



Observations des planètes et satellites effectuées avec la lunette méridienne du laboratoire d'astrophysique de Bordeaux (LAB) (2007-2014)

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*NOTES SCIENTIFIQUES ET TECHNIQUES
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S097

**OBSERVATIONS DES PLANETES ET SATELLITES EFFECTUEES AVEC
LA LUNETTE MERIDIENNE DU LABORATOIRE D'ASTROPHYSIQUE DE BORDEAUX (LAB)
(2007-2014)**

G. Dourneau^(1,2), J.F. Le Champion^(1,2), S. Bontemps^(1,2), C. Ducourant^(1,2), S. Raymond^(1,2), F. Selsis^(1,2), C. Soubiran^(1,2), V. Wakelam^(1,2), W. d'Anna^(1,2), J.M. Desbats^(1,2), M. Soulette^(1,2)

⁽¹⁾ Univ. Bordeaux, LAB, UMR 5804, F-33270, Floirac, France

⁽²⁾ CNRS, LAB, UMR 5804, F-33270, Floirac, France



1. INTRODUCTION

Nous présentons ici les résultats des observations astrométriques des planètes du système solaire et de leurs satellites effectuées durant les 8 dernières oppositions, de 2007 à 2014, avec la lunette méridienne CCD automatique du Laboratoire d'Astrophysique de Bordeaux (LAB).

Ce travail fait suite à celui de Dourneau et al. (2007) qui présentait, dans la Note Scientifique et Technique de l'IMCCE S089, les observations de ces mêmes objets effectuées avec le même instrument, de 1997 à 2006, et jusqu'en 2007 pour les satellites de Saturne seulement.

Sur les 8 dernières oppositions, nous avons effectué plus de 1500 observations de planètes et satellites. Le rythme de nos observations méridiennes de ces objets du système solaire s'est très significativement accru au cours de ces 7 dernières années puisque nous avons effectué un peu moins de 900 observations durant les 10 précédentes oppositions de 1997 à 2006, comme il est indiqué dans la Note S089.

Une analyse des observations méridiennes de planètes et satellites présentées dans la Note S089 a été effectuée par Arlot et al. (2008). Elle a montré que ces observations sont d'une très grande utilité pour la maintenance et l'amélioration de la qualité des éphémérides des objets ainsi observés. En conséquence, une convention a été signée entre le LAB et l'IMCCE début 2012 afin que se poursuive l'effort observationnel du LAB afin de contribuer à l'amélioration du service de la maintenance des éphémérides de l'IMCCE.

2. OBSERVATIONS

Les coordonnées locales du LAB (code UAI=999) sont les suivantes :

Longitude = $0^{\circ} 31' 39''$ W

Latitude = $44^{\circ} 50' 7''$ N

Altitude = 73m

La lunette méridienne du LAB a un diamètre de 20 cm et une longueur focale de 2,7m, conduisant à une échelle de $8,7''/\text{mm}$ dans le plan focal. Cet instrument est totalement automatisé depuis 1996 et il est équipé d'une cellule CCD Thomson 7896M de 1024×1024 pixels carrés de $19\mu\text{m}$ de côté, correspondant à un champ de $1,7'' \times 1,7''$.

Les observations se font en mode TDI qui consiste à laisser défiler le ciel devant l'instrument immobile, positionné à une hauteur choisie. Les bandes de ciel ainsi observées ont une hauteur de $28'$ et leur longueur est limitée à 1h. Dans ces conditions, le temps de pose correspond au temps de transit qui est égal à $112s/\cos\delta$, pour un objet de déclinaison δ . La magnitude des objets observables dans de bonnes conditions est comprise entre 8,5 et 16.

Le nombre total d'observations que nous présentons ici est de 1519, ainsi réparties pour chacun des objets observés:

A. Planètes

- Uranus : 205 observations de 2007 à 2013
- Neptune : 225 observations de 2007 à 2013
- Pluton : 143 observations de 2007 à 2014

B. Satellites des planètes

- Saturne :
 - Dioné : 3 observations de 2011 à 2014
 - Rhéa : 22 observations de 2008 à 2014
 - Titan : 127 observations de 2008 à 2014
 - Hypérion : 120 observations de 2008 à 2014
 - Japet : 159 observations de 2008 à 2014

Cela représente un total de 429 observations des satellites Dioné, Rhéa, Titan, Hypérion et Japet effectuées de 2008 à 2014. Les observations des satellites de Saturne effectuées en 2007 ne sont pas présentées ici car elles ont été déjà publiées par Dourneau et al. (2007) dans la Note S089.

