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SPECKLE INTERFEROMETRY AT THE OBSERVATORIO ASTRONÓMICO NACIONAL. III

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RESUMEN

Se presentan las mediciones interferométricas de motas de estrellas binarias realizadas durante agosto de 2010 con el telescopio 1.5 m y en noviembre de 2010 con el telescopio de 2.1 m del Observatorio Astronómico Nacional en SPM (Mexico). Los resultados reportados aquí son 238 mediciones de 225 pares con una magnitud límite de $V = 12.2$. De éstas, 211 parejas presentan separaciones de menos de $1''$. El error medio obtenido en la separación es de $0''.02$ y en el ángulo de posición de 1.5°. Algunos de los ángulos de posición se determinaron con los 180° usuales de ambigüedad.

ABSTRACT

We present speckle interferometric measurements of binary stars performed during August of 2010 with the 1.5 m telescope and during November of 2010 with the 2.1 m telescope of the Observatorio Astronómico Nacional at SPM (Mexico). We report here the results of 238 measurements of 225 pairs with a primary limiting magnitude of $V = 12.2$; 211 of them have separations less than $1''$. The mean error in separation is $0''.03$ and 1.5° in position angle. Some of the position angles were determined with the usual 180° ambiguity.

Key Words: binaries: visual — stars: fundamental parameters — techniques: high angular resolution — techniques: interferometric

1. INTRODUCTION

This is the third paper in the serie of publications presenting the results of speckle interferometric observations of binary stars performed with telescopes of the Observatorio Astronómico Nacional (OAN) of the Instituto de Astronomía Universidad Nacional Autónoma de México. Regular speckle interferometric measurements of binary stars have been made with telescopes of the OAN since 2008 (Orlov et al. 2009). This paper presents the results of double star observations carried out with the 1.5 m and the 2.1 m Telescopes of Sierra San Pedro Mártir National Astronomical Observatory (OAN-SPM) in August and November of 2010. For these observations we developed a new detector. This detector is a combination of the CCD camera Watec 120N with a third generation image intensifier. The third generation image intensifier also allows us to carry out near infrared speckle interferometric observations. The results reported here consist of 238 measures of 225 pairs with a primary limiting magnitude of $V = 12.2$; 211 of them have separations of less than $1''$. In these speckle observations we confirmed and measured 38 binaries first detected by Hipparcos. The paper concludes with a tabulation of the observational results. The analysis of specklegram has been performed using the technique described by Tokovinin, Mason, & Hartkopf (2010).

2. BRIEF DESCRIPTION OF THE EQUIPMENT

The observations were performed with the CCD camera Wat-120N which is optically connected with the 18 mm third-generation image intensifier. Because the Watec CCD device Wat-120N is primarily designed for amateur astronomers, its limiting sensitivity (0.00002 lx) is not enough for speckle interferometry, so we had to use the third-generation image intensifier. We describe some technical details

Fig. 1. Odd and even half frames taken with good seeing conditions.

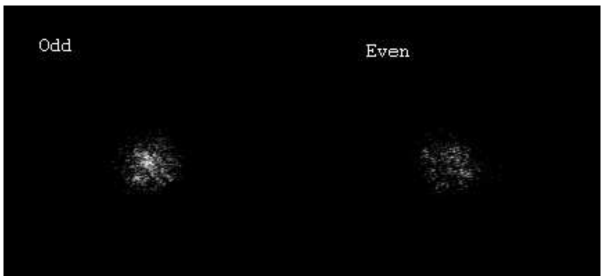

Fig. 2. Odd and even half frames taken with bad seeing conditions.

related to our CCD camera. The Wat-120N is an interline CCD camera where each single frame is a combination of two half-frames. One half-frame contains odd lines while the second one consists of the even lines. One half-frame is taken every 1/50th of a second. As one can see in Figure 1, in the case of good seeing conditions there are no difference between odd and even half frames. So, we can make the data processing for a complete frame 720×480. If the seeing conditions are not so good (Figure 2), the half-frames are very different. In this case we have to perform the data processing for the odd and even half-frames separately. Also we have to note that the Wat-120N does not have square pixels; this has to be taken into account during data processing.

