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Trajectories of Pioneers 6-11, Helios A and B, and Voyagers 1 and 2

R. Parthasarathy, H. K. Hills,
D. A. Couzens, J. H. King

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NSSDC/WDC-A-R&S 86-03

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by

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February 1986

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National Aeronautics and Space Administration
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Greenbelt, Maryland 20771

PREFACE

Several earlier publications have provided trajectories of high-apogee (>15 earth radii) spacecraft in Geocentric Solar Ecliptic (GSE) and/or Geocentric Solar Magnetospheric (GSM) coordinates (Behannon et al., 1970; Fairfield et al., 1973; King and Teague, 1976; Sullivan et al., 1981). This publication extends the series and provides trajectories of heliocentric spacecraft, Pioneers 6-9 and Helios A and B, and the deepspace probes, Pioneers 10 and 11 and Voyagers 1 and 2.

All the plotted trajectories are from launch date to 1 January 1990, except those of Pioneers 7 and 8, and Helios B, for which the trajectories span the operational years. All but the last four figures (pp. 62-65) are plots of ecliptic plane projections of the trajectories, with a fixed earth and with the sun at the center. The dashed circles provide the distance from the sun in A.U. At the top of each figure are shown the start and end times of the trajectories, in year/month/UT hour. Along the trajectories are marked a few day numbers (one or more per year), sometimes accompanied by the year as well. Linear interpolation between these marks should provide the spacecraft coordinates on any day, with an error of less than 5%.

In the figure on page 62 are plotted the trajectories of Pioneers 10 and 11, and Voyagers 1 and 2 for the years 1981 through 1989, in sun-centered, ecliptic plane inertial coordinates (i.e., range from sun versus ecliptic longitude). The arrow marked Solar Motion is the projection of the direction of motion of the sun through the interstellar medium. The next figure provides, in the same coordinate system, the trajectories of Comet Halley, Helios A, Pioneers 6 and 9, and the planets Mercury, Venus and Earth, for about 40 days either side of Halley's expected perihelion passage. Day marks are inserted along the trajectories. The last two figures in the publication are the plots of time versus heliographic latitude of the deepspace probes Pioneers 10 and 11, and Voyagers 1 and 2. Marked along the trajectories are the sun-probe ranges in A.U. The small perturbation of the Voyager 2 curve during 1986 is due to the proximity of Uranus.

All the spacecraft except Pioneers 7 and 8, and Helios B are fully or partially operational, and carry a complement of instruments that are briefly described in *Report on Active and Planned Spacecraft and Experiments* (RAPSE), February 1985 (NSSDC/WDC-A-R&S 85-01). For Pioneers 7 and 8, and Helios B, see RAPSE, August 1978 (NSSDC/WDC-A-R&S 78-04).

Acknowledgments: We wish to thank our colleagues S. G. Doyle and C. M. Wong for their assistance in producing the plots. The elements used in computing the trajectories were supplied to us by the NASA/AMES Research Center and the Jet Propulsion Laboratory.

