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JPL/HORIZONS 4179 Toutatis (1989 AC) 2012-Dec-07 13:45:44  
Rec #: 4179 (+COV) Soln.date: 2012-Nov-26\_23:27:55 # obs: 4101 (1934-2012)

FK5/J2000.0 helio. ecliptic osc. elements (AU, DAYS, DEG, period=Julian yrs):

EPOCH= 2453640.5 ! 2005-Sep-27.00 (CT) Residual RMS= .31995  
EC= .6347615774831018 QR= .9214785889311118 TP= 2453305.082286603  
OM= 122.8634255600113 W= 280.0190838711387 IN= .4461442777116729  
A= 2.522950851066274 MA= 82.49485860693835 ADIST= 4.124423113201437  
PER= 4.00748 N= .245946637 ANGOM= .021113065  
DAN= 1.35659 DDN= 1.69341 L= 42.882807  
B= -.4393404 TP= 2004-Oct-26.5822866

Physical parameters (KM, SEC, rotational period in hours):

GM= n.a. RAD= 2.7 ROTPER= 176.  
H= 15.3 G= .100 B-V= n.a.  
ALBEDO= n.a. STYP= Sk

ASTEROID comments:

1: soln ref.= JPL#439, PHA OCC=0 radar(24 delay,28 Dop.)

2: source=ORB

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Ephemeris / WWW\_USER Fri Dec 7 13:45:44 2012 Pasadena, USA / Horizons  
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Target body name: 4179 Toutatis (1989 AC) {source: JPL#439}  
Center body name: Earth (399) {source: DE405}  
Center-site name: GEOCENTRIC

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Start time : A.D. 2012-Dec-07 00:00:00.0000 UT  
Stop time : A.D. 2013-Jan-06 00:00:00.0000 UT  
Step-size : 1440 minutes

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Target pole/equ : No model available  
Target radii : 2.7 km  
Center geodetic : 0.00000000,0.00000000,0.00000000 {E-lon(deg),Lat(deg),Alt(km)}  
Center cylindric: 0.00000000,0.00000000,0.00000000 {E-lon(deg),Dxy(km),Dz(km)}  
Center pole/equ : High-precision EOP model {East-longitude +}  
Center radii : 6378.1 x 6378.1 x 6356.8 km {Equator, meridian, pole}  
Target primary : Sun {source: DE405}  
Interfering body: MOON (Req= 1737.400) km {source: DE405}  
Deflecting body : Sun, EARTH {source: DE405}  
Deflecting Gms : 1.3271E+11, 3.9860E+05 km^3/s^2  
Small perturbers: Ceres, Pallas, Vesta {source: SB405-CPV-2}  
Small body Gms : 6.32E+01, 1.43E+01, 1.78E+01 km^3/s^2  
Atmos refraction: NO (AIRLESS)  
RA format : HMS  
Time format : CAL  
EOP file : eop.121206.p130227  
EOP coverage : DATA-BASED 1962-JAN-20 TO 2012-DEC-06. PREDICTS-> 2013-FEB-26  
Units conversion: 1 AU= 149597870.691 km, c= 299792.458 km/s, 1 day= 86400.0 s  
Table cut-offs 1: Elevation (-90.0deg=NO ),Airmass (>38.000=NO), Daylight (NO )  
Table cut-offs 2: Solar Elongation ( 0.0,180.0=NO )  
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Initial FK5/J2000.0 heliocentric ecliptic osculating elements (AU, DAYS, DEG):

EPOCH= 2453640.5 ! 2005-Sep-27.00 (CT) Residual RMS= .31995  
EC= .6347615774831018 QR= .9214785889311118 TP= 2453305.082286603  
OM= 122.8634255600113 W= 280.0190838711387 IN= .4461442777116729

Asteroid physical parameters (KM, SEC, rotational period in hours):

GM= n.a. RAD= 2.7 ROTPER= 176.  
H= 15.3 G= .100 B-V= n.a.  
ALBEDO= n.a. STYP= Sk

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Date\_\_(UT)\_\_HR:MN R.A.\_\_(ICRF/J2000.0)\_DEC APmag S-brt delta deldot S-O-T /r S-T-O

