

## Photometry of Titan, 1972-2006

At Lowell Observatory, we have made  $b$  (472 nm) and  $y$  (551 nm) photometric measurements of Titan at every Saturn apparition from 1972 to 2006, thirty four apparitions in all (Lockwood 1975, 1977). Each year we observe Titan on a half-dozen or more nights, comparing its brightness with that of two nearby comparison stars of roughly solar color. We adjust the differential magnitudes to a solar phase angle of zero (a correction that can be as large as 0.03 mag at the maximum solar phase angle of  $6^\circ$ ) and to a standard epoch 1950 heliocentric opposition distance of 9.539 AU.

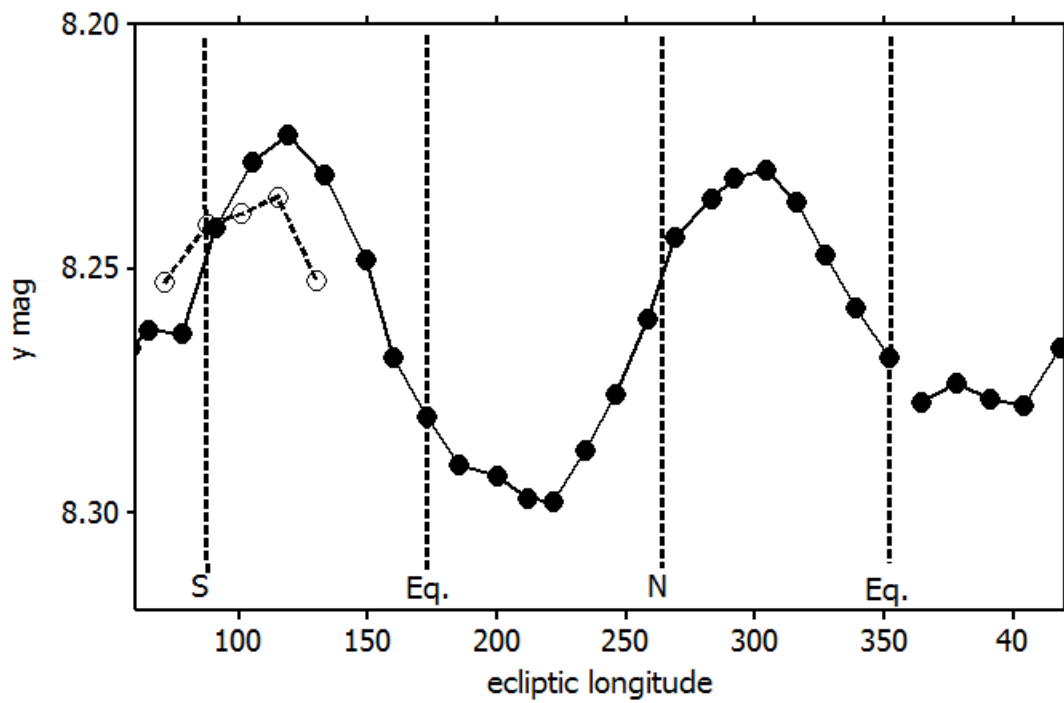
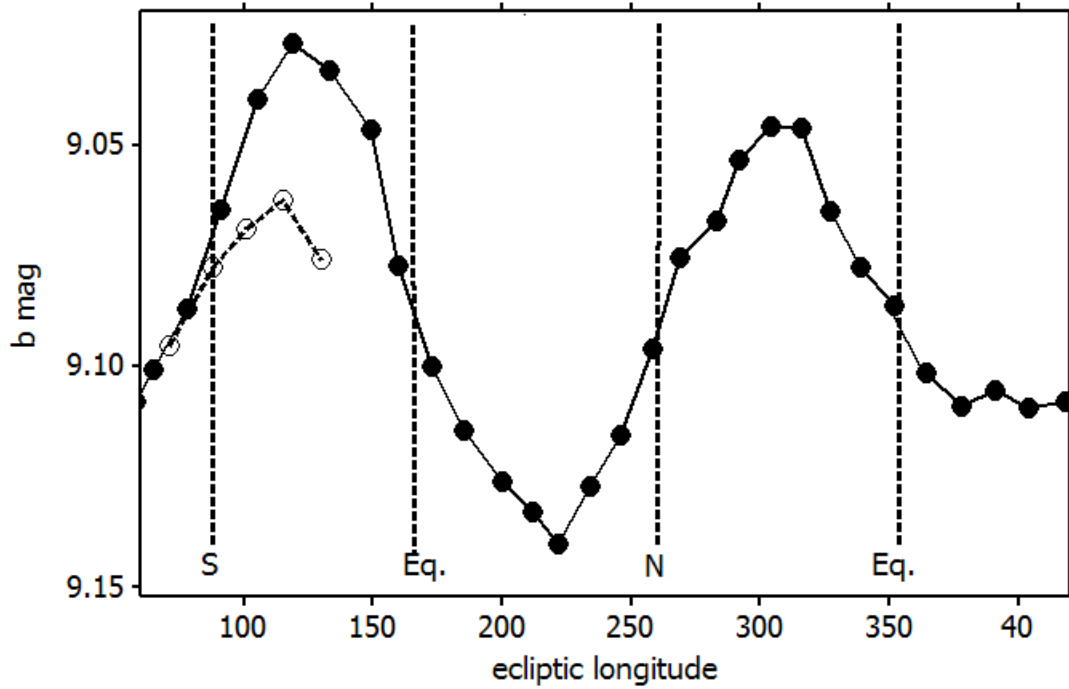
Separate annual observations of a running 5-year string of comparison star pairs including those for the current apparition tie the system of comparison star magnitudes into our local standard  $b$ ,  $y$  photometric system. We have thus defined a set of precisely measured sunlike comparison stars for Titan all around the ecliptic.