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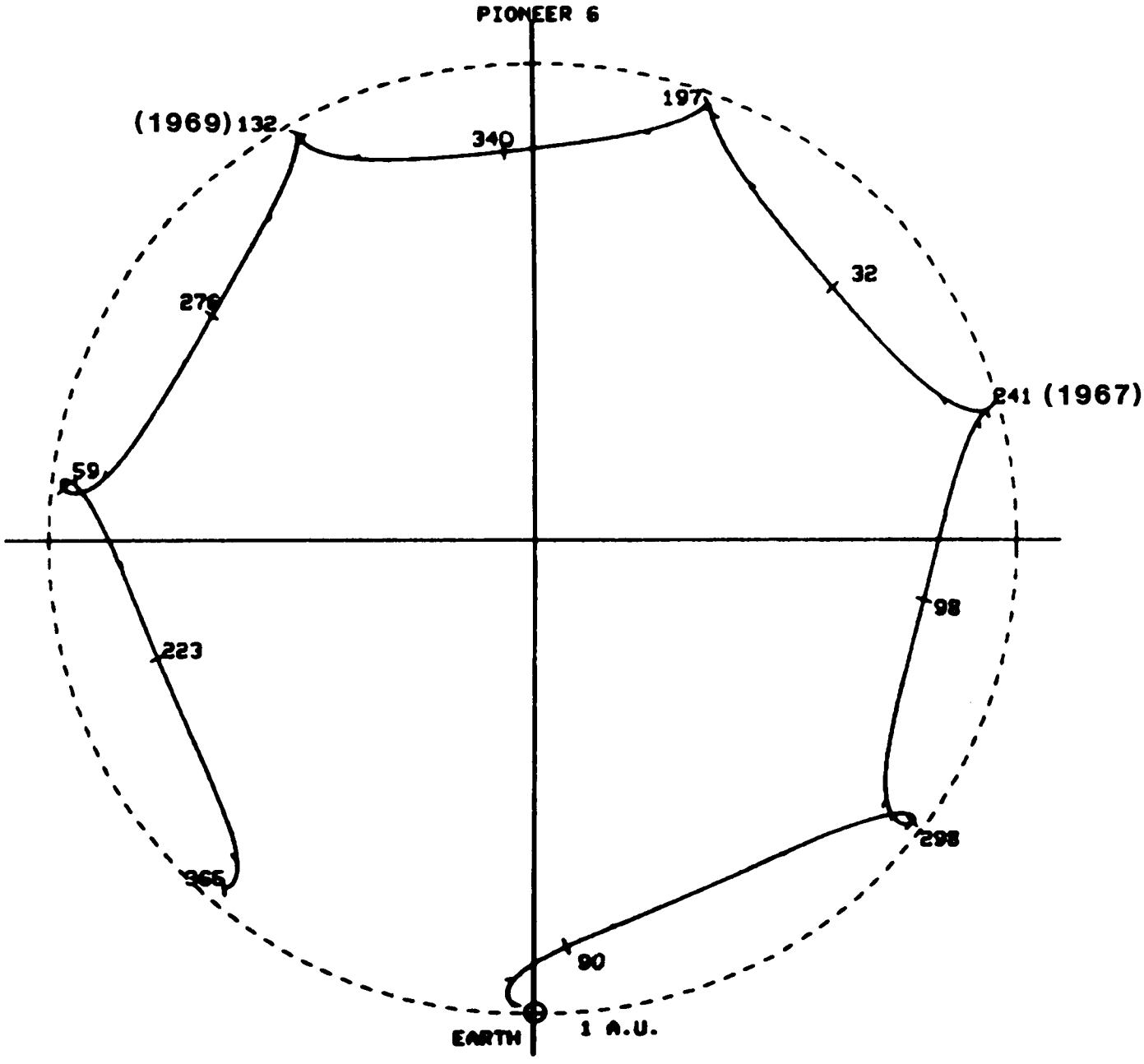

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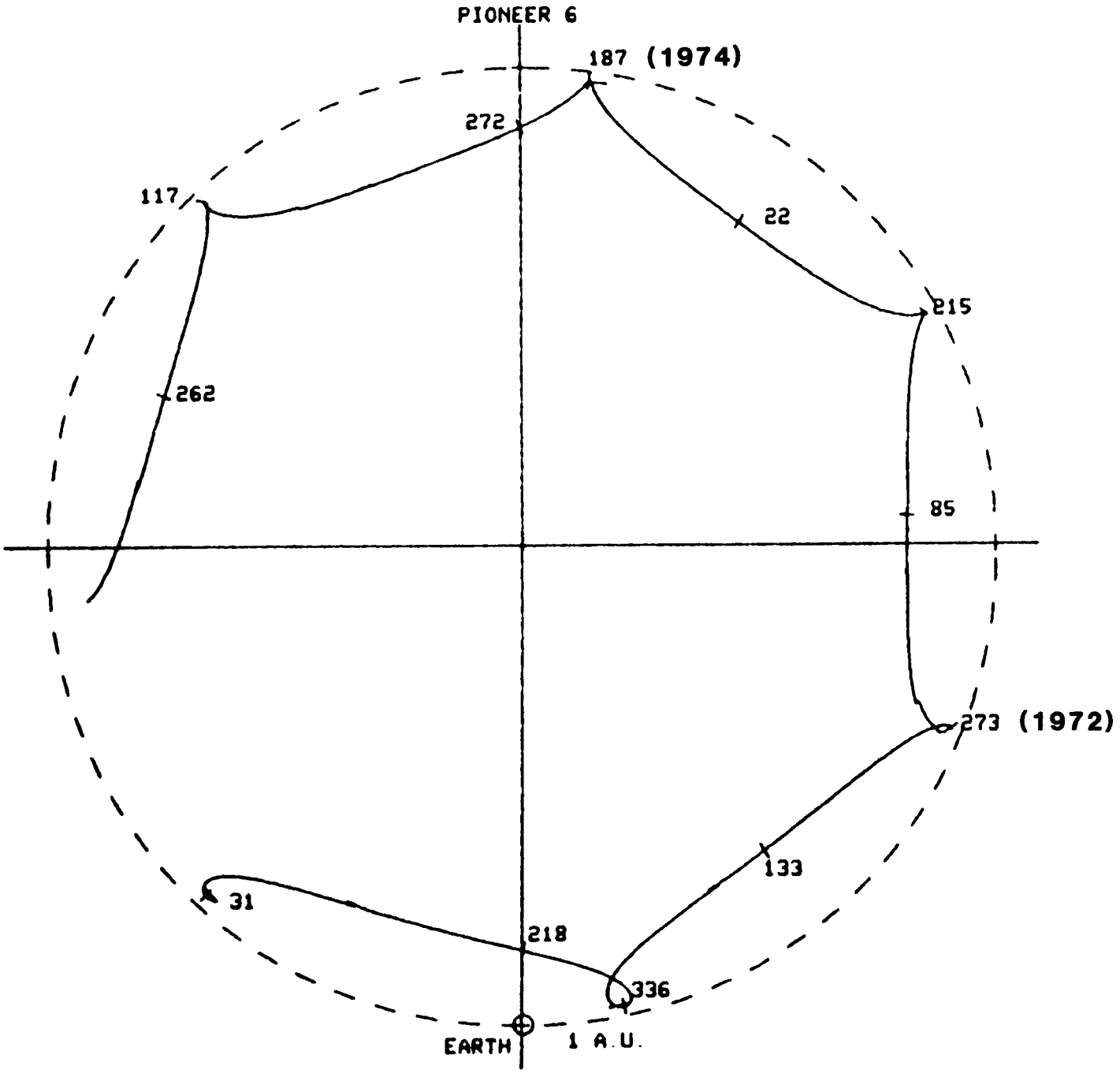

