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DISCOVERY, OBSERVATIONAL DATA AND THE ORBIT OF THE ATEN GROUP ASTEROID 2006 SF77

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Abstract. A project devoted to astrometric and photometric observations of asteroids at the Mołėtai Observatory is described. One of the most important results of the project is the discovery of 2006 SF77, a high-inclination asteroid belonging to the NEO Aten group. New astrometric and photometric data on the asteroid are presented. The brightness variations of the asteroid are not larger than 0.1 mag in R. A possible rotation period of 34 min is estimated.

Key words: asteroids: astrometry, photometry, orbits – asteroids: NEO: individual (2006 SF77)

1. INTRODUCTION

The asteroid project of the Mołėtai Observatory (IAU code 152, longitude 25.5633 E, latitude 55.3166 N, altitude 210 m) involves astrometric and photometric observations of the Main Belt asteroids and the newly discovered Near Earth Objects (hereafter NEOs), including their search. Astrometric observations of asteroids and comets at the Mołėtai Observatory were started in August of 1998, using the 0.41 m f/6 Schmidt-Cassegrain telescope with a Meade 9×13 mm CCD camera (Černis & Janulis 1998). For astrometric observations of asteroids and comets in 2000–2001, the CCD camera of Tromsø University (Norway) with a thinned TK1024 (25×25 mm) chip and two-stage thermo-electric cooling was used in the Newtonian focus of the 0.35/0.50 m Maksutov telescope (Černis & Laugalys 2002), with a scale of $4.1''$/pixel. Occasionally, the 1.65 m telescope with a f/8 focal reducer was used. The first two new asteroids were discovered in 2001. The first one was (124192) Mołetai = 2001 OM65, a deep Mars crosser, discovered on July 26 with the 1.65 m reflector, and the second one was (140628) Klaipeda = 2001 UM14, discovered on October 20 with the Maksutov telescope.

A systematic search for asteroids was started in 2002 after a new VersArray CCD camera with liquid nitrogen cooling was purchased by the Institute of Theoretical Physics and Astronomy. With a chip of 26.8×26 mm size (1340×1300 pixels) this camera gives on the Maksutov telescope a scale of $3.4''$/pixel (Zdanavičius & Zdanavičius 2003). The 1.65 m reflector with a new focal reducer (f/3.1) gives a scale of $0.8''$/pixel and much better astrometric precision. All astrometric measurements and reductions were done using the Astrometrica software (Raab 2003). Reference stars were selected from the catalogs USNO-A2.0, USNO-B1.0 and

UCAC-2. The limiting R magnitude for the Maksutov telescope is about 20.5 for unfiltered CCD images with an exposure time of about 360 s, its field-of-view is $76' \times 73'$. The instrument is very useful for follow-up astrometry of poorly observed 15–18 mag NEOs and comets. Targets for observations we select from public WEB tools for observers (IAU MPEC or The NEO Confirmation Page).

In the last seven years, about 4000 CCD images for astrometry of asteroids and comets were obtained at the Molėtai Observatory. During the sky survey close to the ecliptic 175 new asteroids were discovered in 2001–2007: 72 of them have multiple-apparition orbits, 77 have one-opposition orbits, 34 are one opposition objects with orbits of low accuracy. For 19 numbered objects, high precision orbits have been determined. Except for 2006 SF77, a few unusual objects are present among the discovered asteroids: the Hilda group asteroid 2004 TB21 with $a = 3.98$ AU, 2005 TW52 with $e = 0.4$, and the Mars crossers 2001 OM65 and 2005 TB50. By checking our CCD frames, two NEOs – the Apollo group asteroid 2004 EP20 ($q = 0.58$ AU) and the Amor group asteroid 2004 DK1 ($q = 1.1$ AU) – were discovered independently, however, after the original discoveries were already published in MPECs. Of more than 17 thousand positions, about 250 (1.5 %) belong to NEOs. The number distribution of the observed asteroids and comets is presented in Černis et al. (2007).

2. DISCOVERY OF 2006 SF77

The asteroid 2006 SF77 was discovered on the night of 2006 September 22/23 (Černis & Zdanavičius 2006) during a search for new asteroids with the Maksutov telescope and a CCD camera. The discovery time and position are the following:

2006 UT	RA	DEC	R mag
Sep 23.021	$01^{\rm h}28^{\rm m}50.56^{\rm s}$	$+12^\circ05'53.2''$	17.1

During the inspection of our CCD frames taken about one day earlier, the asteroid was detected in three 360 s exposures as a fast moving object (the motion was $\sim 18''/$ min) at elongation 155°, about 3° above the ecliptic line, about 3° south of η Psc). The object was identified on September 23 at about $23^{\rm h}$ UT (~ 23 h after it was imaged), during the next night observations with the same telescope. One of the authors (K.Č.) did quick astrometric measurements of the new object and calculated its approximate position for the current night. The sky was favorable, and we began to hunt the object at $\sim 7^\circ$ northwest from the discovery position. After a few fruitless attempts, the object was found in the images obtained on September 24.02. Two-night positions with a one-day arc were reported to MPC, and the object was put in the NEO Confirmation Page. The discovery was confirmed after 2–3 hours on the same night (September 24.10) at the Volkssternwarte Drebach, Germany (IAU Code 113), observer A. Knoefel, and at the Remanzacco Observatory, Italy (IAU Code 473), observers G. Sostero and E. Guido. The discovery image is shown in Figure 1.

3. ASTROMETRIC OBSERVATIONS AND THE ORBIT

During four nights at the Molėtai Observatory 148 astrometric positions of the asteroid were collected. The accuracy of astrometric observations was about $\pm 0.25''$ with the signal-to-noise ratio about 10 for the 30 s exposure images. The

