Bull. astr. Soc. India (1981) 9, 24–30

Accurate positions of Markarian galaxies

Mohan N. Joshi *Radio Astronomy Centre, Tata Institute of Fundamental Research, Ootacamund 643 001*
Rafik A. Kandalian *Byurakan Astrophysical Observatory, Byurakan, Armenia, USSR*

Received 1980 August 11; accepted 1980 October 10

Abstract. Optical positions of 304 Markarian galaxies, MRK 1096 to 1399, are given with accuracies better than 1 arcsec.

Key words : Markarian galaxies

1. Introduction

Markarian and his colleagues have catalogued nearly 1400 galaxies which are destinguished by presence of excess ultraviolet emission as compared to normal galaxies (Markarian 1967, 1969a, 1969b; Markarian & Lipovetsky 1971, 1972, 1973, 1974, 1976a, 1976b; Markarian, Lipovetsky & Stepanian 1977a, 1977b, 1979a, 1979b, 1979c). Majority of these Markarian galaxies have emission lines in their spectra and about 10 per cent of them are Seyfert-type. There are also QSOs, BL Lac and other types of peculiar objects amongst them as noted by the authors of the catalogues. Therefore, further studies of these objects in other parts of the electromagnetic spectrum are of much interest. However, more accurate positions than given in the above mentioned catalogues are required for this purpose. For the Markarian galaxies MRK 1 to 1095 of the first eleven lists, accurate positions with rms errors of $\sim$5 arcsec in both coordinates have been given by Peterson (1973), Kojoian, Elliott & Tovmassian (1978) and Tovmassian, Shahbasian & Kandalian (1980). In this paper we present accurate positions with rms errors $\leqslant$ 1 arcsec for the 304 Markarian galaxies, MRK 1096 to 1399, of the remaining three lists.

2. Method of measurement

The positions of the Markarian galaxies were determined from the Palomar Sky Survey prints using a method similar to the one briefly described by Kapahi *et al.* (1973). In this method a computer program first generates a transparent overlay on which are plotted, to the scale of the Sky Survey prints, positions of 10–15 reference stars selected from Smithsonian Astrophysical Observatory star catalogue and lying

within about 2° of the objects of interest. The overlays themselves can be used for quick but less accurate determination of positions with rms errors of about 10 arcsec, but their main purpose is location of the objects of interest and idenification of the reference stars. The X-Y coordinates of the reference stars along with the objects are then measured by means of Ascorecord, the Zeiss coordinate measuring machine. For this purpose, contact plates made from the Sky Survey prints are used, as the prints cannot be directly put on the measuring machine. Finally, the positions of the objects of interest are calculated from the above data by using the well known method of dependences (*e.g.* Smart 1977).

3. Discussion of errors

The computer program which does the above calculations first finds the positions of each reference star with respect to the others and rejects those stars for which the residuals, i.e. the differences between the catalogued and calculated positions in either coordinates comes out to be greater than 1.5 arcsec. Such differences can arise because of possible large proper motions of the stars concerned and/or because of subjective errors in judging the centroid of the star images on which the cross wires of the machine are to be set. The rms error due to the latter has been estimated to be about ± 5 micron, which corresponds to about ± 0.35 arcsec. Galaxies and other objects of interest to us are generally much fainter than the reference stars, and hence their images on the Sky Survey prints are much smaller in size. Therefore, for galaxies in the mag range of 15 to 20, the setting error is found to be only about ± 0.2 arcsec rms. Thus, it is seen that in this method it should be possible to achieve positional accuracies of the order of ± 0.5 arcsec or better. This has been confirmed by comparing measured positions of several hundred reference stars with their catalogued positions. However, in the present work, for the sake of rapidity, the number of reference stars was restricted to only six and all six were used in calculating the position of the object irrespective of their residuals. But in only about 17 per cent of the cases, more than one star had residuals exceeding 1.5 arcsec and no residual was greater than 1.8 arcsec. Thus the positions of the Markarian galaxies presented here are expected to be accurate to ± 1 arcsec rms or better.