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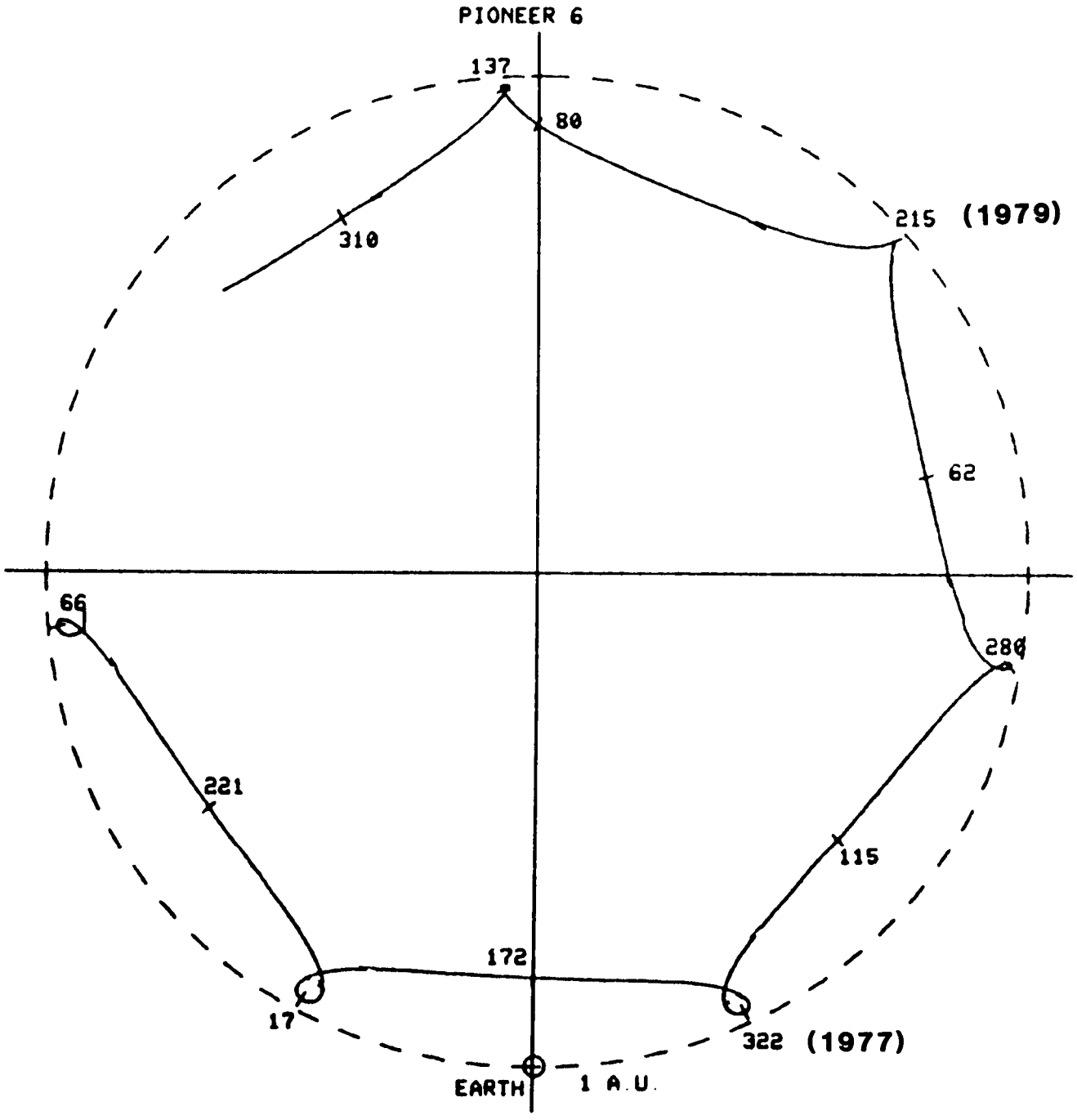