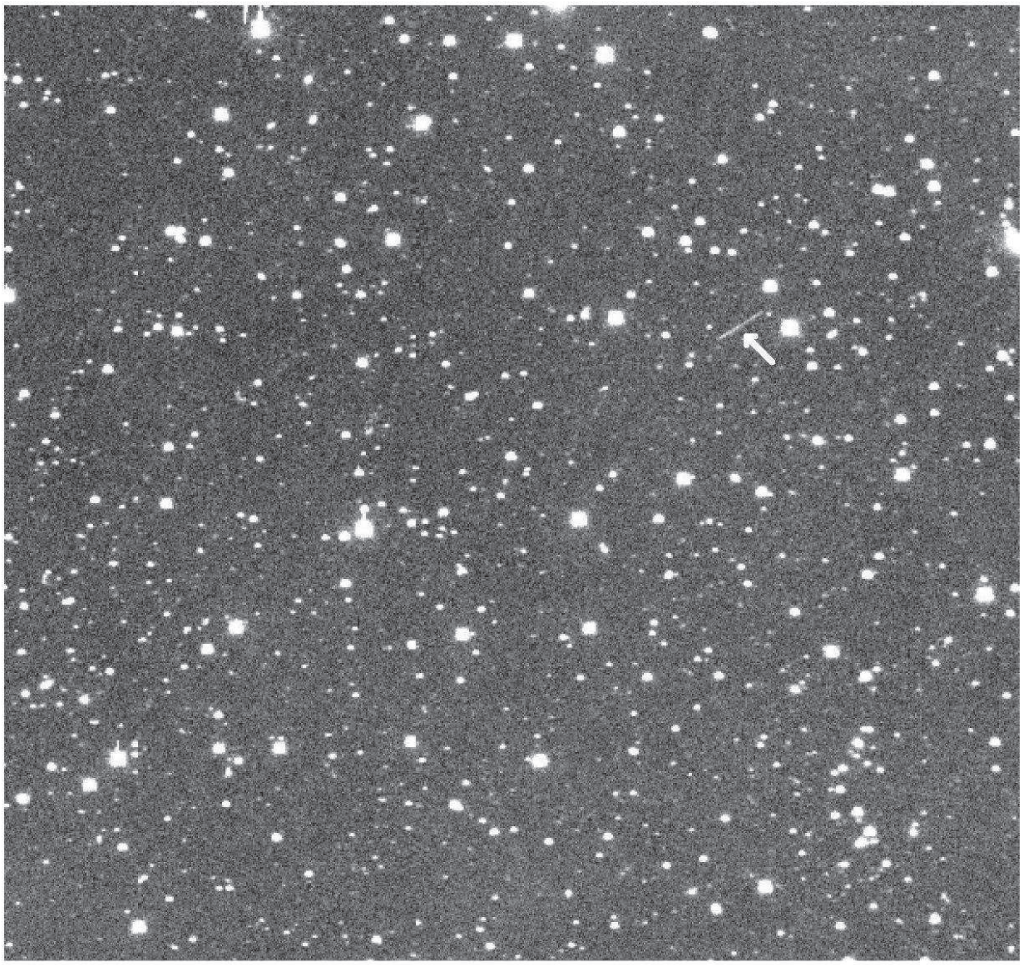

Fig. 1. Discovery image of 2006 SF77. The size of the image is $27' \times 27'$, exposure 6 min., limiting magnitude $R \approx 20$ mag.

asteroid has been observed at 20 observatories with the telescopes having sizes from 0.25 m (RAS Observatory) to 1.06 m (Kłet Observatory). A total of 283 astrometric points were collected, of which more than 50 % belong to the Mołėtai Observatory where the asteroid was observed during four nights. Other most active observing sites of the asteroid were: Remanzacco (Italy) with 30 observations, Table Mountain (USA) with 8 observations, Catalina Sky Survey with 7 observations and Stia (Italy) with 6 observations, from where the asteroid was observed during two nights. Astrometric positions of 2006 SF77 obtained at the Mołėtai Observatory and other observatories are listed in tables at the end of this paper.

The first orbit of 2006 SF77 was computed at the Minor Planet Center (MPO 111245). The orbital elements listed in Table 1 are from the ECS service: http://www.cfa.harvard.edu/iau/ECS/. Here M is the mean anomaly, a is the semi-major axis, e is the eccentricity, ω_{2000} is the argument of perihelion, Ω_{2000} is the longitude of the ascending node and i_{2000} is the orbit inclination. A total of 186 observations from 23 days have been used. These orbital elements are referred to the J2000 equator and equinox. The orbital period of the asteroid is 0.89 yr, its closest approach to the Earth was 0.079 AU. The asteroid was discovered 38 hours after the closest approach.

In the following we calculated the orbital elements of 2006 SF77 using 192

Table 1. Orbital elements of 2006 SF77 from MPO 111245. Nominal orbit: epoch 2006/09/22.

M	a [AU]	e	ω_{2000}	Ω_{2000}	i_{2000}
103°.29433	0.9221956	0.3292135	224°.43221	1°.29007	32°.53075

Table 2. Our orbital elements of 2006 SF77 (top) compared with the NEODyS elements (bottom). Nominal orbit: epoch 2008/05/14, rms = 0.529″. 192 observations covering 23 days are used.

M	a [AU]	e	ω_{2000}	Ω_{2000}	i_{2000}
51°.2727335	0.922028332	0.329083752	224°.4056871	1°.2810048	32°.5103833
0°.2278	0.0001613	0.0001087	0°.02791	0°.001388	0°.02737
51°.2310105	0.922057746	0.329105212	224°.4107871	1°.2812657	32°.5155274
0°.2278	0.0001614	0.0001087	0°.02791	0°.001388	0°.02737

observations covering 23 days from 2006/09/23.02142 to 2006/10/16.12686, with rms = 0.529″. The software OrbFit Package 3.3.2 taken from the NEODyS www site: http://adams. dm.unipi.it/ orbmaint/orbfit/ was used. The weighting of observations was as given in the NEODys file: http://newton.dm.unipi.it/neodys/mpcobs/2006SF77.rwo (Milani et al. 2002). The JPL Planetary and Lunar Ephemerides DE406 were used which take into account the relativistic effects.

In Table 2 our orbital elements (top) are compared with the NEODyS elements (bottom). The NEODyS elements were converted from the published equinoctial elements to the Keplerian ones. The values of orbital elements are given along with the calculated uncertainties. We conclude that the orbits for 2006 SF77, computed in the present paper and published by NEODyS, are very close. The rms of astrometry of the NEODyS orbit is 0.527″.

Figure 2 presents the orbit of 2006 SF77 projected onto the ecliptic plane with the x axis directed to the vernal equinox. The dotted lines indicate part of the orbit below the ecliptic plane. It is seen that the orbit of this asteroid crosses orbits of the Earth and Venus.

4. PHOTOMETRY AND THE VARIABILITY PERIOD

Photometric measurements of the asteroid were done with the IRAF software package. The first step was flat-fielding of each image containing the path of the asteroid. Since our passband used was very broad (images were taken without filter), and we used the magnitudes of the comparison stars in the R system, comparison stars had to be chosen with color indices similar to that of the asteroid. For this purpose we selected R magnitudes for a number of stars from the USNO B1.0 catalog (Monet et al. 2003) with color indices $B2$–$R2$ between 0.6 and 1.0. In the first stage, the asteroid and the comparison stars were measured with the 30 s exposures using the IRAF phot package with a circular aperture. In this way, 79 measurements of the asteroid magnitude were made. In this case the main source of errors is due to small statistics of the registered photons and the inhomogeneity of the sky brightness. The rms errors of the derived magnitudes are estimated to be about 0.13 mag. Additionally, nine measurements of the asteroid images were obtained from the 120–240 s exposures. Since the asteroid was very fast, such long exposures yielded oblong images. For their photometry we used the IRAF polyphot

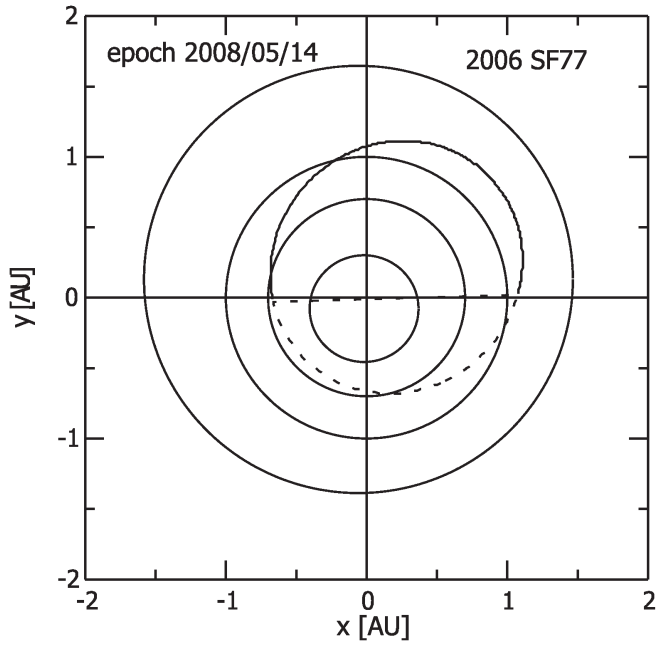

Fig. 2. The orbit of 2006 SF77 projected onto the ecliptic plane, where the x axis is directed toward the vernal equinox.

elongated aperture software. In this case, photon statistics appeared to be better and the rms errors were about ± 0.05 mag. Since the asteroid images sometimes overlapped with stars, only nine of the long exposures could be measured. The resulting 88 photometric measurements with IRAF are given in Table 5, column R. The nine long exposure measurements are marked by asterisks.

