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## ACCURATE OPTICAL POSITIONS OF SEYFERT GALAXIES

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Optical positions of all presently known Seyfert galaxies are given to an accuracy of a few arc seconds or better. Included are new measurements of 33 galaxies with errors  $\sim \pm 0.5$  arcsec.

*Key words:* Seyfert galaxies – optical positions

## 1. INTRODUCTION

We are currently using the Westerbork Synthesis Radio Telescope in a survey for radio emission from all Seyfert galaxies at accessible declinations (Meurs and Wilson, in preparation). This programme represents a continuation of the survey of 43 galaxies by de Bruyn and Wilson (1976). Since the accuracy of the radio positions is generally about 1 or 2 arcsec, a similar accuracy is required of optical positions to enable reliable association of the radio source with the Seyfert galaxy. However, for many of the Seyfert galaxies listed by Weedman (1977), second of arc optical positions were not available, so we have measured positions for 33 galaxies to an accuracy of about  $\pm 0.5$  arcsec. For the sake of completeness, we give in table 1 optical positions, accurate to a few seconds of arc or better, of all Seyfert galaxies currently known to us by including measurements by other workers as well as our own.

## 2. MEASUREMENTS AND RESULTS

The new positions were determined from the Palomar Sky Survey prints and the ESO (B) Survey negatives by means of the “Coradograph” measuring machine of the Royal Greenwich Observatory (RGO). The procedure involved measurement of the galaxy along with 6 nearby AGK3 reference stars in the sequence galaxy–reference stars–galaxy–reference stars–galaxy. The individual measurements of the stars and the galaxy were then averaged and right ascension and declination computed using the RGO astrometric programme, whose method of reduction is described in Appendix I of Murray, Tucker and Clements (1971). From the residuals of the reference star positions, the programme computes a “confidence ellipse” the size of which gives an estimate of the positional error. This value is typically  $\pm 0.5$  arcsec and is representative of the error in both R.A. and Dec. for galaxies with a small, symmetric image. For galaxies with overexposed or asymmetric nuclei, the errors are larger but less than a few seconds of arc.

An independent check of the results is afforded by a comparison of our positions with measurements by E.D. Clements in the RGO astrometric programme, which employs specially obtained plates from the 13 inch and 26 inch refractors at Herstmonceux, and whose accuracy is expected to be better than our own. For the two galaxies (IZwl and IIZwl36) in common to the two projects, the differences between the measurements for each coordinate are +0.06, -0.08, +0.77 and +0.07 arcsec. Although the galaxies in the overlap are too few for any detailed discussion, these results broadly confirm the above estimate of our errors.

Positions of the other Seyfert galaxies have been taken from Véron (1966), Bolton (1968), Gallouët and Heidmann (1971), Argue and Kenworthy (1972), Barbieri *et al.* (1972), Gallouët, Heidmann and Dampierre (1973, 1975), Wills *et al.* (1973), Peterson (1973), de Bruyn and Willis (1974), Hargrave and McEllin (1975),

Véron and Véron (1975, 1977), de Bruyn and Wilson (1976), Dressel and Condon (1976) and Véron *et al.* (1976). The positions listed by Peterson (1973) are systematically in error with respect to both radio (de Bruyn and Wilson 1976) and other optical measurements (Dressel and Condon 1976). Dressel and Condon find the bias to be  $-3$  arcsec in each coordinate *i.e.* Peterson's positions are systematically to the south-west of those of Gallouët and Heidmann (1971) and Gallouët, Heidmann and Dampierre (1973). We have, therefore, corrected Peterson's (1973) positions for this bias.

The positions are listed in order of right ascension in table 1, which contains all Seyfert galaxies listed by Weedman (1977) plus MCG8-11-11 (Ward *et al.* 1977), Mark 573 (Koski 1977), T1351-375 (Penston *et al.* 1977), ESO 113-IG45, ESO 141-G55 and MCG-2-58-22 (Ward *et al.* 1978). The first column gives the name of the galaxy, the second the right ascension (1950.0), the third the declination (1950.0) and the fourth the reference for the position in a code explained at the bottom of the table. Also given with each code is an estimate of the positional error as given in the reference.

Table 2 lists the positions of eight other galaxies which we have measured. They were determined either because they lie nearby to a Seyfert galaxy or because they are emission line objects whose radio emission is also under study.