The other disadvantage of Wat-120N is a manual control. We developed a simple Ethernet controller to resolve this problem. The set of our camera controls consists of three parts: gain control, gamma control, and on/off image intensifier switcher. The gain control has 8 values from 0 to 7 (Figure 3, the value 7 corresponds to the maximum gain). The gamma control allows three modes: linear (Off), low (Lo) and high (Hi). Two modes Lo and Hi are not linear and, if one needs measure accurate magnitude differences of components, they are not used during data recording. The last control is a switch on/off for the image intensifier.

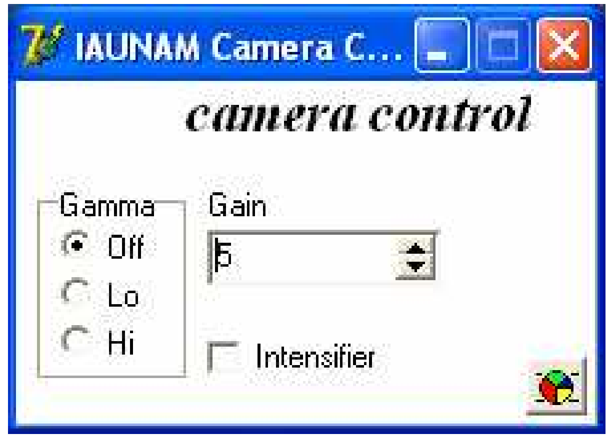

Fig. 3. Ethernet camera control.

3. OBSERVATIONS AND RESULTS

Data were recorded during the two observation campaigns carried out in August and November 2010. In August observations of 105 stars were performed at the OAN-SPM 1.5 m telescope. The atmospheric conditions (seeing and transparency) were excellent. For three nights in November 2010 we observed 120 stars with the 2.1 m telescope of OAN-SPM under poor atmospheric conditions. All the measurements were made through the R filter with a 640/130 nm bandpass window. In these speckle observations we measured 38 new binaries detected by Hipparcos (ESA 1997). For each star, a typical observing procedure involved the accumulation of one set of 998 frames (1996 half-frames). One frame consists of a two-dimensional 440×400 array of 8-bit numbers. After the calibration we determined that the pixel scales are equal to $0.039''$/px and $0.038''$/px for the 2.1 m telescope and for the 1.5 m telescope, respectively. Tables 1 and 2 contain the results of the measurements of binary stars performed at the 1.5 m and 2.1 m telescopes. The format for the presentation of these measurements is the same as in our previous publication (Orlov et al. 2010). The first column contains the epoch-2000 coordinates in the format used in the Washington Double Star (WDS) Catalog (Worley & Douglass 1997). The second column gives the name of the star or the discoverer designation. The third column gives the epoch of the observation in fractional Besselian years. The two following columns contain the measured position angles given in degrees and the angular distances in arcseconds. The last three columns show ephemerides calculated for the date of observation and references to publications in which orbital elements can be found (Hartkopf & Mason 2003).