- Uranus :
 - Umbriel : 45 observations de 2007 à 2013
 - Titania : 131 observations de 2007 à 2013
 - Oberon : 150 observations de 2007 à 2013

Cela représente un total de 326 observations des satellites Umbriel, Titania et Oberon effectuées de 2007 à 2013.

- Neptune :
- Triton : 189 observations de 2007 à 2013.

La répartition des observations des planètes et satellites pour chaque opposition de 2007 à 2014 est donnée dans la Table 1.

Table 1. Nombre d'observations de planètes et satellites par opposition de 2007 à 2014

	2007	2008	2009	2010	2011	2012	2013	2007-2013	2014	2007-2014
Saturne										
Dioné	0	0	0	0	1	0	1	2	1	3
Rhée	0	3	8	2	3	0	2	18	4	22
Titan	12*	33	27	12	11	11	15	109 (121#)	18	127 (139#)
Hypérion	11*	28	25	12	14	6	14	99 (110#)	21	120 (131#)
Japet	14*	38	33	15	18	13	19	136 (150#)	23	159 (173#)
Uranus	60	27	32	21	21	29	15	205		205
Umbriel	11	11	3	7	3	8	2	45		45
Titania	36	15	19	16	11	21	13	131		131
Oberon	40	20	23	15	16	24	12	150		150
Neptune	53	32	53	15	17	37	18	225		225
Triton	50	27	45	14	12	27	14	189		189
Pluton	13	30	33	13	10	12	21	132	11	143
Total	263 (300#)	264	301	142	137	188	146	1441 (1478#)	78	1519(1556#)

(*) Observations des satellites de Saturne de 2007 déjà publiées par Dourneau et al. (2007)

(#) Nombre incluant les observations (*) déjà publiées par Dourneau et al. (2007)

3. REDUCTION ASTROMETRIQUE

La réduction astrométrique des bandes de ciel de 28' de hauteur et d'environ 1h de longueur a été décrite de façon détaillée Dourneau et al. (2007). Vous pouvez vous reporter à ce travail, mais rappelons simplement que le catalogue de référence que nous utilisons est Tycho-2 et que la précision des observations que nous présentons ici est d'environ 60 mas pour les positions et de $4 \cdot 10^{-4}$ pour les magnitudes. Aucune correction d'effets chromatiques a été effectuée, ces effets ayant été évalués négligeables en comparaison de la précision des observations par Arlot et al. (2008).

4. PRESENTATION DES POSITIONS ET MAGNITUDES OBSERVEES

Les positions observées que nous présentons ici sont les coordonnées astrométriques topocentriques des planètes et satellites rapportées à l'ICRF. Les magnitudes observées sont données en bande V. Ces positions et magnitudes observées sont données dans des fichiers disponibles sur le site web de l'IMCCE, à l'adresse : <ftp://ftp.imcce.fr/pub/misc/bordeaux/2007-2013>.

Ces fichiers portent le nom de la planète ou du satellite dont ils contiennent les positions et les magnitudes, suivi de « -data.txt ». Leur contenu est donné en Annexe ci-dessous. Ils comportent 8 colonnes successives, comme indiqué dans l'exemple suivant pour le fichier « uranus-data.txt » :

```
2455039.645977 23 47 22.4542 -2 13 24.826 6.808
2455040.643196 23 47 18.0618 -2 13 55.050 6.969
2455041.640414 23 47 13.5159 -2 14 26.805 6.499
```

La première colonne fournit la date julienne d'observation (temps moyen de la pose), exprimée en Temps Universel. L'ascension droite observée, exprimée en heures, minutes et secondes décimales, est donnée

dans les colonnes 2 à 4. La déclinaison observée, exprimée en degré, minute et secondes décimales, est donnée dans les colonnes 5 à 7. La 8^{ème} colonne indique la magnitude observée.

