IUE Orbital Elements V

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This article extends the previous lists of IUE orbital elements through February 1991. These elements may be used to derive radial velocity corrections as discussed by Jenkins (1979), Harvel (1980) and Schiffer (1982).

Table 1 is the list of orbital elements. Each epoch is given as year, month, and day of the orbit determination in the format YYMMDD, for 00:00 GMT. The semi-major axis a is given in kilometers. The orbital period P in minutes may be found from the equation

$$P = 1.6586 \times 10^{-4} a^{3/2}$$

The inclination, longitude of the ascending node, argument of perigee, and mean anomaly are all given in degrees.

The orbit of IUE is continually changing due to the equatorial bulge and other anomalies in the Earth's gravitational field, as well as various celestial influences. For this reason the orbital elements also change and are updated frequently. In addition, the satellite must be kept within the field of view of the receiving antennae, both at Goddard Space Flight Center and at Villafranca, Spain. When the spacecraft drifts too far west, the orbit is corrected using the large hydrazine jets. This corrective maneuver ('delta V') causes the spacecraft drift to reverse direction and drift eastward for some time. The changes in the drift direction represent discontinuities in the orbital elements, particularly the semi-major axis. Table 1 includes the dates of delta V maneuvers. When deriving radial velocity corrections, caution should be taken in interpolating values near the times of these discontinuities in order to ensure accurate results. Table 2 lists the dates (YYMMDD) and GMT times at which the corrective maneuvers were performed.

As of 8 July 1983 at GSFC, the orbital elements have been recorded in line 83 of the Image Header. These are the most current orbital elements for the observation date, as used in the ground command computer. The format is the following: epoch of the orbit (first Julian date, then seconds), semi-major axis (kilometers), eccentricity, inclination (degrees), longitude of

Table 1: IUE Orbital Elements

Epoch (yymmdd)	Semi-Major Axis (kilometers)	Eccentricity	Inclination (degrees)	Ascending Node (longitude)	Arg. of Perigee (degrees)	Mean Anomaly (degrees)
890525	42164.3	0.1569216	31.664	125.673	343.142	083.094
890607	42165.0	0.1568022	31.704	125.436	343.524	095.648
890619	42166.7	0.1565893	31.742	125.232	343.841	107.101
890703	42167.8	0.1563205	31.782	124.999	344.292	120.156
890715	42169.2	0.1558922	31.805	124.819	344.650	131.198
890728	42170.7	0.1553940	31.833	124.603	345.062	142.970
890809	42170.8	0.1548340	31.852	124.445	345.427	153.653
890828	42173.6	0.1540185	31.885	124.145	345.965	170.389
890830	42173.3	0.1539002	31.885	124.106	346.021	172.068
890907	delta V					
890910	42156.1	0.1531662	31.883	123.921	346.121	182.094
890919	42156.2	0.1526950	31.871	123.765	346.310	191.969
890929	42157.2	0.1523298	31.882	123.605	346.552	202.847
891011	42159.6	0.1519458	31.891	123.380	346.792	215.862
891025	42159.7	0.1516583	31.893	123.109	347.080	230.858
891107	42161.3	0.1514773	31.913	122.855	347.341	244.655
891119	42160.4	0.1513916	31.936	122.611	347.669	257.179
891201	42161.0	0.1513674	31.965	122.381	347.903	269.619
891226	42163.1	0.1510318	32.042	121.949	348.579	294.825
900109	42162.1	0.1507207	32.096	121.734	349.052	308.612
900119	42165.1	0.1503437	32.111	121.606	349.293	318.302
900202	42166.3	0.1497860	32.142	121.383	349.710	331.790
900213	42167.2	0.1494062	32.148	121.241	350.038	342.191
900227	42168.7	0.1487444	32.165	121.025	350.422	355.357
900312	42170.2	0.1483677	32.163	120.807	350.720	007.458
900324	42171.6	0.1480243	32.173	120.588	350.990	018.533
900405	42172.8	0.1478054	32.164	120.359	351.239	029.482
900419	42172.7	0.1475585	32.179	120.093	351.508	042.133
900501	42173.0	0.1474943	32.196	119.851	351.761	052.780
900512	42173.4	0.1473590	32.197	119.630	351.977	062.456
900525	42174.4	0.1473227	32.232	119.395	352.319	073.617
900606	delta V					
900607	42155.1	0.1468311	32.273	119.187	352.752	084.562
900620	42156.8	0.1466761	32.308	118.965	353.168	098.662
900703	42159.1	0.1464993	32.361	118.752	353.562	112.532
900716	42158.8	0.1461197	32.376	118.557	354.046	126.181
900809	42159.6	0.1453399	32.429	118.223	354.864	150.913
900822	42161.7	0.1448666	32.445	118.006	355.269	164.140
900905	42163.1	0.1442233	32.452	117.792	355.652	178.255
900923	42164.4	0.1435475	32.443	117.465	356.915	196.117
900929	42166.2	0.1434109	32.451	117.364	356.228	202.141
901012	42167.3	0.1430887	32.458	117.123	356.543	214.837
901025	42166.9	0.1428251	32.467	116.871	356.796	227.458
901106	42167.2	0.1427130	32.479	116.634	357.078	238.903
901120	42167.8	0.1426017	32.510	116.379	357.388	252.077
901201	42168.8	0.1425084	32.536	116.184	357.669	262.228
901213	42170.2	0.1424142	32.570	115.991	358.034	273.094
901226	42171.3	0.1422346	32.615	115.789	358.426	284.677
910112	delta V					
910113	42153.0	0.1425934	32.667	115.510	359.022	300.479
910121	42153.6	0.1422272	32.684	115.403	359.348	309.204
910202	42154.4	0.1419511	32.715	115.228	359.768	322.289
910215	42156.4	0.1415411	32.731	115.031	000.143	336.385
910227	42159.0	0.1412490	32.736	114.834	000.488	349.277
910311	42160.3	0.1408717	32.734	114.631	000.735	002.136