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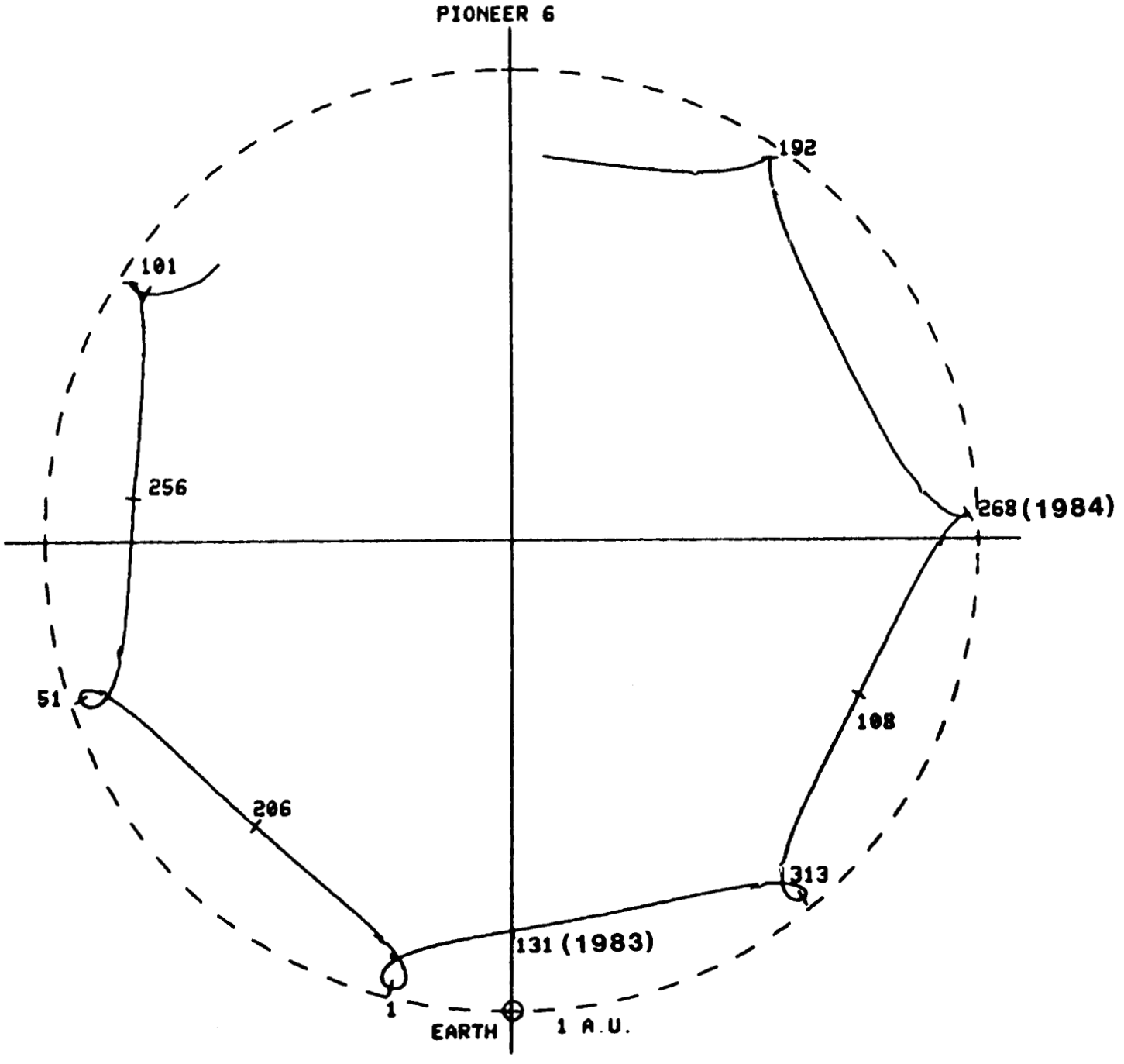