4. Results

The accurate positions of the 304 Markarian galaxies are listed in Table 1. Column 1 gives the MRK number taken from the original catalogues. Columns 2 and 3 give the right ascension and declination, respectively, for epoch 1950.0. As mentioned above, the rms errors in both the coordinates are $\leqslant 1.0$ arcsec. A comparison of the catalogued positions with those presented here shows that, except for four galaxies, the peak errors in the catalogued positions are within 4 arcmin. Of these, 197 have errors less than 1 arcmin, 83 within 1 to 2 arcmin, 18 within 2 to 3 arcmin and 2 within 3 to 4 arcmin. For the four galaxies, namely MRK 1213, 1286, 1364 and 1393, the errors are rather large, being 16.31, 18.41, 15.92 and 19.20 arcmin, respectively.

Table 1. Accurate positions of Markarian galaxies

Markarian galaxy	Right Ascension (1950.0)			Declination (1950.0)			Markarian galaxy	Right Ascension (1950.0)			Declination (1950.0)		
	h	m	s	°	′	″		h	m	s	°	′	″
1096	15	23	45.52	+67	19	26.7	1136	23	48	50.91	+35	22	57.8
1097	15	24	05.43	+71	05	56.9	1137	23	57	57.72	+26	02	49.8
1098	15	27	37.90	+30	39	23.4	1138	00	12	02.20	+08	00	05.1
1099	15	47	47.33	+69	37	17.9	1139	00	13	39.22	+21	08	24.2
1100	15	50	14.27	+41	53	13.2	1140	00	13	41.13	+24	30	45.9
1101	15	54	54.04	+42	01	27.8	1141	00	15	31.82	+22	12	05.2
1102	15	55	27.63	+41	41	12.4	1142	00	18	07.26	+21	41	18.3
1103	15	55	40.99	+41	40	28.1	1143	00	39	59.47	+02	58	56.9
1104	16	04	03.64	+41	28	42.8	1144	00	40	02.75	+02	57	54.8
1105	16	12	53.00	+12	41	51.4	1145	00	41	04.82	+02	05	32.0
1106	16	14	41.29	+18	37	08.6	1146	00	44	42.18	+14	25	50.3
1107	16	44	54.05	+36	10	44.2	1147	00	45	57.95	+10	03	56.6
1108	16	48	49.24	+28	55	46.6	1148	00	49	16.46	+17	09	40.7
1109	16	51	36.01	+63	11	51.4	1149	00	53	42.68	−14	32	45.2
1110	16	51	52.19	+69	00	27.5	1150	00	59	40.76	+34	50	43.7
1111	16	53	08.11	+26	44	28.5	1151	01	05	59.60	−13	14	48.3
1112	16	55	19.09	+28	15	50.5	1152	01	11	21.81	−15	06	38.6
1113	16	55	53.54	+28	12	15.2	1153	01	20	41.22	−00	57	41.9
1114	16	58	39.81	+32	44	36.0	1154	01	22	12.11	−01	49	37.9
1115	17	01	07.52	+33	07	53.2	1155	01	23	22.91	+33	08	44.8
1116	17	36	23.97	+86	46	36.2	1156	01	29	13.83	+32	55	21.0
1117	17	38	42.19	+39	16	47.2	1157	01	30	38.77	+35	24	42.9
1118	17	49	43.45	+24	29	41.0	1158	01	32	07.20	+34	47	01.9
1119	17	50	54.71	+37	45	29.6	1159	01	32	26.47	+32	47	43.6
1120	17	54	59.33	+40	15	11.5	1160	01	35	37.60	+34	57	33.0
1121	18	09	28.55	+31	50	55.3	1161	01	35	58.53	−09	24	59.9
1122	18	25	08.48	+42	38	21.1	1162	01	35	56.72	+29	22	59.6
1123	22	05	05.36	+44	03	15.1	1163	01	37	09.05	+30	58	44.9
1124	22	28	10.27	−14	26	42.6	1164	01	38	10.65	+32	38	25.5
1125	22	47	01.46	+19	09	24.4	1165	01	40	05.69	+27	58	10.5
1126	22	58	09.98	−13	11	14.9	1166	01	46	26.50	+12	50	46.3
1127	22	59	38.29	+26	47	01.6	1167	01	53	58.09	+31	28	12.2
1128	23	00	11.15	+38	26	43.4	1168	01	54	59.39	+03	13	58.4
1129	23	04	09.58	+09	44	00.9	1169	01	55	03.82	+02	10	49.7
1130	23	08	58.00	−00	27	01.6	1170	01	55	06.96	+37	20	05.5
1131	23	25	26.89	−02	26	23.4	1171	01	58	12.02	+31	38	30.8
1132	23	35	30.98	+31	20	55.2	1172	02	03	07.47	−08	29	01.9
1133	23	41	29.94	+27	26	15.2	1173	02	05	16.80	+20	07	07.8
1134	23	44	27.01	+29	10	52.5	1174	02	05	30.04	+01	39	26.3
1135	23	48	01.96	+28	43	12.2	1175	02	10	53.68	+31	38	02.4