TABLE 1

SPECKLE MEASUREMENTS ON THE 1.5 M TELESCOPE

WDS ($\alpha, \delta J2000.0$)	Disc. Name	Date Besselian	P.A. (deg)	Sep. (arcsec)	P.A. Orb. (deg)	Sep. Orb. (arcsec)	Reference
00008+1659	BAG 18	2010.6349	0.7	0.63			
00024+1047	A 1249	2010.6349	72.9	0.21	74.5	0.16	Zirm (2003)
00039+2759	A 429	2010.6349	331.4	0.53			
00039+2759 AC	A 429	2010.6349	289.4	5.26			
00061+0943	HDS 7	2010.6350	178.4	0.19			
00073+2058	HDS 12	2010.6350	191.3	1.35			
00074+2029	KU 3	2010.6350	76.2	0.92			
00090+2339	HU 402	2010.6350	68.7	0.56			
00095+1907	COU 247	2010.6350	249.9	0.30	258.0	0.37	Zirm (2003)
00260+1905	HDS 59	2010.6350	264.7	0.79			
00262+2827	COU 446	2010.6350	312.9	0.85			
00279+2334	BU 779	2010.6350	246.4	0.62			
00287+2134	HU 601	2010.6350	307.4	0.63			
00295+1501	HEI 200	2010.6350	62.9	0.76			
00307+1339	HDS 66	2010.6350	267.3	0.98			
00324+2147	HDS 72	2010.6351	39.4	0.22			
00445+1956	TDS1595	2010.6351	273.3	0.84			
00470+2315	HU 413	2010.6351	313.7	0.35	317.2	0.38	Olevic (2002)
00487+1841	BU 495	2010.6351	253.9	0.28	250.4	0.31	Scardia et al. (2000)
00511+2853	COU 447	2010.6351	39.4	0.84			
00536+1911	COU 252	2010.6351	96.9	0.31			
00557+1706	HEI 94	2010.6351	255.2	1.04			
01007+1659	HEI 96	2010.6351	68.2	0.38			
01024+0504	HDS 135	2010.6351	90.7	0.65	91.1	0.66	Balega et al. (2006)
01028+0214	A 2308	2010.6351	292.2	0.36	293.0	0.27	Baize (1984)
01041+2635	COU 351	2010.6351	245.9	0.77			
01055+2107	AG 14	2010.6351	315.2	0.76	263.5	0.55	Heintz (1998)
01093+2428	COU 78	2010.6351	358.2	0.76			
01166+1831	HDS 169	2010.6351	240.5	0.61			
17452+2107	COU 630	2010.6352	115.2	0.22			
17453+1750	TDT 488	2010.6352	9.7	0.74			
17470+2915	TDS 881	2010.6352	243.2	1.01			
17472+1502	HU 1288	2010.6352	163.2	0.40			
17502+2704	TDT 526	2010.6352	147.2	0.83			
17506+1517	FOX 22	2010.6352	339.2	0.95			
17513+1723	TDT 536	2010.6352	62.2	1.04			
17571+1547	MCT 10	2010.6352	281.2	1.07			
18031+2702	TDT 653	2010.6352	26.4	0.74			
18032+2603	HO 565	2010.6352	91.4	0.19			
18086+1700	HDS2555	2010.6352	111.7	0.48			
18086+1838	HU 314	2010.6352	79.2	0.27			
18088+1923	TDT 707	2010.6352	68.2	0.61			
18303+1907	COU 508	2010.6352	254.4	0.89			
18312+2516	A 248	2010.6352	34.2	0.48			
18382+1426	HU 675	2010.6352	61.2	0.25			
18389+2324	TDT 972	2010.6352	48.7	0.85			
18396+2356	TDT 980	2010.6352	101.9	0.25			
18406+2636	COU 641	2010.6352	54.2	0.57			
18421+2753	TDT1009	2010.6352	268.4	0.58			
18443+2720	TDS 941	2010.6352	92.4	0.85			
19073+2432	A 262	2010.6352	266.9	0.17			
19224+2517 Aa, Ab	TDT1405	2010.6353	159.9	0.61			
19266+2619	HDS2763	2010.6353	209.2	0.76			
19276+1806	TDT1471	2010.6353	105.2	0.59			
19282+1507	TDT1476	2010.6353	330.4	0.73			
19284+2734	TDT1480	2010.6353	167.4	0.66			
19409+1523	HEI 74	2010.6353	109.9	0.86			
19421+1533	HU 1305	2010.6353	102.2	0.42			
19464+2438	TDT1727	2010.6353	222.7	0.61			
19477+1913	TDT1759	2010.6344	354.2	0.65			

TABLE 1 (CONTINUED)

