 ± 11	o	2	2	2
349	2318 + 049		.62	1.0	1.2		125	11	103	12 ± 19	48	12 ± 28	c	1	1	1
350	2319 + 272		1.25	1.1		1.1	27	10	282	32 ± 42	176	88 ± 26	d	1	4	4
351	2320 − 035		1.41	.4		.8	66	11	79	40 ± 22	101	-92 ± 50	c	2	4	4
352	2326 − 477		1.31	2.1	2.4		28	7	141	-79 ±157	28	-69 ± 57	d		4	
353	2328 + 107		1.49	1.0		1.0	13	6	16	32 ± 20	53	115 ± 66	c	2	4	
354	2329 − 162		1.15	1.9		1.2	11	5	28	100 ± 27	37	-48 ± 40	d	2	4	
355	2331 − 240		.05	.9		.9	22	9	161	-102 ± 57	113	43 ± 54	c		4	
356	2335 − 027		1.07	.6		.6	28	10	74	14 ± 36	107	-14 ± 80	c	1	1	
357	2337 + 264					1.0	15	9	147	271 ± 44	197	308 ± 91	o	3	4	4
358	2344 + 092	2344+09A	.67	1.4		1.9	27	11	412	169 ± 94	507	203 ±162	c	2	4	4
359	2345 − 167		.58	3.5	4.1		130	10	147	16 ± 32	86	-94 ± 32	o	1	4	
360	2351 + 456		1.99	1.5	1.4		28	8	36	-15 ± 20	29	24 ± 20	o	2	1	2
361	2355 − 106		1.62	1.6	.5		139	11	161	6 ± 20	175	17 ± 40	c	1	2	2
362	2356 + 385		2.70	.7		.5	206	7	73	41 ± 4	141	-82 ± 11	c		4	4