The magnitudes measured with the Astrometrica software and based on the magnitudes of USNO-B1 catalog are given in column m_1; their rms errors are about 0.25 mag.

From the magnitude variability we made an attempt to derive the rotation period of the asteroid using the software Period 04 (Lenz & Breger 2005). Analysis of 88 IRAF measurements suggests that the rotation period is close to 34 min with an amplitude of ~ 0.06 mag. The light curve corresponding to this period is shown in Figure 3. The phases are calculated taking 0.0 for 2006 September 1.00. Observations cover 160 cycles in four days. Each of the 16 points is a mean of a few observations (from 2 to 6) within 0.005 day (7.2 min) bins. After rejection of single points, the total number of photometric observations used was 66. The error bars mean standard deviations of the averaged magnitudes.

It is evident that for such fast (motion about $18''$/min) and faint ($R \approx 17$ mag) object the size of our telescope was too small for reliable photometry and the determination of the rotational period: the magnitude errors are larger than the amplitude of the asteroid variability. Probably, the brightness variations of the asteroid do not exceed 0.1 mag. We obtain its absolute magnitude $H = 21.7$ mag, and this leads to a diameter of ~ 200 m.

5. EPHEMERIDES

Table 3 lists the approaches of the nominal orbit of 2006 SF77 (given in Table 2) in 1907–2109 to the Earth and Venus closer than 0.14 AU. Here MJD = JD

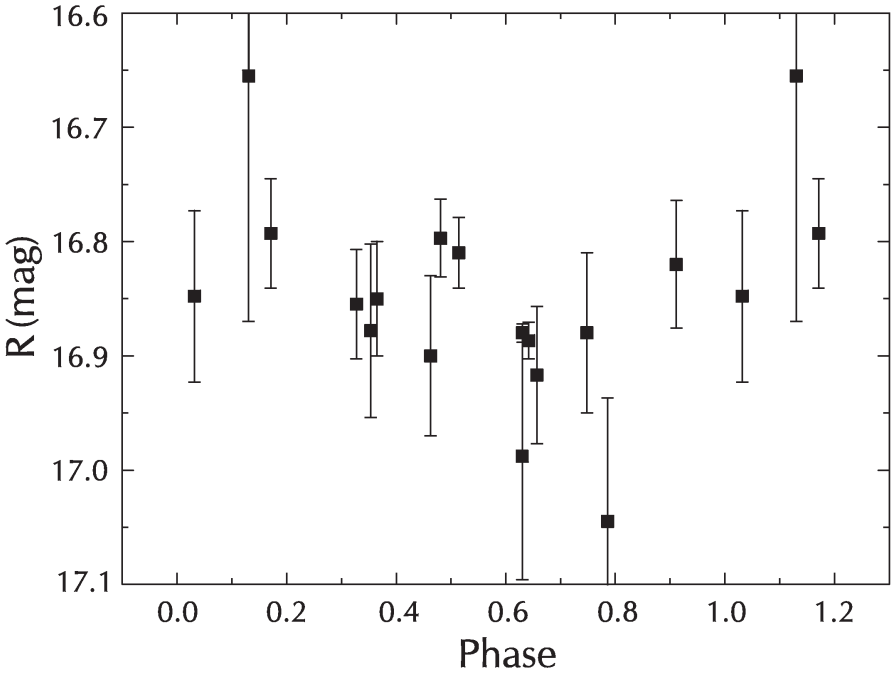

Fig. 3. The light curve of 2006 SF77 calculated with a period of 34 min. Each point is the average of a few observations (from 2 to 6).

– 2400000.5. The całculations were made by use of the OrbFit software. We can see that there are many approaches of the asteroid to the Earth and Venus cłoser than $\sim$0.08 AU, i.e., about 12×10^6 km. However, during this time period the asteroid is not dangerous to both płanets. The accuracy of the computations by using of the OrbFit software with forward and backward integration is described in Włodarczyk (2008).

We ałso łooked for other cłose approaches in 2008–2024 accessibłe for observations from the Mołėtai Observatory. In September and October of 2014 the asteroid wiłł pass the Earth at a distance of 0.216 AU and wiłł be brighter than 21 mag, at an ełongation of about 100°. The ephemerides of this approach are given in Tabłe 4. The computed sky płane error is about 1.5° at different PA. More information about the errors of predicted orbits are given in Włodarczyk (2007).

6. CONCLUSIONS

1. 148 astrometric and 88 photometric observations of the NEO asteroid 2006 SF77 were obtained at the Mołėtai Observatory. This constitute 51% of ałł avaiłabłe astrometric and 100 % of IRAF photometric measurements.

2. The orbit of the asteroid was całcułated from 192 astrometric observations sełected within astrometric errors 0.529″. The totał number of observations is 283.

3. Since S/N ratio of the asteroid images was rather łow, the rms error of R magnitudes is within 0.05–0.13 mag. The ampłitude of its brightness variabiłity seems to be of the same order. The anałysis of 88 photometric resułts obtained with the IRAF reductions gives a suspected rotation period of about 34 min. For obtaining photometry to better precision, a łarger tełescope is needed.

4. The całcułated ephemeris of the asteroid shows that it wiłł be not dangerous to the Earth during the next 100 years. The usefuł window for our future

Table 3. Close approaches of 2006 SF77 to the Earth and Venus within 0.14 AU between 1907 and 2109.

Planet	Date	MJD	Nominal distance [AU]
Earth	1913/09/20.96082	20030.96082	0.06402032
Earth	1921/09/21.86803	22953.86803	0.18242970
Venus	1924/12/02.95426	24121.95426	0.09020748
Earth	1936/09/22.61816	28433.61816	0.13328117
Venus	1939/02/02.78260	29296.78260	0.06461693
Earth	1944/09/20.70542	31353.70542	0.07166669
Venus	1961/03/25.98276	37383.98276	0.03958495
Earth	1967/09/23.27386	39756.27386	0.12588776
Earth	1975/09/21.53130	42676.53130	0.07434661
Venus	1983/05/18.22889	45472.22889	0.03685253
Earth	1998/09/23.02554	51079.02554	0.12136569
Venus	2005/07/08.48783	53559.48783	0.05643649
Earth	2006/09/21.38118	53999.38118	0.07887320
Venus	2019/09/07.84344	58733.84344	0.08794943
Earth	2029/09/22.25752	62401.25752	0.09059007
Earth	2037/09/21.27316	65322.27316	0.11112998
Venus	2041/10/27.99788	66819.99788	0.04296056
Earth	2060/09/21.87150	73723.87150	0.07989404
Venus	2063/12/19.65445	74907.65445	0.03739391
Earth	2068/09/21.16299	76645.16299	0.11565988
Venus	2086/02/08.94362	82994.94362	0.05941184
Earth	2091/09/22.56181	85046.56181	0.07166754
Earth	2099/09/22.15660	87968.15660	0.13465058

astrometric and photometric investigations wiłł happen during the approach of the asteroid to the Earth at a distance of 0.216 AU in 2014.