Table 2: IUE Orbit Corrective Maneuvers

Date	Time (GMT)	Date	Time (GMT)
780214	01:55:00 ± 8 min	850718	18:05:30 ± 1 sec
780724	16:34:04 ± 1 sec	850809	06:25:30 ± 1 sec
790620	18:37:10 ± 1 sec	860319	06:20:56 ± 1 sec
800213	02:16:01 ± 1 sec	860729	06:22:15 ± 1 sec
800624	16:34:59 ± 1 sec	861218	06:45:12 ± 1 sec
801216	06:10:02 ± 1 sec	870909	05:29:35 ± 1 sec
811029	09:24:47 ± 1 sec	880318	06:15:00 ± 1 min
820817	13:53:44 ± 1 sec	880908	05:00:05 ± 1 sec
830527	19:07:28 ± 1 sec	890313	06:12:54 ± 1 sec
840112	03:41:09 ± 1 sec	890907	15:01:00 ± 1 min
840214	20:00:00 ± 1 sec	900606	17:10:56 ± 1 sec
841116	02:05:20 ± 1 sec	910112	16:49:00 ± 1 min

the ascending node (degrees), and mean anomaly (degrees). For all of these elements except the epoch, 8 characters are recorded in floating point format with no delineations between the elements. An example is given in Figure 1. These values may be easily extracted from the Header using the IUERDAF experimental library routine ORBEL.

Plots of the orbital elements over the lifetime of IUE are shown in Figures 2–7. The semi-major axis tends to increase with time, but is kept within acceptable limits by periodic maneuvers, shown as dashed lines. The eccentricity is decreasing with time, that is, the orbit is becoming more circular. The inclination is increasing. Both the eccentricity and inclination show periodic oscillations; these 'wobbles' do not correlate with the delta V times, but appear to be biannual. The ascending node, argument of perigee, and mean anomaly are all nearly linear. The argument of perigee may also show some hint of the biannual wobble.

Figure 1: Orbital Elements in Line 83 of the Image Header

```
  A1 ca   "                ?   ?              +                  79  C
 1    I                                                          80  C
 1         !              !                  *                  81  C
|                                                                82  C
 2446525.5      .0 42163.2 .189408 30.0087146.3926318.5515 32.211  83  C
109082424 1321546+4938 8  626 6 109090327  629298+ 45137 80 551    84  C
109094606  631119+ 43353 795823 109153508  632135+11 953 821317    85  C
     ^    e                A1 ca   ""        /           2A       86  C
          e -  -           QD3so  RF   G?G G '/          1B       87  C
```

A complete list of the orbital elements is available by electronic mail from (SPAN) IUESOC::IUEMAIL.