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2012-Dec-07 00:00	23 02 36.62	-12 34 12.5	12.40	6.91	0.05867441785557	-7.1949363	86.8509	/T	89.7334
2012-Dec-08 00:00	23 24 20.59	-10 40 39.3	12.09	6.82	0.05477623591912	-6.2692515	91.4796	/T	85.3419
2012-Dec-09 00:00	23 48 48.46	-08 24 19.7	11.77	6.73	0.05147282859861	-5.1317572	96.9048	/T	80.1424
2012-Dec-10 00:00	00 15 55.29	-05 44 41.7	11.46	6.62	0.04889124714730	-3.7700011	103.1183	/T	74.1431
2012-Dec-11 00:00	00 45 17.70	-02 44 38.5	11.17	6.50	0.04715755392546	-2.2023492	110.0117	/T	67.4519
2012-Dec-12 00:00	01 16 11.13	+00 28 36.9	10.92	6.37	0.04637536723740	-0.4889916	117.3567	/T	60.2971
2012-Dec-13 00:00	01 47 33.67	+03 44 15.4	10.73	6.24	0.04660205433297	1.2726936	124.8254	/T	53.0064
2012-Dec-14 00:00	02 18 17.14	+06 50 33.2	10.59	6.11	0.04783356700541	2.9728210	132.0591	/T	45.9383

2012-Dec-15 00:00	02 47 21.17	+09 38 08.5	10.51	5.98	0.05000669434877	4.5213068	138.7538	/T	39.3968
2012-Dec-16 00:00	03 14 03.57	+12 01 58.9	10.47	5.85	0.05301724202297	5.8679151	144.7160	/T	33.5752
2012-Dec-17 00:00	03 38 03.28	+14 01 14.6	10.48	5.74	0.05674388782372	7.0020894	149.8703	/T	28.5490
2012-Dec-18 00:00	03 59 17.10	+15 37 55.8	10.52	5.64	0.06106771154898	7.9401296	154.2306	/T	24.3041
2012-Dec-19 00:00	04 17 53.79	+16 55 21.5	10.58	5.55	0.06588343432053	8.7108375	157.8634	/T	20.7740
2012-Dec-20 00:00	04 34 08.36	+17 57 04.2	10.66	5.47	0.07110347855098	9.3454546	160.8573	/T	17.8702
2012-Dec-21 00:00	04 48 18.05	+18 46 17.2	10.75	5.41	0.07665767103463	9.8724653	163.3037	/T	15.5012
2012-Dec-22 00:00	05 00 39.85	+19 25 41.7	10.85	5.35	0.08249099131080	10.3157273	165.2872	/T	13.5825
2012-Dec-23 00:00	05 11 29.32	+19 57 26.6	10.96	5.31	0.08856080915826	10.6943489	166.8817	/T	12.0403
2012-Dec-24 00:00	05 21 00.09	+20 23 12.7	11.07	5.27	0.09483429462411	11.0232839	168.1495	/T	10.8123
2012-Dec-25 00:00	05 29 23.86	+20 44 17.4	11.18	5.25	0.10128624207875	11.3141116	169.1425	/T	9.8465
2012-Dec-26 00:00	05 36 50.47	+21 01 40.3	11.30	5.23	0.10789733833066	11.5757720	169.9033	/T	9.1004
2012-Dec-27 00:00	05 43 28.23	+21 16 07.3	11.42	5.22	0.11465282191206	11.8151794	170.4669	/T	8.5392
2012-Dec-28 00:00	05 49 24.08	+21 28 13.7	11.54	5.21	0.12154145894415	12.0377068	170.8619	/T	8.1341
2012-Dec-29 00:00	05 54 43.84	+21 38 26.9	11.67	5.21	0.12855476451123	12.2475551	171.1118	/T	7.8615
2012-Dec-30 00:00	05 59 32.38	+21 47 08.0	11.79	5.22	0.13568641017762	12.4480318	171.2363	/T	7.7020
2012-Dec-31 00:00	06 03 53.83	+21 54 34.0	11.91	5.23	0.14293177101196	12.6417591	171.2516	/T	7.6391
2013-Jan-01 00:00	06 07 51.67	+22 00 58.0	12.04	5.25	0.15028757671179	12.8308287	171.1716	/T	7.6590
2013-Jan-02 00:00	06 11 28.87	+22 06 30.5	12.16	5.26	0.15775164040726	13.0169180	171.0081	/T	7.7499
2013-Jan-03 00:00	06 14 47.96	+22 11 19.9	12.28	5.28	0.16532264553837	13.2013763	170.7714	/T	7.9018
2013-Jan-04 00:00	06 17 51.11	+22 15 32.9	12.41	5.31	0.17299997613896	13.3852900	170.4701	/T	8.1060
2013-Jan-05 00:00	06 20 40.21	+22 19 15.1	12.53	5.33	0.18078357917018	13.5695291	170.1120	/T	8.3548
2013-Jan-06 00:00	06 23 16.88	+22 22 30.7	12.65	5.36	0.18867384969097	13.7547799	169.7037	/T	8.6418