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Table 4. Ephemerides of the close approach of 2006 SF77 in 2014 for the Molėtai Observatory.

Date, UTC	RA	DEC	Mag	Elong.
	h m s	° ′ ″		deg
2014 Sep 15	4 12 47.404	+28 40 19.58	20.9	105.3
2014 Sep 16	4 07 56.379	+30 32 27.44	20.9	106.8
2014 Sep 17	4 02 42.640	+32 26 08.83	20.8	108.4
2014 Sep 18	3 57 04.136	+34 20 57.81	20.8	109.9
2014 Sep 19	3 50 58.700	+36 16 24.21	20.7	111.5
2014 Sep 20	3 44 24.078	+38 11 53.67	20.7	113.0
2014 Sep 21	3 37 17.961	+40 06 47.81	20.6	114.4
2014 Sep 22	3 29 38.041	+42 00 24.52	20.6	115.8
2014 Sep 23	3 21 22.090	+43 51 58.53	20.6	117.1
2014 Sep 24	3 12 28.060	+45 40 42.05	20.6	118.4
2014 Sep 25	3 02 54.223	+47 25 45.71	20.5	119.6
2014 Sep 26	2 52 39.333	+49 06 19.60	20.5	120.6
2014 Sep 27	2 41 42.817	+50 41 34.57	20.5	121.6
2014 Sep 28	2 30 04.990	+52 10 43.62	20.5	122.5
2014 Sep 29	2 17 47.268	+53 33 03.45	20.5	123.3
2014 Sep 30	2 04 52.345	+54 47 56.04	20.5	123.9
2014 Oct 01	1 51 24.328	+55 54 50.23	20.5	124.5
2014 Oct 02	1 37 28.756	+56 53 23.08	20.6	124.9
2014 Oct 03	1 23 12.505	+57 43 21.06	20.6	125.2
2014 Oct 04	1 08 43.544	+58 24 40.67	20.6	125.4
2014 Oct 05	0 54 10.559	+58 57 28.60	20.7	125.5
2014 Oct 06	0 39 42.490	+59 22 01.22	20.7	125.5
2014 Oct 07	0 25 28.035	+59 38 43.51	20.7	125.5
2014 Oct 08	0 11 35.182	+59 48 07.52	20.8	125.3
2014 Oct 09	23 58 10.849	+59 50 50.52	20.8	125.1
2014 Oct 10	23 45 20.643	+59 47 33.10	20.9	124.8
2014 Oct 11	23 33 08.762	+59 38 57.30	20.9	124.4

Table 5. Catalog of astrometric and photometric data on 2006 SF77 obtained at the Molėtai Observatory.

Object	Date	α (J2000)	δ (J2000)	R	$m1$
K06S77F	C2006 09 23.02105	01 28 51.44	+12 05 46.5		17.14
K06S77F	C2006 09 23.02142	01 28 50.56	+12 05 53.2		16.70
K06S77F*	C2006 09 23.02351	01 28 47.41	+12 06 20.1		17.10
K06S77F	C2006 09 23.02559	01 28 44.93	+12 06 43.2		17.00
K06S77F	C2006 09 23.04076	01 28 21.26	+12 09 54.5		17.00
K06S77F	C2006 09 23.04285	01 28 18.54	+12 10 17.9		16.60
K06S77F	C2006 09 23.04493	01 28 15.81	+12 10 44.1		17.10
K06S77F	C2006 09 23.06005	01 27 51.98	+12 13 55.0		16.90
K06S77F	C2006 09 23.06213	01 27 49.03	+12 14 18.9		16.50
K06S77F	C2006 09 23.06421	01 27 46.47	+12 14 46.9		17.10
K06S77F	C2006 09 24.01046	01 04 39.06	+15 22 11.3		16.40

Table 5. Continued

Object	Date	α (J2000)	δ (J2000)	R	$m1$
K06S77F	C2006 09 24.02024	01 04 24.56	+15 24 03.2		16.50
K06S77F	C2006 09 24.02350	01 04 19.68	+15 24 39.8		17.50
K06S77F	C2006 09 24.02597	01 04 16.06	+15 25 08.3		16.70
K06S77F	C2006 09 24.02791	01 04 13.18	+15 25 29.2		16.40
K06S77F	C2006 09 24.02994	01 04 10.18	+15 25 53.2		16.40
K06S77F	C2006 09 24.08976	01 02 43.57	+15 36 51.0		16.70
K06S77F	C2006 09 24.09094	01 02 41.28	+15 37 08.8		16.50
K06S77F	C2006 09 24.09209	01 02 39.36	+15 37 23.2		16.20
K06S77F	C2006 09 24.09331	01 02 37.60	+15 37 36.0		16.00
K06S77F	C2006 09 24.09461	01 02 36.34	+15 37 48.7		16.30
K06S77F	C2006 09 24.09704	01 02 32.11	+15 38 17.5	16.96	16.80
K06S77F	C2006 09 24.09903	01 02 29.51	+15 38 37.8	16.90	17.00
K06S77F	C2006 09 24.10036	01 02 27.64	+15 38 54.8	16.58	16.70
K06S77F	C2006 09 24.10155	01 02 25.90	+15 39 05.6	16.80	17.00
K06S77F	C2006 09 24.10281	01 02 23.76	+15 39 19.8	17.13	17.00
K06S77F	C2006 09 24.78874	00 46 23.40	+17 40 03.8		16.62
K06S77F	C2006 09 24.79122	00 46 22.09	+17 40 13.0		16.40
K06S77F	C2006 09 24.79360	00 46 18.76	+17 40 38.8	16.96	17.22
K06S77F	C2006 09 24.79503	00 46 16.68	+17 40 53.5	16.89	16.70
K06S77F	C2006 09 24.79676	00 46 14.31	+17 41 10.8	17.00	17.26
K06S77F	C2006 09 24.79804	00 46 12.47	+17 41 24.5	16.90	16.50
K06S77F	C2006 09 24.79925	00 46 10.89	+17 41 35.4	16.83	17.03
K06S77F	C2006 09 24.80770	00 45 54.26	+17 43 36.3		16.40
K06S77F	C2006 09 24.81227	00 45 52.60	+17 43 45.9	16.92	17.60
K06S77F	C2006 09 24.81384	00 45 50.52	+17 44 02.3	16.97	17.48
K06S77F	C2006 09 24.81593	00 45 47.67	+17 44 22.3		16.80
K06S77F	C2006 09 24.81716	00 45 45.88	+17 44 35.4	16.87	17.10
K06S77F	C2006 09 24.81832	00 45 44.26	+17 44 46.3	16.89	17.20
K06S77F	C2006 09 24.81955	00 45 42.42	+17 45 00.4	16.44	16.64
K06S77F	C2006 09 24.82009	00 45 42.23	+17 45 01.2		17.70
K06S77F	C2006 09 24.82079	00 45 41.06	+17 45 10.4		17.20
K06S77F	C2006 09 24.82642	00 45 20.30	+17 47 40.0	16.93	17.19
K06S77F	C2006 09 24.83593	00 45 19.68	+17 47 44.3	17.05	16.89
K06S77F	C2006 09 24.84005	00 45 14.03	+17 48 25.3	16.85	16.96
K06S77F	C2006 09 24.84122	00 45 12.30	+17 48 37.6		16.30
K06S77F	C2006 09 24.84333	00 45 09.51	+17 48 57.5		16.10
K06S77F	C2006 09 24.84403	00 45 08.89	+17 49 02.2		17.40
K06S77F	C2006 09 24.84594	00 45 05.80	+17 49 24.2		17.14
K06S77F	C2006 09 24.84654	00 45 04.96	+17 49 29.9		16.75
K06S77F	C2006 09 24.84745	00 45 03.60	+17 49 38.5		16.75
K06S77F	C2006 09 24.84818	00 45 02.66	+17 49 46.6		16.82
K06S77F	C2006 09 24.85284	00 44 56.15	+17 50 32.4	16.85	16.79
K06S77F	C2006 09 24.85461	00 44 53.76	+17 50 48.9		16.80
K06S77F	C2006 09 24.85530	00 44 53.00	+17 50 55.3		17.70
K06S77F	C2006 09 24.85620	00 44 51.47	+17 51 06.1	16.81	17.06
K06S77F	C2006 09 24.85691	00 44 50.51	+17 51 13.2	16.95	17.13
K06S77F	C2006 09 24.85763	00 44 48.87	+17 51 23.5		17.60