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Table 1 Optical positions of Seyfert galaxies

Name	$\alpha$ (1950.0) h m s	$\delta$ (1950.0) ° ' "	References
Mark 335	00 03 45.3	+19 55 30	P
IIIZw2	00 07 56.73	+10 41 47.0	WM
Zw0039+4003	00 39 32.31	+40 03 10.1	WM
Mark 348	00 46 04.88	+31 41 04.3	VV2
Izwl	00 50 57.82	+12 25 19.9	WM
Mark 352	00 57 08.8	+31 33 30	P
ToO109-383	01 09 09.76	-38 20 56.0	WM, Ext
Mark 1	01 13 19.7	+32 49 36	P
IIZwl	01 19 26.54	-01 18 05.5	WM
ESO113-IG45	01 21 51.18	-59 03 58.2	WM
Arak 42	01 21 56.27	+31 54 20.5	WM, Ext
Mark 358	01 23 45.3	+31 21 16	P
Mark 573	01 41 22.93	+02 05 56.7	WM
4C29.6	02 04 08.81	+29 16 31.3	WM
Mark 590	02 11 59.9	-01 00 05	DC
Arak 79	02 14 19.74	+38 10 59.3	WM, Ext
Arak 81	02 20 20.88	+31 57 44.0	WM, Ext
NGC 985	02 32 10.46	-09 00 21.2	WM
NGC 1068	02 40 07.0	-00 13 31.1	B
Mark 372	02 46 31.1	+19 05 57	P
NGC 1275	03 16 29.548	+41 19 52.19	AK
Mark 609	03 22 57.27	-06 19 09.2	WM
IIIZw55 (NGC1409)	03 38 38.33	-01 27 30.2	WM
NGC 1566	04 18 53.3	-55 03 23	WM, Ext.
3C 120	04 30 31.46	+05 15 01.0	B
Mark 618	04 33 59.95	-10 28 36.4	WM
Arak 120	05 13 37.88	-00 12 15.8	WM
MCG8-11-11	05 51 09.9	+46 25 55	DC
Mark 3	06 09 48.24	+71 03 10.8	SC2
Mark 6	06 45 43.89	+74 29 09.5	VVAG
Mark 374	06 55 34.2	+54 15 56	P
Mark 376	07 10 36.1	+45 47 10	P
Mark 9	07 32 42.4	+58 53 03	P
Mark 78	07 37 56.4	+65 17 46	P
Mark 79	07 38 47.2	+49 55 50	P
Mark 10	07 43 07.8	+61 03 26	P
Mark 382	07 52 03.5	+39 19 10	P
Mark 110	09 21 44.7	+52 30 17	P
Zw0934+0120	09 34 26.45	+01 19 14.2	WM
3C227	09 45 06.48	+07 39 17.7	WWD
Mark 124	09 45 24.6	+50 43 29	P
Arak 223	09 54 42.82	+07 25 38.9	WM,Ext
Mark 141	10 15 39.2	+64 13 17	P
NGC 3227	10 20 46.79	+20 07 07.8	SC1
Mark 142	10 22 23.4	+51 55 43	P
Ton 524a	10 28 46.45	+29 02 26.9	WM
Mark 34	10 30 52.6	+60 17 23	P

Name	$\alpha$ (1950.0) h m s	$\delta$ (1950.0) ° ' "	References
Arak 253	10 41 19.20	-01 01 54.9	WM
NGC 3516	11 03 22.8	+72 50 24	Mean of DC & GHD2
Mark 40	11 22 48.4	+54 39 29	P
Mark 176	11 29 54.3	+53 13 30	P
NGC 3783	11 36 33.00	-37 27 40.9	WM, Ext
Mark 42	11 51 05.6	+46 29 23	P
NGC 4051	12 00 36.1	+44 48 44	Mean of DC & GHD2
NGC 4151	12 08 00.4	+39 41 02	Mean of DC & GHD2
Mark 50	12 20 51.1	+02 57 23	P
NGC 4507	12 32 54.52	-39 38 02.0	WM, Ext
Mark 231	12 54 05.4	+57 08 40	P
X Comae	12 57 57.71	+28 40 11.0	WM
Mark 236	12 58 18.4	+61 55 30	P
Mark 64	13 04 48.10	+34 40 22.5	BCGP
3C 287.1	13 30 20.46	+02 16 09.0	V
Mark 268	13 38 54.4	+30 37 50	P
Mark 270	13 39 41.2	+67 55 36	P
Mark 69	13 43 51.5	+29 53 06	P
IC 4329A	13 46 27.87	-30 03 40.6	WM
To1351-375	13 51 17.31	-37 31 50.9	WM
Mark 279	13 51 52.5	+69 33 16	P
Mark 463	13 53 39.71	+18 36 57.8	WM,Ext
Mark 464	13 53 45.4	+38 48 57	P
NGC 5548	14 15 43.7	+25 21 59	Mean of DC & GH1
Mark 474	14 33 06.3	+48 52 50	P
Mark 478	14 40 04.8	+35 38 56	P
4C 35.37	15 31 45.24	+35 54 21.6	WM
Mark 290	15 34 45.8	+58 04 03	P
Mark 486	15 35 21.8	+54 43 07	P
Mark 291	15 52 54.3	+19 20 23	P
Mark 298	16 03 21.9	+17 56 06	P
Mark 504	16 59 10.6	+29 28 50	P
Mark 506	17 20 45.8	+30 55 33	P
3C 382	18 33 11.96	+32 39 18.5	VV1
3C 390.3	18 45 37.58	+79 43 06.5	C
NGC 6764	19 07 01.5	+50 51 06	Mean of DC & GHD2
ESO 141-G55	19 16 56.99	-58 45 51.9	WM
NGC 6814	19 39 55.4	-10 26 37	GHD3
Mark 509	20 41 26.25	-10 54 17.4	WM
IIZw136	21 30 01.22	+09 55 01.0	WM
Mark 304	22 14 45.4	+13 59 30	P
NGC 7469	23 00 44.5	+08 36 18	Mean of DC & GH1
Mark 315	23 01 35.8	+22 21 13	P
MCG-2-58-22	23 02 07.16	-08 57 19.4	WM, Ext
NGC 7603	23 16 22.6	-00 01 39	DC
PKS 2349-01	23 49 22.30	-01 25 54.2	B
Mark 541	23 53 28.36	+07 14 40.7	WM