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Column meaning:

TIME

Prior to 1962, times are UT1. Dates thereafter are UTC. Any 'b' symbol in the 1st-column denotes a B.C. date. First-column blank (" ") denotes an A.D. date. Calendar dates prior to 1582-Oct-15 are in the Julian calendar system. Later calendar dates are in the Gregorian system.

Time tags refer to the same instant throughout the universe, regardless of where the observer is located.

The uniform Coordinate Time scale is used internally. It is equivalent to the current IAU definition of "TDB". Conversion between CT and the selected non-uniform UT output scale has not been determined for UTC times after the next July or January 1st. The last known leap-second is used over any future interval.

NOTE: "n.a." in output means quantity "not available" at the print-time.

R.A.\_(ICRF/J2000.0)\_DEC =

J2000.0 astrometric right ascension and declination of target center. Corrected for light-time. Units: HMS (HH MM SS.ff) and DMS (DD MM SS.f)

APmag S-brt =

Asteroid's approximate apparent visual magnitude & surface brightness:  
 $APmag = H + 5 \cdot \log_{10}(\delta) + 5 \cdot \log_{10}(r) - 2.5 \cdot \log_{10}((1-G) \cdot \phi_1 + G \cdot \phi_2)$   
 In principle, accurate to  $\sim \pm 0.1$  magnitude. For solar phase angles  $> 90^\circ$ , the error could exceed 1 magnitude. No values are output for phase angles greater than 120 degrees, since the errors could be large and unknown.  
 Units: NONE & VISUAL MAGNITUDES PER SQUARE ARCSECOND

delta deldot =

Range ("delta") and range-rate ("delta-dot") of target center with respect to the observer at the instant light seen by the observer at print-time would have left the target center (print-time minus down-leg light-time); the distance traveled by a light ray emanating from the center of the target and recorded by the observer at print-time. "deldot" is a projection of the velocity vector along this ray, the light-time-corrected line-of-sight from the coordinate center, and indicates relative motion. A positive "deldot" means the target center is moving away from the observer (coordinate center). A negative "deldot" means the target center is moving toward the observer.  
 Units: AU and KM/S

S-0-T /r =

Sun-Observer-Target angle; target's apparent solar elongation seen from observer location at print-time. If negative, the target center is behind the Sun. Angular units: DEGREES.

The '/r' column is a Sun-relative code, output for observing sites with defined rotation models only.

/T indicates target trails Sun (evening sky)

/L indicates target leads Sun (morning sky)

NOTE: The S-O-T solar elongation angle is the total separation in any direction. It does not indicate the angle of Sun leading or trailing.

S-T-O =

Sun-Target-Observer (~ PHASE ANGLE) angle: the vertex angle at target center formed by a vector to the apparent center of the Sun and a vector intersecting the observer at print-time. This measurable angle is within 20 arcseconds (0.006 deg) of the reduced PHASE ANGLE at observer's location at print time. The difference is due to down-leg stellar aberration affecting measured target position but not apparent solar illumination direction. When computing phase, Horizons uses the true phase angle, not S-T-O, but the resulting difference in illuminated fraction is less than 0.001%.

Units: DEGREES

Computations by ...

Solar System Dynamics Group, Horizons On-Line Ephemeris System

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