WDS ($\alpha, \delta J2000.0$)	Disc. Name	Date Besselian	P.A. (deg)	Sep. (arcsec)	P.A. Orb. (deg)	Sep. Orb. (arcsec)	Reference
20216+2346	STF2672	2010.6344	345.7	0.69			
20227+2837	COU1169	2010.6344	64.4	0.26			
20227+2930	TDT2218	2010.6344	292.4	0.41			
21067+2321	TDT2755	2010.6344	215.7	0.84			
21068+2306	HU 364	2010.6345	96.7	0.21			
21083+2913	COU1331	2010.6345	36.2	0.30			
21085+2332	TDT2781	2010.6345	317.9	0.75			
21091+1906	COU 329	2010.6345	99.9	0.64			
21091+2922	COU1332	2010.6345	21.2	0.23			
21096+2632	COU 529	2010.6345	218.7	0.36			
21106+1650	HU 367	2010.6345	339.2	0.30			
21107+1334	HEI 186	2010.6345	262.2	0.17			
21109+2925	BAG 29	2010.6345	279.7	0.24			
21115+2144	COU 227	2010.6345	112.9	0.51	213.0	0.13	Couteau (1995)
21125+2821	HO 152	2010.6345	135.4	0.22	132.8	0.27	Scardia et al. (2002)
21461+2448	TDT3149	2010.6345	218.4	0.65			
21466+1929	COU 431	2010.6345	183.2	0.46			
21468+2718	HO 608	2010.6346	127.4	0.57			
21481+2100	HU 378	2010.6346	297.4	0.18			
21488+2439	TDT3169	2010.6346	350.2	0.82			
21500+2157	TDT3184	2010.6346	170.7	2.56			
21521+2748	HO 171	2010.6346	341.7	0.73			
22196+2107	HU 383	2010.6346	29.9	0.36			
22202+2931	BU 1216	2010.6346	278.2	0.91			
22217+1125	TDT3484	2010.6346	256.7	0.26			
22392+2014	HU 393	2010.6347	226.4	0.87			
22396+2822	A 413	2010.6347	14.9	1.09			
22457+2924	HO 481	2010.6347	287.2	0.44			
22474+1749	WSI 91	2010.6347	113.7	0.26			
22479+1259	HU 985	2010.6347	136.4	0.70	139.6	0.67	Seymour et al. (2002)
23024+1837	HU 398	2010.6347	287.9	0.47	293.3	0.45	Baize (1981)
23038+2851	TDT3868	2010.6347	10.2	0.17			
23039+2512	COU 142	2010.6347	190.4	0.50			
23361+2027	TDT4118	2010.6347	1.9	0.58			
23368+2346	HU 498	2010.6348	298.2	0.67			
23379+2510	COU 441	2010.6348	10.7	0.69			
23380+1253	A 1241	2010.6348	9.9	0.62			
23401+1258	HU 1325	2010.6348	30.2	0.83	31.6	0.63	Olevic & Jovanovic (2001)
23401+1258	HU 1325				26.0	0.84	Scardia (2003)
23431+1150	A 1242	2010.6348	337.7	0.99	337.4	0.96	Ling (2004)
23435+1652	HEI 196	2010.6348	167.4	0.83			
23465+1705	EGB 8	2010.6348	86.4	1.07			
23470+1726	TDT4190	2010.6348	33.9	0.55			
23475+1729	TDT4195	2010.6348	315.2	0.70			
23486+1622	HEI 91	2010.6348	152.7	0.68			
23491+1915	COU 343	2010.6349	102.7	0.17			
23504+2620	COU 545	2010.6349	315.7	0.73			

4. CONCLUSION

We have presented the results of binary star observations focused on binaries from the WDS catalogue. In particular, we have been interested in new binaries discovered by Hipparcos. We confirmed 38 new binaries detected by Hipparcos. The main aim of this study was in the selection of binaries with a fast relative motion allowing to obtain candidates for determinations of new orbits. From our observation results we can also conclude that our new detector based on Wat-120N CCD is suitable for speckle observations with the OAN-based telescopes.