5. CONCLUSION

Les observations des planètes et satellites présentées ici ont été comparées aux éphémérides disponibles à ce jour sur le site de l'IMCCE. L'analyse détaillée de ces résidus a fait l'objet d'un travail indépendant (Arlot et al., 2012) qui montre notamment que ces positions observées présentent un niveau de précision élevé, avec des erreurs standard inférieures ou égales à 100 mas pour Uranus, Neptune et leurs satellites, ainsi que Pluton. Pour les satellites de Saturne, la précision est encore meilleure, avec des erreurs standard de l'ordre de 50 mas. Par ailleurs, les dérives systématiques qui avaient été mises en évidence par l'analyse des observations de 1997 à 2006 par Arlot et al. (2008) semblent persister, notamment pour Uranus et Neptune et leurs satellites. Par contre aucune dérive significative n'affecte les positions de Pluton et des satellites de Saturne.

Pour terminer, ajoutons que les positions observées des satellites planétaires permettent de déduire de pseudo-positions de leur planètes respectives, par l'intermédiaire des positions théoriques des satellites. Les positions observées des planètes ainsi obtenues, via les positions observées de leurs satellites, présentent une meilleure précision que celle issue de l'observation directe, notamment pour Saturne.

Il en résulte que les observations méridiennes effectuées au LAB présentent un intérêt scientifique certain pour leur contribution au service de maintenance des éphémérides des objets du système solaire de l'IMCCE. Cet effort observationnel devra donc se poursuivre durant les années à venir.

6. REFERENCES

Dourneau G., Le Campion J.F., Rapaport M. et al., « Observations des planètes, satellites et astéroïdes avec la lunette méridienne de l'observatoire de Bordeaux (1995-2007) » 2007, Note Scientifique et Technique de l'IMCCE, S089

Arlot J.E., Dourneau G. and Le Campion J.F., « An analysis of Bordeaux meridian transit circle observations of planets and satellites (1997-2007) » 2008, A&A, 484, 869

Arlot J.E., Dourneau G. and Le Campion J.F. « Analysis of meridian circle observations of planets and satellites made at LAB (2007-2013) » 2014, en préparation

ANNEXE

Nous présentons dans cette Annexe le contenu des fichiers suivants qui fournissent les positions et les magnitudes observées des planètes et satellites, les observations de chaque opposition successive étant séparées par un interligne. :

- Planètes : « uranus-data.txt », « neptune-data.txt » et « pluto-data.txt »
- Satellites : « dione-data.txt », « rhea-data.txt », « titan-data.txt », « hyperion-data.txt », « iapetus-data.txt », « umbriel-data.txt », « titania-data.txt », « oberon-data.txt » et « triton-data.txt ».

Ces fichiers sont également disponibles électroniquement sur le site web de l'IMCCE à l'adresse :
<ftp://ftp.imcce.fr/pub/misc/bordeaux/2007-2013>