Continued

Table 1—*Continued*

Markarian Galaxy	Right Ascension (1950.0)			Declination (1950.0)			Markarian Galaxy	Right Ascension (1950.0)			Declination (1950.0)		
	h	m	s	°	′	″		h	m	s	°	′	″
1176	02	24	27.16	+41	47	02.0	1216	08	26	19.91	—06	46	22.7
1177	02	24	36.45	—13	20	37.2	1217	08	27	55.77	—04	14	18.4
1178	02	24	37.24	—13	21	33.7	1218	08	35	13.23	+25	04	18.1
1179	02	30	26.92	+27	43	03.6	1219	08	50	25.79	—04	35	03.9
1180	02	33	48.38	+33	06	37.6	1220	08	51	49.92	+17	52	49.8
1181	02	36	02.10	+03	49	48.7	1221	09	00	27.29	+18	27	34.9
1182	02	37	54.72	+16	36	58.6	1222	09	00	33.59	+20	51	58.2
1183	02	39	51.21	+28	21	44.4	1223	09	01	21.15	+17	16	31.6
1184	02	43	25.39	—05	50	58.7	1224	09	01	48.87	+14	47	39.0
1185	02	44	04.55	+15	34	30.2	1225	09	06	35.78	+15	59	58.0
1186	02	45	00.93	+15	43	44.2	1226	09	06	47.51	+19	40	21.6
1187	02	45	37.31	+13	43	39.7	1227	09	11	10.59	+18	09	07.1
1188	03	01	26.75	—01	05	22.9	1228	09	12	13.13	+19	54	19.9
1189	03	02	46.18	—02	32	03.3	1229	09	13	03.91	+21	08	16.0
1190	03	04	38.33	—02	18	19.7	1230	09	14	10.49	+25	38	21.3
1191	03	40	12.61	—06	32	24.3	1231	09	17	06.94	—10	17	11.6
1192	03	53	07.45	—09	43	44.0	1232	09	17	20.61	+01	09	06.1
1193	04	04	37.86	—10	18	13.8	1233	09	31	36.58	+00	27	52.6
1194	05	09	06.41	+05	08	27.7	1234	09	36	34.16	—09	13	49.3
1195	06	39	59.13	+78	04	30.9	1235	09	39	26.46	—08	22	27.3
1196	06	59	37.10	+39	18	52.4	1236	09	47	19.98	+00	51	00.5
1197	07	02	53.00	+28	22	25.9	1237	09	47	30.18	+44	33	55.4
1198	07	08	02.19	+25	59	54.8	1238	09	48	54.60	—01	18	49.0
1199	07	20	28.41	+33	32	24.2	1239	09	49	46.26	—01	22	35.7
1200	07	21	55.34	+27	25	25.4	1240	09	52	26.33	+11	16	36.0
1201	07	22	34.49	+30	03	10.7	1241	09	53	54.01	+11	24	02.3
1202	07	42	24.74	+28	33	45.4	1242	09	55	54.39	+13	29	40.4
1203	07	44	52.44	+28	26	57.5	1243	09	57	14.20	+13	17	04.6
1204	07	46	33.20	+29	04	19.0	1244	09	57	13.55	—05	07	36.5
1205	07	52	57.68	+16	41	23.0	1245	10	04	05.82	—07	12	45.0
1206	07	54	21.30	+14	47	36.6	1246	10	06	57.23	+77	55	27.8
1207	07	59	31.62	+09	32	04.0	1247	10	07	55.42	+16	55	54.5
1208	08	01	13.72	+08	50	28.8	1248	10	09	20.14	+78	07	24.0
1209	08	01	16.06	+10	09	05.3	1249	10	10	32.04	—07	17	11.0
1210	08	01	26.85	+05	15	20.9	1250	10	11	52.30	+77	08	45.6
1211	08	03	04.18	+07	44	06.0	1251	10	14	04.44	—09	15	29.3
1212	08	04	02.51	+27	16	16.1	1252	10	14	04.27	—07	56	26.4
1213	08	11	35.24	—00	13	05.6	1253	10	17	00.76	—03	05	09.6
1214	08	21	03.93	+14	54	54.4	1254	10	17	41.01	—08	39	22.1
1215	08	25	34.13	+23	13	41.8	1255	10	22	29.77	+79	28	54.4