Table 5. Continued

Object	Date	α (J2000)	δ (J2000)	R	$m1$
K06S77F	C2006 09 24.85832	00 44 48.29	+17 51 29.3	16.93	17.20
K06S77F	C2006 09 24.85951	00 44 46.86	+17 51 39.3	16.90	16.99
K06S77F	C2006 09 24.86013	00 44 45.98	+17 51 45.0	16.66	16.98
K06S77F	C2006 09 24.86071	00 44 45.22	+17 51 50.8	16.82	17.02
K06S77F	C2006 09 24.86130	00 44 44.37	+17 51 56.7	16.90	17.06
K06S77F	C2006 09 24.86205	00 44 43.33	+17 52 04.7	17.00	16.82
K06S77F	C2006 09 24.86266	00 44 42.45	+17 52 11.1	16.66	16.94
K06S77F	C2006 09 24.86326	00 44 41.58	+17 52 16.4	16.67	16.99
K06S77F	C2006 09 24.86384	00 44 40.82	+17 52 22.0	16.96	17.25
K06S77F	C2006 09 24.86444	00 44 39.95	+17 52 27.7	16.95	17.23
K06S77F	C2006 09 24.86506	00 44 39.11	+17 52 34.3	16.90	17.26
K06S77F	C2006 09 24.86564	00 44 38.31	+17 52 40.2	16.94	16.97
K06S77F	C2006 09 24.86624	00 44 37.43	+17 52 46.6	16.67	16.70
K06S77F	C2006 09 24.86682	00 44 36.65	+17 52 52.0	16.70	16.79
K06S77F	C2006 09 24.86747	00 44 35.76	+17 52 58.1	16.70	16.80
K06S77F	C2006 09 24.86804	00 44 34.96	+17 53 03.9	16.85	16.91
K06S77F	C2006 09 24.86869	00 44 34.05	+17 53 10.3	16.83	17.07
K06S77F	C2006 09 24.86929	00 44 33.22	+17 53 16.2	16.92	17.13
K06S77F	C2006 09 24.86992	00 44 32.34	+17 53 22.4	17.01	17.03
K06S77F	C2006 09 24.87054	00 44 31.47	+17 53 28.7	16.89	17.16
K06S77F	C2006 09 24.87113	00 44 30.64	+17 53 34.9	16.82	17.00
K06S77F	C2006 09 24.87179	00 44 29.73	+17 53 41.3	16.66	16.83
K06S77F	C2006 09 24.87237	00 44 28.89	+17 53 46.8	16.90	17.01
K06S77F	C2006 09 24.87297	00 44 28.07	+17 53 52.9	16.71	16.79
K06S77F	C2006 09 24.87354	00 44 27.27	+17 53 58.8	16.79	16.97
K06S77F	C2006 09 24.87412	00 44 26.45	+17 54 04.4	16.90	17.00
K06S77F	C2006 09 24.87476	00 44 25.61	+17 54 10.4	16.73	17.07
K06S77F	C2006 09 24.87539	00 44 24.69	+17 54 17.1	16.75	16.87
K06S77F	C2006 09 24.87608	00 44 23.71	+17 54 23.6	16.87	17.11
K06S77F	C2006 09 24.87679	00 44 22.71	+17 54 30.9	16.88	17.06
K06S77F	C2006 09 24.87740	00 44 21.89	+17 54 36.6	17.21	16.99
K06S77F	C2006 09 24.87802	00 44 21.04	+17 54 43.5	17.27	17.19
K06S77F	C2006 09 24.87861	00 44 20.23	+17 54 48.7	16.91	16.76
K06S77F	C2006 09 24.87918	00 44 19.65	+17 54 53.9		17.00
K06S77F	C2006 09 24.87977	00 44 18.60	+17 55 00.1	16.77	16.70
K06S77F	C2006 09 24.88046	00 44 15.72	+17 55 22.4		16.73
K06S77F	C2006 09 24.88243	00 44 14.89	+17 55 26.4	16.86	16.94
K06S77F	C2006 09 24.88302	00 44 13.89	+17 55 33.1		17.00
K06S77F	C2006 09 24.88431	00 44 12.29	+17 55 44.5	16.75	17.00
K06S77F	C2006 09 24.88494	00 44 11.37	+17 55 50.0		17.10
K06S77F	C2006 09 24.88926	00 44 05.18	+17 56 31.6		17.00
K06S77F	C2006 09 24.88990	00 44 04.43	+17 56 40.1		16.80
K06S77F	C2006 09 24.89050	00 44 03.68	+17 56 46.2		16.80
K06S77F	C2006 09 24.89109	00 44 02.77	+17 56 52.1		16.50
K06S77F	C2006 09 24.89170	00 44 01.93	+17 56 58.2		17.15
K06S77F	C2006 09 24.89231	00 44 01.11	+17 57 04.3		16.82
K06S77F	C2006 09 24.89296	00 44 00.21	+17 57 10.9	16.66	16.77