PLANETES							2454675.632206	23	32	26.3039	-3	50	37.407	6.659	
uranus-data.txt							2454676.629416	23	32	21.1171	-3	51	12.771	6.758	
							2454677.626624	23	32	15.7964	-3	51	48.720	6.926	
							2454680.618240	23	31	58.9906	-3	53	42.266	6.375	
2454306.632323	23	17	50.8056	-5	24	10.449	6.617	2454683.609842	23	31	40.9964	-3	55	42.950	5.917
2454307.629532	23	17	45.5531	-5	24	45.497	6.743	2454687.598624	23	31	15.2505	-3	58	34.781	6.867
2454308.626740	23	17	40.1630	-5	25	21.726	6.748	2454711.530941	23	28	8.3894	-4	18	57.777	6.816
2454312.615555	23	17	17.2561	-5	27	54.018	6.694	2454717.513957	23	27	16.1583	-4	24	34.372	5.822
2454315.607150	23	16	58.7081	-5	29	56.745	6.668	2454725.491299	23	26	5.5607	-4	32	5.688	6.144
2454316.604345	23	16	52.2684	-5	30	39.276	6.727	2454726.488467	23	25	56.7421	-4	33	1.901	6.100
2454320.593114	23	16	25.3538	-5	33	36.039	6.590	2454729.479971	23	25	30.3699	-4	35	49.413	5.985
2454321.590303	23	16	18.3375	-5	34	22.170	6.260	2454730.477140	23	25	21.6225	-4	36	44.932	6.153
2454322.587491	23	16	11.2164	-5	35	8.095	6.757	2454731.474309	23	25	12.9048	-4	37	40.103	5.821
2454337.545179	23	14	13.5032	-5	47	48.848	6.094	2454733.468648	23	24	55.5613	-4	39	30.010	6.047
2454343.528205	23	13	22.2098	-5	53	15.861	6.222	2454735.462989	23	24	38.3622	-4	41	18.419	5.773
2454344.525374	23	13	13.5202	-5	54	11.075	6.312	2454736.460160	23	24	29.8340	-4	42	12.174	6.316
2454345.522543	23	13	4.7828	-5	55	6.652	6.228	2454738.454504	23	24	12.9250	-4	43	58.597	5.917
2454346.519712	23	12	56.0220	-5	56	2.094	6.287	2454739.451677	23	24	4.5512	-4	44	50.963	6.683
2454348.514048	23	12	38.4206	-5	57	53.427	6.185	2454744.437553	23	23	23.6894	-4	49	6.562	7.104
2454349.511216	23	12	29.5843	-5	58	49.409	6.324	2454746.431910	23	23	7.8668	-4	50	45.120	7.397
2454350.508384	23	12	20.7350	-5	59	45.199	6.072	2454750.420635	23	22	37.2807	-4	53	54.994	6.169
2454351.505551	23	12	11.8697	-6	0	41.262	6.117	2454757.400948	23	21	47.6489	-4	59	0.534	6.049
2454352.502718	23	12	2.9990	-6	1	37.118	6.179	2454758.398141	23	21	41.0062	-4	59	40.921	6.029
2454353.499886	23	11	54.1299	-6	2	32.820	6.035	2454759.395336	23	21	34.4889	-5	0	21.006	6.285
2454354.497053	23	11	45.2487	-6	3	28.761	6.300	2454762.386927	23	21	15.6854	-5	2	15.095	5.881
2454355.494220	23	11	36.3808	-6	4	24.473	6.279	2454763.384127	23	21	9.6768	-5	2	51.645	6.113
2454356.491387	23	11	27.5104	-6	5	20.116	6.045	2454765.378532	23	20	58.0687	-5	4	1.501	6.201
2454359.482890	23	11	0.9932	-6	8	6.209	6.000	2455039.645977	23	47	22.4542	-2	13	24.826	6.808
2454362.474395	23	10	34.6698	-6	10	50.320	5.706	2455040.643196	23	47	18.0618	-2	13	55.050	6.969
2454363.471564	23	10	25.9626	-6	11	44.622	6.410	2455041.640414	23	47	13.5159	-2	14	26.805	6.499
2454364.468734	23	10	17.2949	-6	12	38.740	6.410	2455044.632056	23	46	59.0032	-2	16	6.655	6.204
2454385.409461	23	7	29.8317	-6	29	45.863	6.599	2455047.623683	23	46	43.2037	-2	17	54.513	6.320