The figures show the  $b$  and  $y$  light curves plotted as a function of Titan's ecliptic longitude beginning with the first apparition in 1972 (leftmost solid dot) and ending 29.5 years later in 2001 (rightmost solid dot). The first few apparitions of a second trip around the Sun, 2002-2006, are shown as open symbols connected by the dotted line. On each light curve Eq denotes the equinoxes and N and S indicate northern and southern summer solstices, respectively. Titan's inclination of its equator to orbit is  $29^\circ$  and its extreme sub-Earth latitude ranges from  $-32^\circ$  to  $+32^\circ$ . Titan's 0.11 mag brightness variation in  $b$  and 0.08 mag in  $y$  is caused by its changing aspect seen from Earth coupled with the shifting pattern of its intrinsic north-south albedo asymmetry (NSA). The NSA was first hypothesized by Sromovsky et al. in 1981 to explain the brightness variations and then refined by Lorenz et al. (1997, 1999) using the accumulated Lowell data.

The table gives the mean opposition magnitudes of Titan at each observed apparition and their standard deviations along with ecliptic longitude, sub-Earth latitude, range of solar phase angle covered before and after opposition, and the standard deviations of the differential magnitudes of the comparison stars,

### References

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Lightcurves of Titan in *b* and *y* plotted as a function of ecliptic longitude (see table below). Solid symbols show the first full 29.5 year orbit around the Sun, 1972-2001 and open symbols show the beginning of a second orbit, 2002-2006.

Updated July 2007. To be submitted to *Icarus*. Some values in the table below have been revised slightly from those used by Lorenz et al. (1997, 1999).