Continued

Table 1—*Continued*

Markarian Galaxy	Right Ascension (1950.0) h	m	s	Declination (1950.0) °	′	″	Markarian Galaxy	Right Ascension (1950.0) h	m	s	Declination (1950.0) °	′	″
1256	10	22	38.98	−03	56	26.7	1296	11	26	21.08	+21	01	30.9
1257	10	22	55.50	−07	13	41.8	1297	11	26	36.03	+20	02	53.9
1258	10	35	29.71	−07	02	25.2	1298	11	26	43.56	−04	07	36.3
1259	10	36	03.06	−06	54	34.7	1299	11	31	31.34	−07	20	44.9
1260	10	36	56.03	+05	22	06.6	1300	11	31	53.32	+24	41	20.7
1261	10	41	19.22	−01	01	55.1	1301	11	33	10.67	+35	36	43.4
1262	10	43	04.50	+11	36	27.3	1302	11	36	20.83	+03	51	29.4
1263	10	46	18.57	+12	27	34.6	1303	11	37	39.50	−00	08	04.7
1264	10	46	31.28	+07	10	56.9	1304	11	39	38.55	+00	36	40.8
1265	10	46	57.89	+23	06	12.4	1305	11	40	24.57	−08	03	17.5
1266	10	49	50.84	+08	21	37.5	1306	11	42	52.52	−09	47	06.2
1267	10	50	28.44	+04	53	53.6	1307	11	50	03.80	−02	11	28.4
1268	10	52	13.55	+39	24	10.8	1308	11	51	38.63	+00	24	54.0
1269	10	52	29.51	+40	43	16.2	1309	11	55	11.14	−09	54	00.2
1270	10	53	18.67	−09	35	33.3	1310	11	58	40.59	−03	23	58.6
1271	10	53	33.22	+06	26	24.4	1311	12	07	58.40	−01	02	10.2
1272	10	55	02.46	+15	36	06.6	1312	12	09	05.42	+20	07	24.1
1273	10	56	16.26	−09	34	37.3	1313	12	09	41.00	+00	21	01.6
1274	10	56	15.29	+06	59	56.2	1314	12	11	27.21	−09	17	29.6
1275	10	57	32.85	+10	38	21.1	1315	12	12	46.35	+20	55	06.4
1276	10	58	37.86	+10	44	59.3	1316	12	13	32.06	+20	34	06.1
1277	11	01	02.11	−01	07	19.6	1317	12	15	15.12	+18	42	08.6
1278	11	01	56.64	+39	04	17.5	1318	12	16	36.54	+04	07	57.9
1279	11	02	57.14	+35	23	16.5	1319	12	16	52.58	+18	20	54.4
1280	11	03	20.47	−05	58	08.8	1320	12	16	34.91	−01	31	49.9
1281	11	04	55.15	+77	33	33.7	1321	12	16	54.47	+05	19	29.9
1282	11	04	44.70	+21	55	39.8	1322	12	21	08.05	−01	11	58.1
1283	11	05	09.44	+28	46	16.1	1323	12	21	20.97	+03	21	43.2
1284	11	06	22.19	+00	42	57.3	1324	12	23	42.75	+05	45	11.1
1285	11	08	55.71	+22	27	20.2	1325	12	23	56.49	+09	17	44.8
1286	11	15	16.06	+78	21	26.9	1326	12	24	14.07	+08	11	43.3
1287	11	10	02.90	−10	01	01.2	1327	12	24	52.01	−08	02	57.4
1288	11	15	53.30	+23	44	34.3	1328	12	29	06.52	+15	07	59.6
1289	11	16	11.67	+36	56	53.4	1329	12	34	29.96	+07	12	01.0
1290	11	17	23.40	−05	34	43.4	1330	12	37	04.94	−05	04	08.7
1291	11	21	00.25	−08	23	02.8	1331	12	38	05.21	−09	57	27.3
1292	11	21	31.48	−07	00	49.8	1332	12	39	24.68	−03	18	35.2
1293	11	22	10.78	+20	02	56.4	1333	12	39	50.12	−06	41	50.5
1294	11	23	35.81	−05	18	41.4	1334	12	43	12.20	−06	47	46.9
1295	11	11	05.67	+08	02	06.9	1335	12	44	28.31	+26	50	13.5