2454386.406650	23	7	22.8416	-6	30	27.860	6.393	2455053.606895	23	46	7.9785	-2	21	52.277	6.150
2454387.403840	23	7	15.9623	-6	31	9.524	6.739	2455057.595674	23	45	41.9792	-2	24	47.029	5.978
2454388.401032	23	7	9.1985	-6	31	50.248	6.444	2455069.561893	23	44	13.6963	-2	34	33.297	6.017
2454389.398225	23	7	2.5638	-6	32	30.006	6.391	2455072.553424	23	43	49.6309	-2	37	11.832	5.868
2454390.395419	23	6	56.0539	-6	33	8.766	6.626	2455073.550600	23	43	41.4741	-2	38	5.233	5.775
2454392.389812	23	6	43.4124	-6	34	24.618	6.551	2455074.547775	23	43	33.2533	-2	38	59.307	5.975
2454393.387011	23	6	37.2870	-6	35	1.028	6.515	2455080.530810	23	42	42.7158	-2	44	29.562	6.036
2454394.384212	23	6	31.3002	-6	35	36.531	6.911	2455082.525150	23	42	25.4942	-2	46	21.816	6.093
2454395.381414	23	6	25.4487	-6	36	11.235	6.710	2455085.516658	23	41	59.4107	-2	49	11.418	6.134
2454397.375822	23	6	14.1562	-6	37	17.763	6.555	2455088.508164	23	41	33.0880	-2	52	2.197	6.072
2454398.373029	23	6	8.7387	-6	37	49.522	6.709	2455097.482675	23	40	13.7528	-3	0	33.301	6.154
2454400.367448	23	5	58.3200	-6	38	50.547	6.747	2455099.477012	23	39	56.2574	-3	2	25.546	5.838
2454401.364660	23	5	53.3381	-6	39	19.648	6.528	2455104.462862	23	39	13.0477	-3	7	1.471	5.893
2454405.353526	23	5	34.9549	-6	41	5.787	6.577	2455107.454377	23	38	47.6326	-3	9	43.011	6.094
2454412.334112	23	5	9.0496	-6	43	31.280	7.302	2455111.443073	23	38	14.5557	-3	13	12.897	5.694
2454414.328584	23	5	3.1885	-6	44	3.070	7.064	2455117.426143	23	37	27.1019	-3	18	12.234	6.481
2454420.312047	23	4	49.8933	-6	45	11.078	6.739	2455119.420507	23	37	11.9557	-3	19	47.164	5.964
2454421.309298	23	4	48.3132	-6	45	18.400	6.976	2455121.414876	23	36	57.2066	-3	21	19.387	6.052
2454422.306552	23	4	46.9241	-6	45	24.537	6.803	2455123.409249	23	36	42.8632	-3	22	48.703	6.040
2454426.295586	23	4	43.2145	-6	45	37.488	6.758	2455130.389599	23	35	56.2983	-3	27	36.721	6.063
2454429.287385	23	4	42.3986	-6	45	34.615	6.691	2455131.386797	23	35	50.1492	-3	28	14.569	5.853
2454432.279204	23	4	43.2769	-6	45	21.402	6.812	2455132.383997	23	35	44.1174	-3	28	51.358	6.126
2454433.276481	23	4	43.9424	-6	45	14.474	7.254	2455134.378402	23	35	32.4988	-3	30	2.426	6.021
2454438.262900	23	4	50.1341	-6	44	22.692	6.805	2455145.347749	23	34	39.0200	-3	35	23.132	6.195
2454445.243978	23	5	6.7903	-6	42	20.551	6.666	2455154.322837	23	34	9.8107	-3	38	9.578	6.054
2454446.241284	23	5	9.9287	-6	41	58.351	6.695	2455160.306320	23	33	58.2767	-3	39	8.415	6.056
2454447.238592	23	5	13.2459	-6	41	34.896	7.141	2455177.259942	23	34	1.8756	-3	38	0.117	6.087
2454448.235902	23	5	16.7584	-6	41	10.531	7.127								
2454449.233214	23	5	20.4460	-6	40	44.913	6.881								
2454451.227844	23	5	28.3857	-6	39	50.114	7.001								
2454452.225162	23	5	32.6275	-6	39	20.915	6.851								
2454453.222483	23	5	37.0569	-6	38	50.892	6.874								