References

[1] Broude, S. M. and Bradley, R. E. 1984, *NASA IUE Newsletter*, **24**, 131.

[2] Ehlers, R. 1981, *NASA IUE Newsletter*, **14**, 100.

[3] Fireman, G. F. 1989, *NASA IUE Newsletter*, **40**, 30.

[4] Jenkins, E. B. 1979, *NASA IUE Newsletter*, **5**, 23.

[5] Harvel, C. 1980, *NASA IUE Newsletter*, **10**, 32.

[6] Imhoff, C. L. and Butchsky, M. T. 1985, *NASA IUE Newsletter*, **26**, 42.

[7] Schiffer, F. H. III 1982, *Data Analysis Procedures for the IUE RDAF (Part I)*, 3-8.

[8] Turnrose, B. E. and Thompson, R. W. 1984, *IUE Image Processing Information Manual*, 9-4.

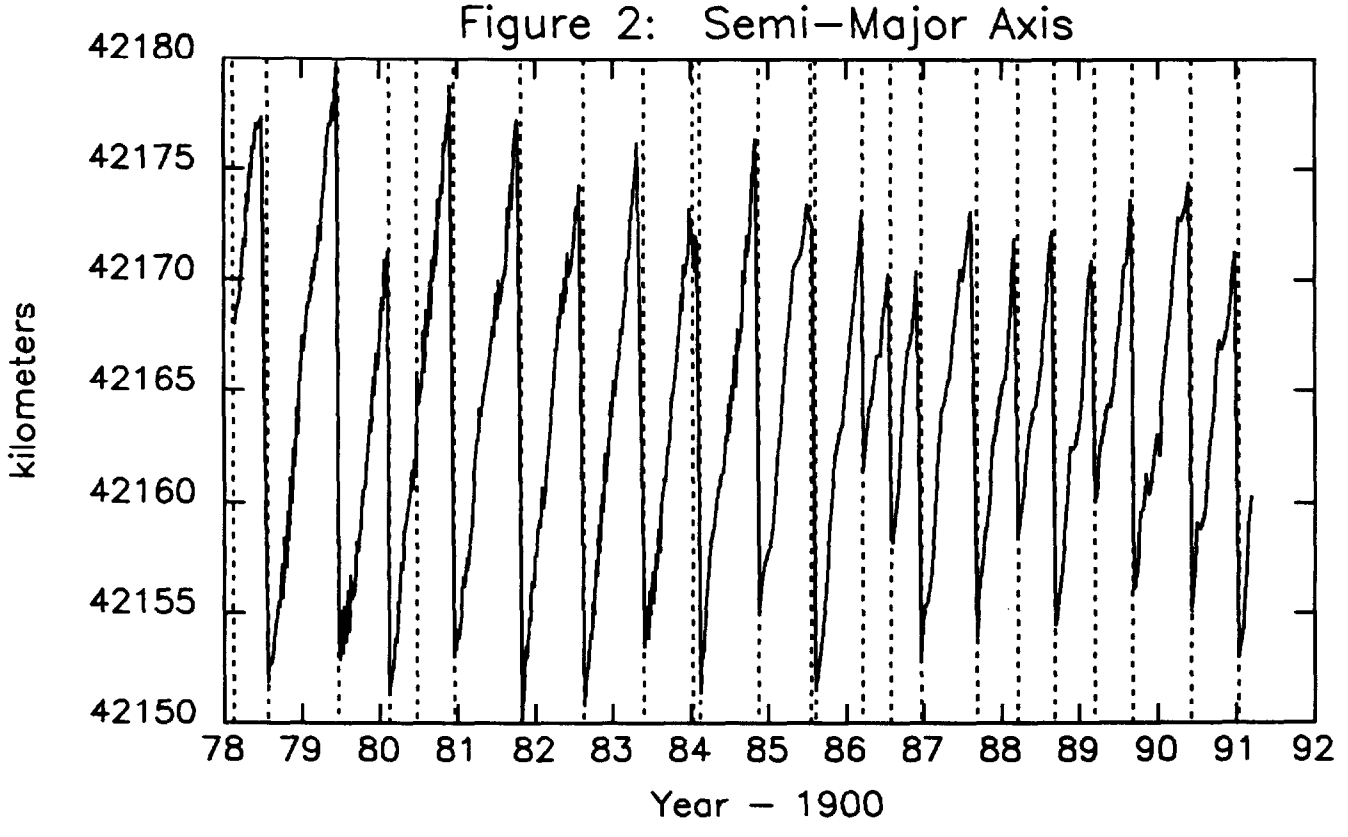

Figure 3: Eccentricity

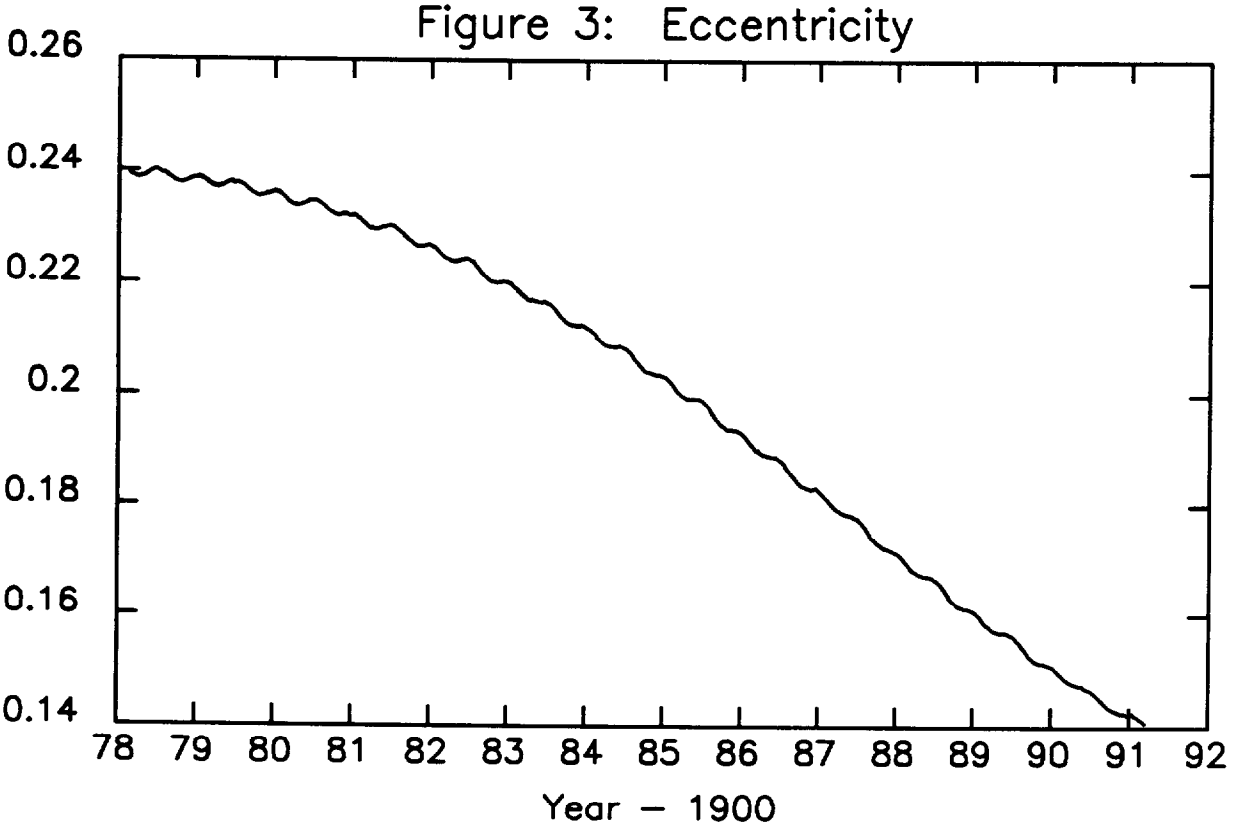