AK = Argue and Kenworthy (1972). Standard errors are  $\pm 0^{\circ}014$  in R.A.,  $\pm 0.12$  arcsec in Dec.

B = Bolton (1968). Errors from  $\pm 0.3$  to  $\pm 0.8$  arcsec in each coordinate. BCGP = Barbieri *et al.* (1972). Standard errors are  $0^{\circ}03$  in R.A. and  $0.4$  arcsec in Dec.

C = Clements quoted in Hargrave and McEllin (1975). Error  $+0^{\circ}07$  in R.A.,  $\pm 0.2$  arcsec in Dec.

DC = Dressel and Condon (1976). r.m.s. errors 4 arcsec in each coordinate. GH1 = Gallouët and Heidmann (1971). Mean error 3.5 arcsec in each coordinate.

GHD2 = Gallouët, Heidmann and Dampierre (1973). Mean error about 4 arcsec in each coordinate.

GH 3 = Gallouët, Heidmann and Dampierre (1975). Mean error about 4 arcsec in each coordinate.

P = Peterson (1973) corrected for bias of 3 arcsec in each coordinate (see text). r.m.s. errors 5 and 7 arcsec in R.A. and Dec. respectively.

SC1 = Schoenmaker quoted in de Bruyn and Willis (1974). Error about  $\pm 0.5$  arcsec in each coordinate.

SC2 = Schoenmaker quoted in de Bruyn and Wilson (1976). Error about 1 arcsec in each coordinate.

V = Véron (1966). Standard errors are of the order of 1.0 arcsec in each coordinate.

VV1 = Véron and Véron (1975). Errors in the range 0.5–0.6 arcsec in each coordinate.

VV2 = Véron and Véron (1977). r.m.s. errors are 0.4–0.5 arcsec in each coordinate.

VVAG = Véron *et al.* (1976). r.m.s. errors are 0.5 arcsec in each coordinate.

WM = This paper. Error typically  $\pm 0.5$  arcsec in each coordinate.

WM, Ext = As WM, but the image of the galaxy is large or asymmetric so the errors are typically a few arcsec.

WWD = Wills *et al.* (1973). r.m.s. errors are  $\pm 0^{\circ}03$  in R.A.,  $\pm 0.5$  arcsec in Dec.

Table 2 Optical positions of other galaxies

Name	$\alpha$ (1950.0)			$\delta$ (1950.0)			References
	h	m	s	"	'	"	
Arak 80	02	20	23.91	+31	58	14.1	WM, Ext
Mark 610	03	23	03.33	-06	18	14.2	WM
III Zw 55 (NGC1410)	03	38	38.01	-01	27	43.6	WM, Ext
Ton 524b	10	28	45.99	+29	03	33.7	WM
T1032-283	10	32	18.30	-28	19	28.0	WM, Ext
T1038-290	10	38	10.09	-29	00	29.3	WM
IZw81	14	06	20.36	+49	05	56.2	WM
Mark 700	17	01	21.53	+31	31	37.5	WM

For referencing code see below table 1.