2455417.620729	0	1	9.5229	-0	43	21.235	5.982	2454302.571678	21	34	28.6977	-14	42	36.607	8.455
2455418.617934	0	1	3.8872	-0	43	59.536	6.046	2454306.560488	21	34	5.4088	-14	44	34.530	8.253
2455439.558919	23	58	38.3586	-1	0	12.001	7.036	2454307.557689	21	33	59.4691	-14	45	4.511	8.374
2455442.550449	23	58	14.1569	-1	2	51.796	6.877	2454308.554890	21	33	53.4807	-14	45	34.577	7.981
2455443.547624	23	58	5.9556	-1	3	45.616	6.733	2454309.552090	21	33	47.4468	-14	46	5.054	8.118
2455450.527830	23	57	6.8721	-1	10	13.634	6.436	2454312.543688	21	33	29.1335	-14	47	37.063	8.300
2455451.525000	23	56	58.2436	-1	11	9.590	7.050	2454315.535282	21	33	10.5179	-14	49	10.597	8.355
2455452.522170	23	56	49.5841	-1	12	6.190	6.997	2454316.532480	21	33	4.2572	-14	49	41.973	8.299
2455454.516508	23	56	32.1657	-1	13	59.854	7.027	2454320.521267	21	32	38.9851	-14	51	48.150	8.139
2455458.505182	23	55	57.0661	-1	17	48.083	6.949	2454321.518463	21	32	32.6296	-14	52	20.027	8.205
2455461.496685	23	55	30.6144	-1	20	39.829	6.972	2454322.515660	21	32	26.2562	-14	52	51.741	8.177
2455482.437274	23	52	31.0098	-1	39	51.870	6.902	2454337.473604	21	30	50.8528	-15	0	44.362	7.911
2455484.431630	23	52	15.1507	-1	41	32.632	6.646	2454343.456795	21	30	13.9272	-15	3	46.033	7.972
2455514.347586	23	49	10.7384	-2	0	34.376	6.463	2454344.453995	21	30	7.9021	-15	4	15.564	8.079
2455524.319913	23	48	38.8497	-2	3	36.938	6.981	2454345.451196	21	30	1.9186	-15	4	44.915	7.870
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2455546.259766	23	48	32.4030	-2	3	20.807	6.969	2454349.440003	21	29	38.4486	-15	6	39.772	7.920
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2455783.628945	0	15	57.5577	0	53	53.517	6.887	2454352.431616	21	29	21.4119	-15	8	3.117	8.053
2455784.626155	0	15	52.3730	0	53	18.175	6.920	2454353.428821	21	29	15.8521	-15	8	30.260	7.944
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2455825.510692	0	10	47.2149	0	19	41.061	7.018	2454363.400918	21	28	24.0877	-15	12	41.968	8.402
2455827.505028	0	10	29.5895	0	17	46.477	6.094	2454364.398133	21	28	19.3471	-15	13	5.009	8.270
2455833.488034	0	9	36.5613	0	12	3.319	6.821	2454378.359253	21	27	22.7331	-15	17	38.836	7.907
2455835.482369	0	9	18.9204	0	10	9.758	6.711	2454385.339901	21	27	2.1511	-15	19	18.269	7.560
2455837.476706	0	9	1.3611	0	8	16.796	6.796	2454386.337142	21	26	59.6732	-15	19	30.211	8.060
2455838.473875	0	8	52.6190	0	7	20.577	6.880	2454387.334384	21	26	57.3165	-15	19	41.463	7.975
2455840.468213	0	8	35.2258	0	5	28.904	6.931	2454388.331627	21	26	55.0839	-15	19	52.382	8.068
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2455856.423008	0	6	23.7606	-0	8	28.116	6.723	2454393.317867	21	26	45.7632	-15	20	37.232	7.921
2455865.397689	0	5	19.2392	-0	15	13.501	7.079	2454394.315119	21	26	44.2702	-15	20	44.474	8.072
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2455878.361322	0	4	3.8320	-0	22	57.904	6.903	2454398.304143	21	26	39.5941	-15	21	7.015	7.780
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2456150.634379	0	30	41.1082	2	30	18.935	6.974	2454414.260479	21	26	41.8401	-15	20	57.803	7.909
2456157.614840	0	30	4.0241	2	26	9.532	6.913	2454420.244208	21	26	51.5171	-15	20	12.222	8.044
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2456177.558627	0	27	44.7870	2	10	50.199	6.931	2454665.584158	21	43	36.2054	-14	1	22.849	7.739
2456178.555805	0	27	36.7902	2	9	57.982	7.059	2454666.581365	21	43	30.7693	-14	1	51.591	7.854
2456179.552982	0	27	28.7260	2	9	5.642	6.727	2454668.575777	21	43	19.7079	-14	2	49.658	7.810
2456186.533195	0	26	30.3387	2	2	45.980	6.788	2454669.572981	21	43	14.0819	-14	3	19.228	7.714
2456189.524706	0	26	4.5078	1	59	58.141	6.480	2454670.570186	21	43	8.4081	-14	3	49.139	7.833
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2456193.513382	0	25	29.5442	1	56	12.263	6.437	2454676.553399	21	42	33.2663	-14	6	52.472	7.582
2456201.490721	0	24	18.7475	1	48	36.813	6.454	2454677.550600	21	42	27.2455	-14	7	23.878	7.874
2456229.411584	0	20	26.1204	1	24	0.748	6.277	2454680.542198	21	42	8.9765	-14	8	59.063	7.768
2456231.405957	0	20	11.7861	1	22	31.226	6.403	2454683.533793	21	41	50.4278	-14	10	35.162	7.934
2456238.386307	0	19	25.2561	1	17	42.103	6.184	2454687.522582	21	41	25.3304	-14	12	44.994	7.775
2456239.383505	0	19	19.1096	1	17	4.775	6.024	2454711.455318	21	38	54.9088	-14	25	34.128	7.758
2456243.372315	0	18	55.8876	1	14	42.203	6.147	2454717.438530	21	38	19.7593	-14	28	31.797	7.972
2456245.366730	0	18	45.1351	1	13	36.509	6.293	2454725.416182	21	37	36.0835	-14	32	11.583	7.851
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2456263.316797	0	17	37.2535	1	6	59.115	6.166	2454727.410603	21	37	25.8464	-14	33	2.867	8.153
2456268.303041	0	17	28.3704	1	6	14.173	6.362	2454729.405027	21	37	15.9222	-14	33	52.606	8.297
2456273.289339	0	17	24.0897	1	5	59.203	6.114	2454730.402241	21	37	11.0636	-14	34	16.942	7.927
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2455081.448215	21	47	21.7111	-13	47	9.367	7.949	2456201.398849	22	11	37.9805	-11	50	3.954	7.928
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2455442.466273	21	56	39.5258	-13	2	51.429	7.850	2454298.425027	17	46	55.8997	-16	26	33.159	14.181
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2455485.346512	21	53	15.9429	-13	20	49.703	7.801	2454321.360987	17	45	8.5108	-16	31	31.564	14.317
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2454452.708203	10	43	0.6480	9	54	50.763	8.333	2456782.517969	15	14	9.4746	-15	24	14.435	8.392
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2454920.448965	11	13	44.3286	7	23	9.155	10.365
2454925.434417	11	12	26.6547	7	31	14.381	10.345
2454929.422876	11	11	33.0273	7	37	2.095	10.317
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2455215.687117	12	20	39.1240	0	21	45.757	12.236
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2455257.567431	12	13	24.2875	1	18	40.671	10.498
2455265.544380	12	11	39.5470	1	32	46.195	10.961
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2455314.401361	11	58	19.9843	2	53	50.693	10.678