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TABLE 2

SPECKLE MEASUREMENTS ON THE 2.1 M TELESCOPE

WDS ($\alpha, \delta J2000.0$)	Disc. Name	Date Besselian	P.A. (deg)	Sep. (arcsec)	P.A. Orb. (deg)	Sep. Orb. (arcsec)	Reference
00004+2749	TDS1238	2010.8836	87.9	0.85			
00008+1659	BAG 18	2010.8836	0.9	0.59			
00055+3406	HU 1201	2010.8919	304.2	0.21	307.19	0.192	Zirm (2003)
00085+3456	HDS 17	2010.8919	78.9	0.12	79.71	0.126	Cvetkovic (2010)
00260+1905	HDS 59	2010.8836	263.7	0.84			
00271+1852	TDS 19	2010.8836	137.4	0.90			
00295+1501	HEI 200	2010.8836	60.7	0.77			
00307+1339	HDS 66	2010.8836	266.9	0.93			
00312+0237	TDS1505	2010.8836	76.2	0.76			
00324+2147	HDS 72	2010.8836	38.9	0.21			
00344+2411	COU 350	2010.8837	140.9	0.94			
00353+2456	TDS1533	2010.8837	28.7	0.77			
00364+1213	A 807	2010.8837	233.9	0.86			
00374+0900	A 808	2010.8837	181.4	0.23			
00404+2504	COU 75	2010.8837	52.2	0.48			
00429+2047	A 2205	2010.8837	6.9	0.34	4.37	0.306	Baize (1989)
00487+1841	BU 495	2010.8837	247.7	0.28	249.789	0.314	Scardia et al. (2000)
01014+1155	BU 867	2010.8837	354.2	0.63	354.475	0.626	Hartkopf et al. (2008)
01046+2558	COU 253	2010.8837	95.9	0.95			
01055+2107	AG 14	2010.8837	314.7	0.76	263.073	0.549	Heintz (1998)
01072+3839	A 1516	2010.8920	4.7	0.22	355.60	0.145	Hartkopf et al. (2000)
01080+1204	A 2101	2010.8837	258.9	0.64			
01093+2428	COU 78	2010.8837	357.9	0.89			
01106+4917	COU2156	2010.8920	161.9	0.45			
01112+4113	A 655	2010.8920	353.9	0.33	349.24	0.317	Cvetkovic & Novakovic (2006)
01148+6056	BU 1100	2010.8920	353.4	0.33	351.21	0.268	Muller (1955)
01148+6056	BU 1100				153.72	0.199	Starikova (1977)
01178+4945	HU 520	2010.8920	167.4	0.33			
01251+4537	A 939	2010.8921	194.9	0.23	226.87	0.175	Starikova (1983)
01283+4247	AC 14	2010.8838	91.4	0.78			
01283+4247	AC 14	2010.8921	91.4	0.75			
01449+1951	A 2322	2010.8921	208.2	1.26			
01502+2702	BU 1313	2010.8921	153.7	0.53			
01510+2551	COU 452	2010.8921	179.2	0.23			
01513+6021	A 951	2010.8921	225.9	0.43			
01535+4437	STF3113	2010.8838	278.2	0.66			
01550+5817	A 954	2010.8921	198.7	0.63			
01551+5958	A 955	2010.8838	106.4	1.00			
01573+4812	A 818	2010.8838	204.7	0.28			
01584+5154	COU2559	2010.8838	65.4	0.40			
01586+3334	HDS 267	2010.8838	161.7	0.26			
01586+3334	HDS 267	2010.8922	165.7	0.23			
01588+3826	TDS2077	2010.8838	237.2	0.41			
02016+4107	COU1510	2010.8838	133.4	0.41			
02019+4831	COU2009	2010.8839	60.2	0.56			
02063+4936	COU2561	2010.8839	123.4	0.77			
02085+5852	HDS 284	2010.8839	77.7	0.22			
02085+5852	HDS 284	2010.8922	76.7	0.24			
02279+4523	COU2011	2010.8922	59.7	0.34			
02314+4234	A 660	2010.8922	311.4	0.52			
02323+3542	A 1927	2010.8922	192.2	0.81			
02382+4604	A 1278	2010.8922	311.7	0.22	286.29	0.231	Hartkopf & Mason (2001)
02417+5529	A 1280	2010.8923	12.7	0.33			
02454+5634 Aa, Ab	MLR 599	2010.8923	359.7	0.23			
03032+4121	COU1381	2010.8839	71.2	0.24			
03041+5040	COU2567	2010.8839	62.2	0.41			
03058+4818	COU2016	2010.8839	58.7	0.15			
03061+5144	COU2454	2010.8839	24.9	0.41			
03068+5813	TDS2446	2010.8839	351.4	0.77			

TABLE 2 (CONTINUED)