Year	Mean JD 2,430,000+	<i>n</i>	Ecliptic long.(deg)	Sub-Earth lat. (deg)	Phase Angle (deg)	<i>y</i> (mag)	<i>s.d.</i>	<i>b</i> (mag)	<i>s.d.</i>	<i>s.d.</i> comp <i>y</i>	<i>s.d.</i> comp <i>b</i>
1972.06	11335.5	7	65	-30.1	4.7 6.2	8.263	0.0068	9.101	0.0079	0.0083	0.0099
1972.99	11674.0	12	78	-31.6	6.2 0.7 6.1	8.263	0.0087	9.087	0.0112	0.0021	0.0023
1973.96	12030.3	12	91	-31.4	6.7 0.3 5.3	8.242	0.0083	9.065	0.0108	0.0022	0.0020
1974.96	12394.2	32	105	-29.6	6.4 0.3 6.4	8.228	0.0083	9.040	0.0074	0.0072	0.0076
1976.04	12788.1	11	119	-25.7	6.0 0.3 5.7	8.222	0.0041	9.027	0.0053	0.0065	0.0058
1977.07	13166.8	8	133	-20.5	6.1 0.8 6.1	8.230	0.0059	9.033	0.0058	0.0024	0.0013
1978.28	13606.7	18	149	-13.0	3.8 0.6 6.2	8.248	0.0047	9.047	0.0054	0.0027	0.0031
1979.13	13916.0	15	160	-7.3	6.1 0.4 6.0	8.268	0.0040	9.077	0.0068	0.0036	0.0036
1980.11	14275.1	9	173	-0.5	6.0 0.3 3.3	8.280	0.0025	9.100	0.0031	0.0035	0.0025
1981.14	14652.9	5	185	6.6	5.8 0.6 1.2	8.290	0.0019	9.114	0.0051	0.0029	0.0025
1982.32	15084.6	6	200	13.9	4.5 1.2 4.7	8.292	0.0031	9.126	0.0029	0.0029	0.0022
1983.36	15462.3	6	212	19.7	5.4 1.7 4.9	8.297	0.0037	9.133	0.0039	0.0031	0.0023
1984.23	15782.0	9	222	23.7	5.8 0.3 2.1	8.298	0.0043	9.140	0.0032	0.0063	0.0047
1985.32	16177.6	7	234	27.6	5.6 1.2 2.7	8.287	0.0045	9.127	0.0039	0.0030	0.0033
1986.39	16570.7	7	246	30.3	4.8 1.8 4.1	8.276	0.0041	9.116	0.0037	0.0047	0.0049
1987.41	16940.9	5	258	31.5	5.9 0.8 1.6	8.260	0.0047	9.096	0.0047	0.0053	0.0037
1988.41	17308.1	5	269	31.6	4.4 0.5	8.243	0.0062	9.076	0.0095	0.0031	0.0023
1989.42	17676.1	5	283	30.5	4.2 2.2	8.236	0.0052	9.067	0.0057	0.0054	0.0064
1990.57	18095.2	5	292	27.8	2.5 0.8 3.8	8.231	0.0022	9.053	0.0043	0.0041	0.0036
1991.61	18477.2	9	304	24.1	3.9 2.5 5.7	8.230	0.0055	9.046	0.0053	0.0054	0.0043
1992.71	18878.5	10	316	19.2	3.6 5.5	8.236	0.0047	9.046	0.0046	0.0032	0.0041
1993.62	19209.1	9	327	14.3	4.4 0.8 3.4	8.247	0.0063	9.065	0.0072	0.0021	0.0026
1994.69	19601.0	6	339	7.8	0.8 0.3 1.4	8.258	0.0032	9.078	0.0042	0.0008	0.0010
1995.77	19994.5	9	352	0.9	1.3 0.6 3.6	8.268	0.0036	9.086	0.0034	0.0029	0.0027
1996.77	20362.5	4	4	-5.9	0.6 0.5 3.7	8.277	0.0030	9.101	0.0026	0.0030	0.0017
1997.88	20766.0	3	18	-13.2	1.7 5.6	8.273	0.0041	9.109	0.0041	0.0017	0.0041
1998.88	21131.0	7	31	-19.1	0.7 0.6 4.9	8.276	0.0027	9.106	0.0048	0.0023	0.0052
1999.86	21490.0	6	44	-24.3	1.9 0.3 1.1	8.278	0.0024	9.109	0.0038	0.0023	0.0036
2000.95	21888.2	5	58	-28.6	4.6 4.1 6.2	8.266	0.0034	9.108	0.0037	0.0054	0.0042
2001.90	22248.5	5	71	-31.0	4.4 1.9 4.4	8.253	0.0053	9.095	0.0020	0.0044	0.0029
2003.14	22688.7	3	88	-31.7	2.5 5.4	8.241	0.0022	9.078	0.0026	0.0047	0.0007
2004.13	23047.2	4	101	-30.2	2.1 6.0	8.239	0.0045	9.069	0.0064	0.0048	0.0071
2005.10	23406.8	6	115	-27.2	3.6 2.8 6.3	8.235	0.0072	9.062	0.0061	0.0029	0.0043
2006.21	23813.2	4	130	-22.0	3.0 6.5	8.252	0.0052	9.076	0.0066	0.0042	0.0026