2455583.711465	13	6	37.6595	-4	20	36.952	11.147
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2456402.527060	14	29	10.6903	-11	52	24.777	12.126	2456634.311131	0	32	5.4898	2	41	37.928	15.472
2456396.544547	14	30	46.4707	-11	59	34.290	11.944	titania-data.txt							
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2456326.741005	14	38	29.4087	-12	51	53.237	12.858	2454316.604341	23	16	51.9130	-5	30	19.657	14.136
2456346.686526	14	38	39.9805	-12	50	12.987	11.354	2454321.590309	23	16	18.8359	-5	34	49.696	14.297
2456345.689304	14	38	44.1053	-12	50	45.919	11.478	2454322.587497	23	16	11.7354	-5	35	36.981	14.234
2456344.692077	14	38	47.8478	-12	51	16.552	11.500	2454343.528199	23	13	21.6712	-5	52	46.453	14.046
2456343.694845	14	38	51.1811	-12	51	43.981	11.594	2454344.525369	23	13	13.0183	-5	53	43.519	14.012
2456341.700368	14	38	56.5807	-12	52	30.746	11.821	2454348.514054	23	12	38.9465	-5	58	23.443	14.019
2456340.703121	14	38	58.5773	-12	52	49.643	11.915	2454349.511220	23	12	29.8967	-5	59	8.283	14.025
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2456177.558637	0	27	45.6478	2	10	31.946	14.354								
2456179.552984	0	27	28.8879	2	9	26.916	14.178	2455040.643198	23	47	18.1853	-2	14	20.397	14.689
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2456624.338755	0	32	33.0728	2	45	1.629	14.255	2455134.378402	23	35	32.5467	-3	30	18.608	14.356
2456630.322166	0	32	15.2387	2	42	27.499	14.479	2455177.259950	23	34	2.5805	-3	38	38.855	14.570
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2454354.497059	23	11	45.8257	-6	3	58.949	14.198	2455811.550308	0	12	47.7236	0	32	13.073	14.401
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2456263.316785	0	17	36.2432	1	7	15.173	14.878
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2456639.297379	0	31	56.9060	2	41	52.173	14.642
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Satellite de Neptune

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2455044.551886	21	51	11.2685	-13	27	7.237	13.372
2455053.526665	21	50	15.0734	-13	31	43.441	13.506
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