Continued

Table 1 – *Continued*

Markarian Galaxy	Right Ascension (1950.0)			Declination (1950.0)			Markarian Galaxy	Right Ascension (1950.0)			Declination (1950.0)		
	h	m	s	°	′	″		h	m	s	°	′	″
1336	12	46	43.79	—09	01	11.8	1371	14	06	12.32	+15	27	28.3
1337	12	49	58.45	—09	30	18.4	1372	14	06	34.99	+14	59	39.7
1338	12	50	43.59	+25	32	59.6	1373	14	07	47.19	—03	53	55.8
1339	12	51	41.66	+05	38	09.6	1374	14	08	44.85	+01	30	36.1
1340	12	54	14.60	+06	11	11.9	1375	14	09	38.52	+32	09	49.0
1341	12	58	24.87	+00	14	27.8	1376	14	10	39.25	—02	58	27.4
1342	12	58	36.80	—05	17	17.2	1377	14	12	15.96	+13	36	38.7
1343	13	06	31.96	+07	13	51.2	1378	14	12	41.91	+66	02	16.9
1344	13	06	41.72	—05	00	23.8	1379	14	15	01.74	—07	11	12.0
1345	13	17	09.77	+20	24	02.1	1380	14	18	57.15	+30	51	29.0
1346	13	19	08.58	+38	47	58.1	1381	14	18	59.51	+05	18	04.9
1347	13	20	24.88	+08	25	19.5	1382	14	25	35.18	—01	27	12.6
1348	13	22	24.94	+76	12	41.1	1383	14	26	33.77	+01	30	26.9
1349	13	27	02.45	+12	00	15.7	1384	14	30	23.45	+06	13	06.2
1350	13	28	03.20	+12	46	40.2	1385	14	37	36.92	—05	58	55.7
1351	13	29	52.82	+03	19	04.0	1386	14	37	51.80	+41	15	37.8
1352	13	30	01.87	+13	04	27.8	1387	14	41	31.57	+16	41	06.4
1353	13	30	31.30	+07	22	35.4	1388	14	48	23.05	+22	56	24.0
1354	13	30	34.61	+09	45	32.8	1389	14	49	45.18	+79	57	41.3
1355	13	30	52.90	+09	47	00.7	1390	14	58	29.98	+00	54	19.5
1356	13	32	46.12	+10	56	50.5	1391	14	58	36.00	+17	08	39.9
1357	13	38	39.98	—03	58	24.8	1392	15	03	26.03	+03	54	00.3
1358	13	41	53.76	+05	22	33.3	1393	15	07	40.87	—00	00	36.0
1359	13	42	08.21	+20	27	41.0	1394	15	07	05.00	—07	38	52.6
1360	13	44	22.59	+11	52	14.1	1395	15	08	34.99	+04	28	59.5
1361	13	44	36.51	+11	21	19.7	1396	15	11	06.60	+04	42	53.6
1362	13	47	33.97	+23	34	00.9	1397	15	14	48.42	+24	40	16.1
1363	13	51	22.44	—07	41	04.9	1398	15	15	43.07	+69	31	08.1
1364	13	51	41.84	—01	17	55.2	1399	15	23	20.21	+33	45	29.2
1365	13	52	06.00	+15	17	21.3							
1366	13	52	58.79	+06	50	27.6							
1367	13	57	37.68	+04	19	20.3							
1368	14	00	26.76	+07	01	09.4							
1369	14	02	06.73	+36	57	53.2							
1370	14	05	34.82	+07	33	52.6							

Acknowledgements

We are grateful to Academician B. E. Markarian, V. A. Lipovetky and J. A. Stepanian for supplying the lists and the finding charts of the Markarian Galaxies prior to their publication and to R. Nanjan for considerable help in the measurements. The method used for measuring the optical positions from Sky Survey prints was initially suggested by Dr M. K. V. Bappu and developed by one of the authors (MNJ) and C. R. Subrahmanya under his guidance. We wish to express our gratitude to Dr Bappu and C. R. Subrahmanya.

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