Table 5. Continued

Object	Date	α (J2000)	δ (J2000)	R	$m1$
K06S77F	C2006 09 24.89354	00 43 59.45	+17 57 16.2	16.72	16.54
K06S77F	C2006 09 24.89414	00 43 58.59	+17 57 21.7	16.86	16.87
K06S77F	C2006 09 24.89475	00 43 57.75	+17 57 28.2	16.87	17.07
K06S77F	C2006 09 24.89536	00 43 56.82	+17 57 34.3	16.98	17.14
K06S77F	C2006 09 24.89603	00 43 55.93	+17 57 41.2	17.18	17.00
K06S77F	C2006 09 24.89666	00 43 55.14	+17 57 47.9		17.00
K06S77F	C2006 09 24.89735	00 43 54.09	+17 57 54.2	16.80	17.11
K06S77F	C2006 09 24.89794	00 43 53.29	+17 57 59.8	16.90	17.04
K06S77F	C2006 09 24.89858	00 43 52.41	+17 58 06.0	16.77	16.84
K06S77F	C2006 09 24.89914	00 43 51.57	+17 58 12.0	16.77	16.82
K06S77F	C2006 09 24.89975	00 43 50.78	+17 58 17.3	16.88	16.89
K06S77F	C2006 09 24.90037	00 43 49.88	+17 58 23.7	16.95	16.99
K06S77F	C2006 09 24.90097	00 43 49.01	+17 58 30.1	16.83	16.90
K06S77F	C2006 09 24.90154	00 43 48.24	+17 58 35.6	16.87	16.99
K06S77F	C2006 09 24.90212	00 43 47.46	+17 58 40.9	16.88	16.87
K06S77F	C2006 09 24.90286	00 43 46.40	+17 58 48.3	16.91	17.08
K06S77F	C2006 09 25.10648	00 39 04.94	+18 31 29.0		17.00
K06S77F	C2006 09 25.10718	00 39 03.62	+18 31 36.1		17.00
K06S77F	C2006 09 25.10787	00 39 02.86	+18 31 39.2		17.00
K06S77F	C2006 09 25.10833	00 39 02.53	+18 31 44.1	16.83	16.96
K06S77F	C2006 09 25.10955	00 39 01.12	+18 31 53.7		16.87
K06S77F	C2006 09 25.11075	00 38 59.03	+18 32 07.6	16.97	16.95
K06S77F	C2006 09 25.11135	00 38 57.81	+18 32 16.5		17.00
K06S77F	C2006 09 25.11205	00 38 57.51	+18 32 18.4	17.26	17.00
K06S77F	C2006 09 25.11274	00 38 56.71	+18 32 25.1		17.00
K06S77F	C2006 09 25.11321	00 38 55.85	+18 32 29.5	16.89	16.54
K06S77F	C2006 09 25.11382	00 38 54.99	+18 32 35.9	16.87	16.97
K06S77F	C2006 09 26.85184	00 02 29.35	+22 27 51.7	16.89	17.90
K06S77F	C2006 09 26.85439	00 02 26.27	+22 28 09.6		17.40
K06S77F	C2006 09 26.85576	00 02 24.72	+22 28 18.0	16.91	17.90
K06S77F	C2006 09 26.86016	00 02 19.46	+22 28 48.5	16.88	17.90
K06S77F	C2006 09 26.85651	00 02 23.71	+22 28 21.1		17.60
K06S77F	C2006 09 26.85789	00 02 22.27	+22 28 31.3		17.60
K06S77F	C2006 09 26.85928	00 02 21.06	+22 28 39.9		17.60
K06S77F	C2006 09 26.86074	00 02 18.82	+22 28 52.3	16.89	17.80
K06S77F	C2006 09 26.86163	00 02 17.75	+22 28 58.5	16.81	17.70
K06S77F	C2006 09 26.86285	00 02 16.29	+22 29 06.7	17.09	17.80
K06S77F	C2006 09 26.86344	00 02 15.61	+22 29 10.7	17.34	18.00
K06S77F	C2006 09 26.86404	00 02 14.87	+22 29 15.4	16.96	17.90
K06S77F	C2006 09 26.86468	00 02 14.13	+22 29 19.5	16.83	18.00
K06S77F	C2006 09 26.86541	00 02 13.27	+22 29 23.9	17.05	17.90
K06S77F	C2006 09 26.86667	00 02 11.76	+22 29 33.0		17.80
K06S77F	C2006 09 26.86804	00 02 10.12	+22 29 42.6	17.08	17.70

Table 6. Astrometric observations of 2006 SF77 from other observatories.

Object	Date (UT)	α (J2000)	δ (J2000)	Mag.	Obs. codes
K06S77F	C2006 09 24.09707	01 02 32.77	+15 38 25.0	17.2 R	ES057113
K06S77F	C2006 09 24.09743	01 02 32.27	+15 38 28.5	17.3 R	ES057113
K06S77F	C2006 09 24.09778	01 02 31.72	+15 38 32.8	17.2 R	ES057113
K06S77F	C2006 09 24.09829	01 02 30.99	+15 38 38.4	17.2 R	ES057113
K06S77F	C2006 09 24.09869	01 02 30.42	+15 38 43.0	17.0 R	ES057113
K06S77F	C2006 09 24.11730	01 02 02.97	+15 42 14.1	16.9 R	ES057473
K06S77F	C2006 09 24.11848	01 02 01.31	+15 42 26.9	16.8 R	ES057473
K06S77F	C2006 09 24.12070	01 01 58.07	+15 42 51.1	17.2 R	ES057473
K06S77F	C2006 09 24.12189	01 01 56.35	+15 43 04.4	17.0 R	ES057473
K06S77F	C2006 09 24.12307	01 01 54.61	+15 43 17.3	16.9 R	ES057473
K06S77F	C2006 09 24.12545	01 01 51.16	+15 43 43.2	16.8 R	ES057473
K06S77F	C2006 09 24.12663	01 01 49.48	+15 43 56.2	16.7 R	ES057473
K06S77F	C2006 09 24.12782	01 01 47.70	+15 44 09.1	17.1 R	ES057473
K06S77F	C2006 09 24.12901	01 01 45.97	+15 44 22.0	17.1 R	ES057473
K06S77F	C2006 09 24.13020	01 01 44.27	+15 44 35.3	16.9 R	ES057473
K06S77F	C2006 09 24.13138	01 01 42.54	+15 44 48.2	16.7 R	ES057473
K06S77F	C2006 09 24.13257	01 01 40.79	+15 45 01.6	16.9 R	ES057473
K06S77F	C2006 09 24.13376	01 01 39.08	+15 45 14.9	17.0 R	ES057473
K06S77F	C2006 09 24.13494	01 01 37.31	+15 45 26.2	16.7 R	ES057473
K06S77F	C2006 09 24.13613	01 01 35.63	+15 45 40.1	16.7 R	ES057473
K06S77F	C2006 09 24.13732	01 01 33.91	+15 45 53.5	16.9 R	ES057473
K06S77F	C2006 09 24.13851	01 01 32.20	+15 46 05.8	16.7 R	ES057473
K06S77F	C2006 09 24.13970	01 01 30.50	+15 46 19.5	17.0 R	ES057473
K06S77F	C2006 09 24.14088	01 01 28.76	+15 46 31.7	17.0 R	ES057473
K06S77F	C2006 09 24.15282	01 01 11.80	+15 48 36.0	17.0 R	ES057113
K06S77F	C2006 09 24.15312	01 01 11.42	+15 48 38.8	17.0 R	ES057113
K06S77F	C2006 09 24.15347	01 01 10.81	+15 48 42.8	17.1 R	ES057113
K06S77F	C2006 09 24.15376	01 01 10.47	+15 48 46.3	17.0 R	ES057113
K06S77F	C2006 09 24.15406	01 01 10.05	+15 48 49.1	17.0 R	ES057113
K06S77F	C2006 09 24.17303	01 00 52.03	+15 52 44.6	17.4 R	ES057854
K06S77F	C2006 09 24.17540	01 00 48.59	+15 53 09.8	17.3 R	ES057854
K06S77F	C2006 09 24.17682	01 00 46.59	+15 53 25.8	17.5 R	ES057854
K06S77F	C2006 09 24.17872	01 00 43.85	+15 53 47.0	17.6 R	ES057854
K06S77F	C2006 09 24.25364	00 58 52.60	+16 07 21.9	17.7	ES057H55
K06S77F	C2006 09 24.25512	00 58 50.46	+16 07 37.8	17.8	ES057H55
K06S77F	C2006 09 24.25659	00 58 48.35	+16 07 53.6	17.8	ES057H55
K06S77F	C2006 09 24.25805	00 58 46.23	+16 08 09.4	17.6	ES057H55
K06S77F	C2006 09 24.25988	00 58 43.57	+16 08 29.3	17.8	ES057H55
K06S77F	5C2006 09 24.273877	00 58 26.131	+16 11 07.51	17.8 R	ES057673
K06S77F	5C2006 09 24.277928	00 58 20.236	+16 11 51.64		ES057673
K06S77F	5C2006 09 24.283831	00 58 11.687	+16 12 55.77		ES057673
K06S77F	5C2006 09 24.288345	00 58 05.069	+16 13 44.60		ES057673
K06S77F	C2006 09 24.44193	00 54 21.56	+16 41 04.4	17.1 V	ES057703
K06S77F	C2006 09 24.44246	00 54 20.77	+16 41 10.0	17.2 V	ES057703
K06S77F	C2006 09 24.44349	00 54 19.33	+16 41 21.3	17.3 V	ES057703
K06S77F	C2006 09 24.77842	00 46 40.81	+17 38 07.0	17.0 V	ES057A17
K06S77F	C2006 09 24.78909	00 46 26.07	+17 39 56.5	17.0 V	ES057198