Figure 4: Inclination

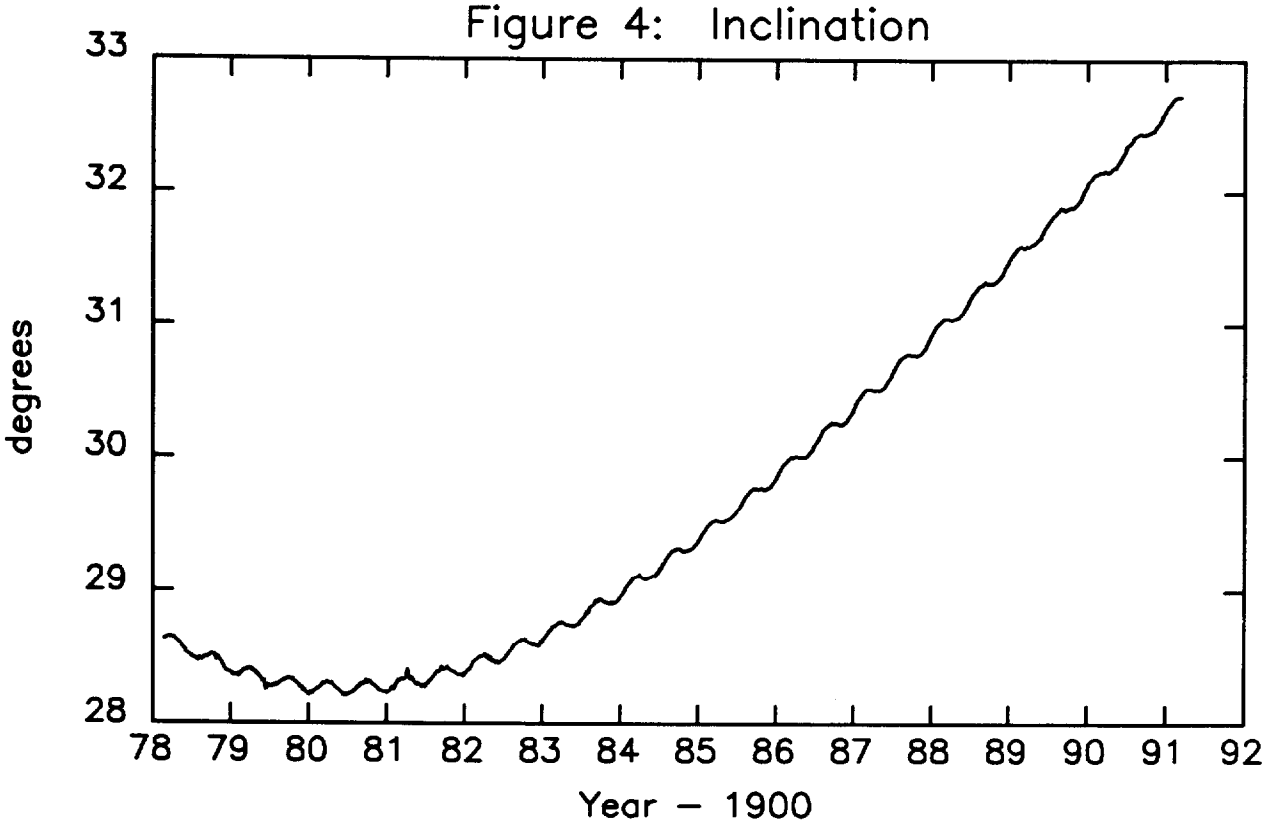

Figure 5: Ascending Node

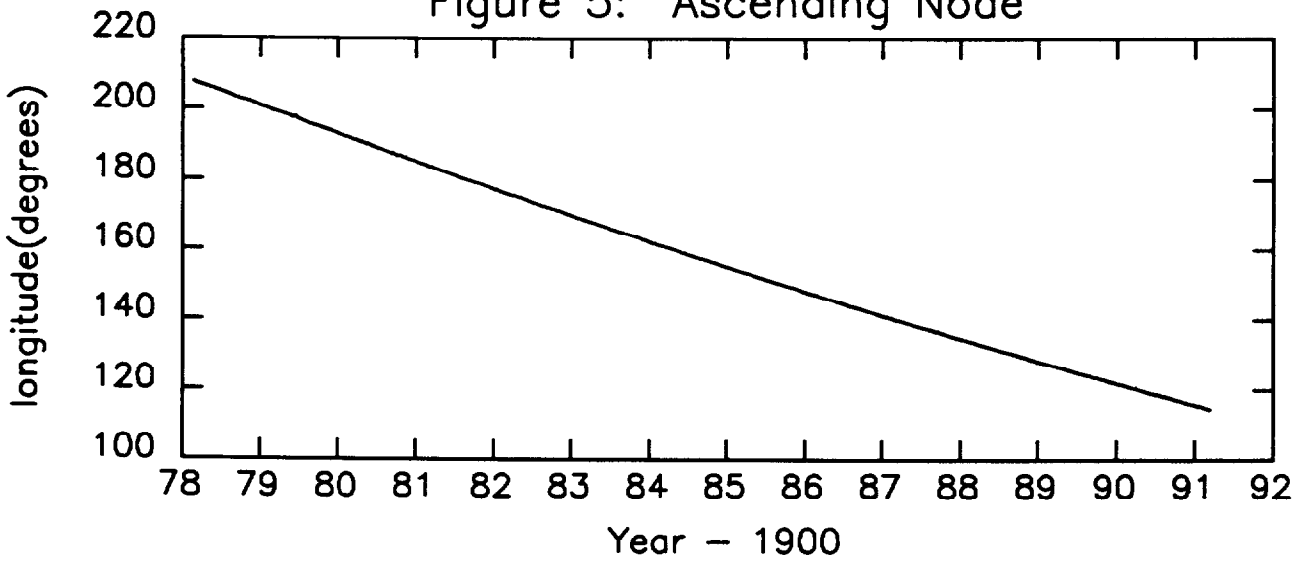

Figure 6: Argument of Perigee

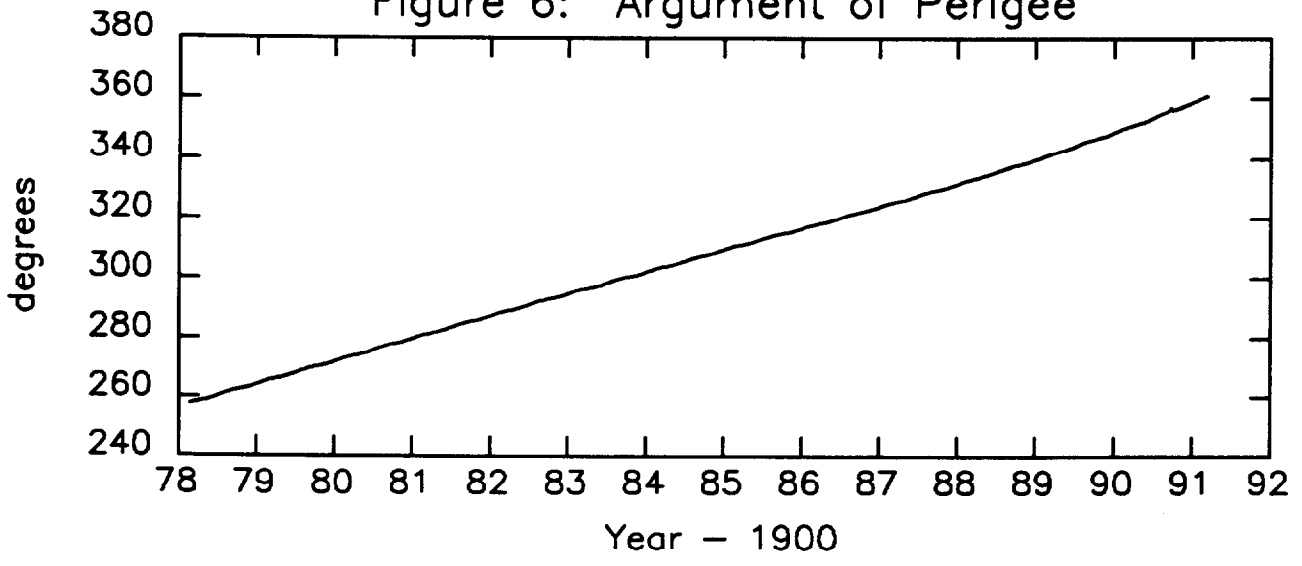

Figure 7: Mean Anomaly