WDS ($\alpha, \delta J2000.0$)	Disc. Name	Date Besselian	P.A. (deg)	Sep. (arcsec)	P.A. Orb. (deg)	Sep. Orb. (arcsec)	Reference
03076+5230	MLR 658	2010.8839	80.2	0.40			
03081+4327	COU1679	2010.8839	1.9	0.50			
03084+4736	COU2017	2010.8839	9.4	0.28			
03129+5126	COU2568	2010.8839	309.4	0.40			
03138+3733 Aa, Ab	COU1075	2010.8839	40.4	0.89			
03141+5023	HU 543	2010.8840	106.9	0.29			
03150+3543	HO 502	2010.8840	15.2	0.84			
03250+4013	HU 1058	2010.8923	112.4	0.82			
03264+3520	HDS 430	2010.8923	278.2	0.23			
03279+4551	COU1687	2010.8840	290.4	0.77			
03279+4614	COU1686	2010.8840	262.7	0.53			
03354+3529	POP 83	2010.8923	265.9	0.51			
03484+5202	HU 546	2010.8840	26.2	0.30	28.527	0.358	Hartkopf & Mason (2009)
03499+4314	COU1691	2010.8840	318.4	0.38			
03503+4403	COU1692	2010.8840	37.9	0.53			
03522+5357	MLR 665	2010.8840	335.4	0.37			
03546+4554	TDS 121	2010.8840	113.4	0.97			
03586+4605	COU1696	2010.8840	139.2	0.86			
03594+4321	A 1708	2010.8840	338.2	0.82			
04016+5044	COU2458	2010.8841	141.2	0.65			
04017+5611	HDS 507	2010.8841	133.4	0.45			
04035+4211	A 1709	2010.8923	222.7	1.01			
04050+4936	COU2267	2010.8841	106.9	0.42			
04081+3407	COU1082	2010.8923	57.9	0.33			
04081+4535	COU2025	2010.8923	339.2	0.33			
04159+3142	STT 77	2010.8924	294.2	0.53	295.60	0.550	Starikova (1985)
04284+4914	HDS 575	2010.8924	315.7	0.45			
04302+5343	A 1300	2010.8841	148.2	0.85			
04306+5014	HU 550	2010.8841	298.4	0.53			
04308+4550	A 1007	2010.8841	161.9	0.27			
04310+4159	HDS 583	2010.8924	116.7	0.21			
04378+5249	MLR 696	2010.8841	66.2	1.05			
04381+5707	HDS 598	2010.8924	333.9	0.23			
04430+5712	A 1014	2010.8924	17.4	0.34	18.19	0.346	Brendley & Hartkopf (2007)
04477+4014	A 1545	2010.8924	95.7	0.45			
04542+4935 B	STF 603	2010.8925	105.9	1.13			
04542+4935 A	STF 603	2010.8925	99.4	2.18			
04599+4319	A 1551	2010.8841	273.4	0.23			
05038+3813	TDS3054	2010.8841	4.2	0.26			
05044+2139	COU 154	2010.8869	303.9	0.17			
05044+2938	A 1024	2010.8869	332.4	0.73			
05047+4458	A 1022	2010.8842	342.2	0.62			
05057+4516	COU2463	2010.8842	40.9	0.53			
05061+4222	COU2464	2010.8842	181.4	0.59			
05078+3723	COU1529	2010.8842	358.2	0.59			
05085+3755	COU1531	2010.8925	45.7	0.22			
05106+4924	HDS 684	2010.8925	57.2	0.46			
05119+4459	TDS3105	2010.8842	214.2	0.65			
05133+4940	COU2578	2010.8842	109.4	0.47			
05140+3655	POP 140	2010.8925	166.4	0.32			
05195+3809	COU1870	2010.8925	19.2	0.43			
05208+3329	COU1231	2010.8925	165.9	0.64			
05240+3238	COU1090	2010.8925	233.9	0.22			
05267+3857	HDS 714	2010.8925	262.4	0.45			
05310+2635	COU 574	2010.8869	136.2	0.32			
05319+2141	COU 268	2010.8869	164.2	0.72			
05326+4422	HDS 729	2010.8926	163.7	0.22			
05350+1838	A 2354	2010.8870	310.9	0.43			
05357+2054	COU 270	2010.8870	42.4	0.71			
06000+4643	A 1727	2010.8842	247.4	0.62			
06016+4111	COU2049	2010.8843	233.9	1.28			

TABLE 2 (CONTINUED)

WDS ($\alpha, \delta J2000.0$)	Disc. Name	Date Besselian	P.A. (deg)	Sep. (arcsec)	P.A. Orb. (deg)	Sep. Orb. (arcsec)	Reference
06025+3620	HU 1236	2010.8843	37.2	0.41			
06049+3211	HU 827	2010.8843	74.4	0.23			
06060+2331	HU 450	2010.8870	244.2	0.44			
06065+1832	A 2444	2010.8870	181.4	0.12			
06073+1848	COU 471	2010.8870	159.2	0.34			
06087+1724	STF 849	2010.8870	241.4	0.91			
06097+1630	A 2514	2010.8870	102.7	0.24			
06097+2914	A 54	2010.8870	332.4	0.55			
06117+2846	A 55	2010.8870	259.7	0.43			
06142+1217	TDS3652	2010.8870	17.9	0.43			
06150+1649	A 2044	2010.8871	34.9	0.34			
06152+2917	COU1103	2010.8871	51.9	0.23			
06185+2241	HDS 863	2010.8871	50.7	0.22			

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