Table 6. Continued

Object	Date (UT)	α (J2000)	δ (J2000)	Mag.	Obs. codes
K06S77F	C2006 09 24.78946	00 46 25.54	+17 39 58.1	17.2 V	ES057A17
K06S77F	C2006 09 24.79037	00 46 24.29	+17 40 09.4	17.0 V	ES057198
K06S77F	C2006 09 24.79148	00 46 22.74	+17 40 20.8	17.1 V	ES057198
K06S77F	C2006 09 24.79235	00 46 21.56	+17 40 29.6	17.1 V	ES057198
K06S77F	C2006 09 24.79384	00 46 19.51	+17 40 44.6	17.2 V	ES057198
K06S77F	C2006 09 24.80063	00 46 10.06	+17 41 51.6	17.0 V	ES057A17
K06S77F	C2006 09 24.81220	00 45 53.86	+17 43 51.5	17.6 V	ES057A44
K06S77F	C2006 09 24.81683	00 45 47.44	+17 44 38.1	17.8 V	ES057A44
K06S77F	C2006 09 24.81989	00 45 43.18	+17 45 08.9	17.7 V	ES057A44
K06S77F	C2006 09 24.82369	00 45 37.90	+17 45 46.9	17.6 V	ES057A44
K06S77F	C2006 09 24.85527	00 44 54.38	+17 50 55.7		ES057J95
K06S77F	C2006 09 24.85696	00 44 52.09	+17 51 12.1		ES057J95
K06S77F	C2006 09 24.85865	00 44 49.68	+17 51 29.7	17.2 R	ES057J95
K06S77F	C2006 09 24.86367	00 44 42.16	+17 52 27.1		ES057246
K06S77F	C2006 09 24.86370	00 44 42.29	+17 52 32.0	17.2 V	ES057595
K06S77F	C2006 09 24.86397	00 44 41.68	+17 52 30.3		ES057246
K06S77F	C2006 09 24.86565	00 44 39.38	+17 52 46.8		ES057246
K06S77F	C2006 09 24.86604	00 44 39.01	+17 52 55.0	17.5 V	ES057595
K06S77F	C2006 09 24.86840	00 44 35.73	+17 53 18.6	17.4 V	ES057595
K06S77F	C2006 09 24.87075	00 44 32.46	+17 53 41.9	17.6 V	ES057595
K06S77F	C2006 09 24.87599	00 44 24.91	+17 54 26.8	17.5 R	ES057113
K06S77F	C2006 09 24.87628	00 44 24.55	+17 54 29.3	17.1 R	ES057113
K06S77F	C2006 09 24.87688	00 44 23.68	+17 54 35.6	17.7 R	ES057113
K06S77F	C2006 09 24.88001	00 44 19.49	+17 55 14.1	17.3 R	ES057473
K06S77F	C2006 09 24.88120	00 44 17.84	+17 55 25.8	17.0 R	ES057473
K06S77F	C2006 09 24.88238	00 44 16.23	+17 55 38.4	17.3 R	ES057473
K06S77F	C2006 09 24.88357	00 44 14.55	+17 55 49.0	17.2 R	ES057473
K06S77F	C2006 09 24.88476	00 44 12.90	+17 56 01.2	17.1 R	ES057473
K06S77F	C2006 09 24.90607	00 43 43.09	+17 59 31.8	16.8 R	ES057473
K06S77F	C2006 09 24.90726	00 43 41.45	+17 59 44.0	17.2 R	ES057473
K06S77F	C2006 09 24.90963	00 43 38.20	+18 00 06.9	17.0 R	ES057473
K06S77F	C2006 09 24.91082	00 43 36.54	+18 00 19.4	16.7 R	ES057473
K06S77F	C2006 09 24.91200	00 43 34.82	+18 00 30.5	16.9 R	ES057473
K06S77F	C2006 09 24.91319	00 43 33.17	+18 00 42.1	16.9 R	ES057473
K06S77F	C2006 09 25.01975	00 41 04.43	+18 17 55.3	17.3 R	ES057118
K06S77F	C2006 09 25.02053	00 41 03.36	+18 18 02.4	17.2 R	ES057118
K06S77F	C2006 09 25.02131	00 41 02.38	+18 18 09.6	17.8 R	ES057118
K06S77F	C2006 09 25.02208	00 41 01.30	+18 18 17.0	17.3 R	ES057118
K06S77F	C2006 09 25.02286	00 41 00.10	+18 18 25.0	17.1 R	ES057118
K06S77F	C2006 09 25.02363	00 40 59.03	+18 18 32.5	17.0 R	ES057118
K06S77F	C2006 09 25.02441	00 40 57.96	+18 18 39.9	17.3 R	ES057118
K06S77F	C2006 09 25.11591	00 38 52.33	+18 33 04.5	17.4 R	ES057113
K06S77F	C2006 09 25.11622	00 38 51.91	+18 33 07.4	17.5 R	ES057113
K06S77F	C2006 09 25.11654	00 38 51.48	+18 33 10.0	17.3 R	ES057113
K06S77F	C2006 09 25.13376	00 38 32.70	+18 38 12.7	16.9 R	ES057844
K06S77F	C2006 09 25.13499	00 38 31.28	+18 38 24.8	16.7 R	ES057844
K06S77F	C2006 09 25.13620	00 38 29.63	+18 38 36.1	16.7 R	ES057844

Table 6. Continued

Object	Date (UT)	α (J2000)	δ (J2000)	Mag.	Obs. codes
K06S77F	C2006 09 25.13743	00 38 27.97	+18 38 47.2	16.6 R	ES057844
K06S77F	C2006 09 25.13867	00 38 26.04	+18 39 00.5	16.3 R	ES057844
K06S77F	C2006 09 25.13990	00 38 24.45	+18 39 10.9	16.9 R	ES057844
K06S77F	C2006 09 25.14111	00 38 22.85	+18 39 21.5	16.9 R	ES057844
K06S77F	C2006 09 25.14234	00 38 21.19	+18 39 34.1	16.6 R	ES057844
K06S77F	C2006 09 25.14358	00 38 19.44	+18 39 46.2	16.9 R	ES057844
K06S77F	C2006 09 25.14479	00 38 17.81	+18 39 56.7	16.9 R	ES057844
K06S77F	C2006 09 25.14603	00 38 16.06	+18 40 08.8	16.8 R	ES057844
K06S77F	C2006 09 25.14726	00 38 14.36	+18 40 20.6	16.9 R	ES057844
K06S77F	C2006 09 25.14848	00 38 12.45	+18 40 24.7	17.0 R	ES057844
K06S77F	C2006 09 25.14970	00 38 10.91	+18 40 43.7	16.8 R	ES057844
K06S77F	C2006 09 25.15094	00 38 09.24	+18 40 56.1	16.7 R	ES057844
K06S77F	C2006 09 25.23285	00 36 21.67	+18 51 54.1	17.3 V	ES057703
K06S77F	C2006 09 25.24100	00 36 10.51	+18 53 10.4	17.2 V	ES057703
K06S77F	C2006 09 25.24917	00 35 59.28	+18 54 26.6	17.2 V	ES057703
K06S77F	C2006 09 25.25734	00 35 48.12	+18 55 43.0	17.4 V	ES057703
K06S77F	IC2006 09 25.28003	00 35 16.35	+18 59 17.0		ES057711
K06S77F	C2006 09 25.28300	00 35 12.31	+18 59 44.5	16.9 R	ES057711
K06S77F	C2006 09 25.28596	00 35 08.25	+19 00 12.2	16.8 R	ES057711
K06S77F	5C2006 09 25.288113	00 35 06.612	+19 00 24.25	17.8 R	ES057673
K06S77F	2C2006 09 25.29754	00 34 52.55	+19 01 55.3	16.3 R	ES057H06
K06S77F	5C2006 09 25.297720	00 34 53.479	+19 01 53.15		ES057673
K06S77F	2C2006 09 25.29988	00 34 49.36	+19 02 16.0	17.0 R	ES057H06
K06S77F	2C2006 09 25.30219	00 34 46.19	+19 02 37.3	16.9 R	ES057H06
K06S77F	5C2006 09 25.303044	00 34 46.218	+19 02 41.95		ES057673
K06S77F	5C2006 09 25.309178	00 34 37.832	+19 03 38.74		ES057673
K06S77F	C2006 09 25.37531	00 33 05.82	+19 13 29.9	17.5 R	ES057734
K06S77F	C2006 09 25.37606	00 33 04.79	+19 13 36.4	17.5 R	ES057734
K06S77F	C2006 09 25.37630	00 33 04.49	+19 13 38.6	17.5 R	ES057734
K06S77F	C2006 09 25.37680	00 33 03.80	+19 13 43.2	17.3 R	ES057734
K06S77F	C2006 09 25.37730	00 33 03.13	+19 13 47.6	17.4 R	ES057734
K06S77F	C2006 09 29.79633	23 13 17.43	+26 34 28.8	18.0 V	ET084A78
K06S77F	C2006 09 29.80077	23 13 13.62	+26 34 44.9	18.2 V	ET084A78
K06S77F	C2006 09 29.80522	23 13 09.80	+26 35 00.6	18.0 V	ET084A78
K06S77F	C2006 09 30.80721	22 59 50.28	+27 27 25.5	18.2 V	ET084A78
K06S77F	C2006 09 30.81162	22 59 46.89	+27 27 37.3	18.1 V	ET084A78
K06S77F	C2006 09 30.81624	22 59 43.31	+27 27 51.3	18.1 V	ET084A78
K06S77F	C2006 10 16.12090	21 30 56.94	+30 30 56.6		EU015693
K06S77F	C2006 10 16.12289	21 30 56.69	+30 30 56.6		EU015693
K06S77F	C2006 10 16.12487	21 30 56.40	+30 30 56.7		EU015693
K06S77F	C2006 10 16.12686	21 30 56.12	+30 30 56.3	20.2 R	EU015693

Notes to Table 6

Observer details (the numbers mean the observatory codes shortened to three last characters):

113. Volkssternwarte Drebach, Schoenbrunn; observer A. Knoefel; 0.5 m f/5 reflector + CCD.

118. Modra; observer L. Kornos; 0.6 m f/5.5 reflector + CCD.

198. Wildberg; observer R. Apitzsch; 0.35 m f/4.2 reflector + CCD.

246. Klet Observatory; observers J. Ticha and M. Tichy, measurer M. Tichy; 1.06 m telescope + CCD.

473. Remanzacco; observers G. Sostero and E. Guido; 0.45 m f/4.4 Newtonian reflector + CCD.

595. Farra d'Isonzo; observers F. Piani, G. Lombardi, E. Pettarin, measurer E. Pettarin; 0.40 m f/4.5 reflector + CCD.

673. Table Mountain Observatory, Wrightwood; observer J. Young; 0.61 m f/16 Cassegrain + CCD.

703. Catalina Sky Survey; observers E. J. Christensen and R. A. Kowalski, measurers E. C. Beshore, E. J. Christensen, G. J. Garradd, A. R. Gibbs, A. D. Grauer, R. E. Hill, R. A. Kowalski, S. M. Larson, R. H. McNaught; 0.68 m Schmidt + CCD.

711. McDonald Observatory; observer J. G. Ries; 0.76 m reflector + CCD + prime-focus corrector.

734. Farpoint Observatory; observer D. Tibbets, measurer G. Hug; 0.7 m reflector + CCD.

844. Los Molinos; observer S. Roland; 0.46 m f/2.8 reflector + CCD.

854. Sabino Canyon Observatory, Tucson; observer J. E. McGaha; 0.36 m f/10.0 Schmidt-Cassegrain + CCD.

A17. Guidestar Observatory, Weinheim; observers M. Emmerich and S. Melchert; 0.36 m f/6 Schmidt-Cassegrain + CCD.

A44. Altschwendt; observer W. Ries; 0.45 m f/3.6 reflector + CCD.

H06. RAS Observatory, Mayhill; observer R. Hutsebaut; 0.25 m reflector + CCD.

H55. Astronomical Research Observatory, Charleston; observer R. Holmes; 0.81 m f/4.0 astrograph + CCD.

J95. Great Shefford; observer P. Birtwhistle; 0.40 m f/6.0 Schmidt-Cassegrain + CCD.