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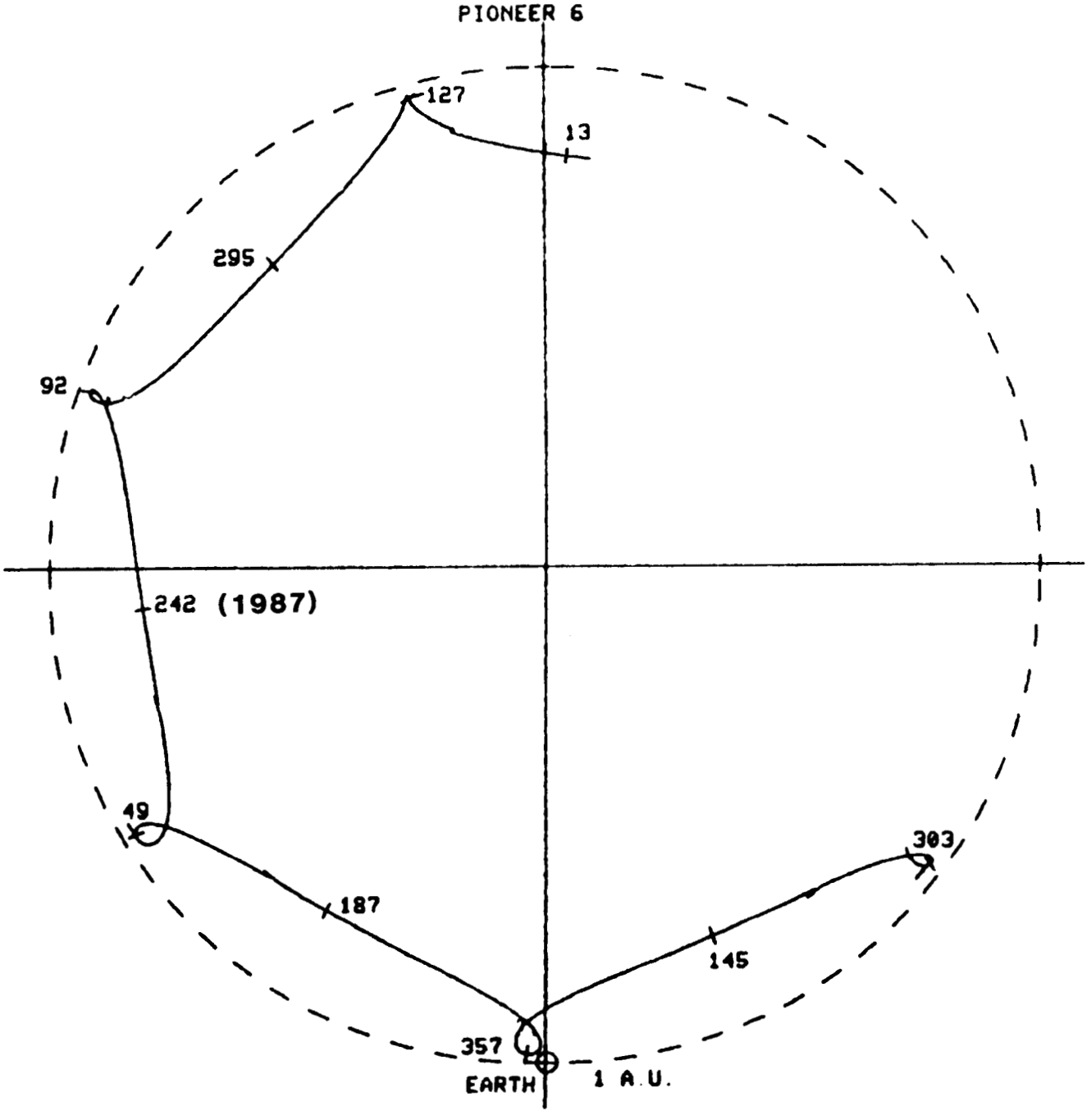

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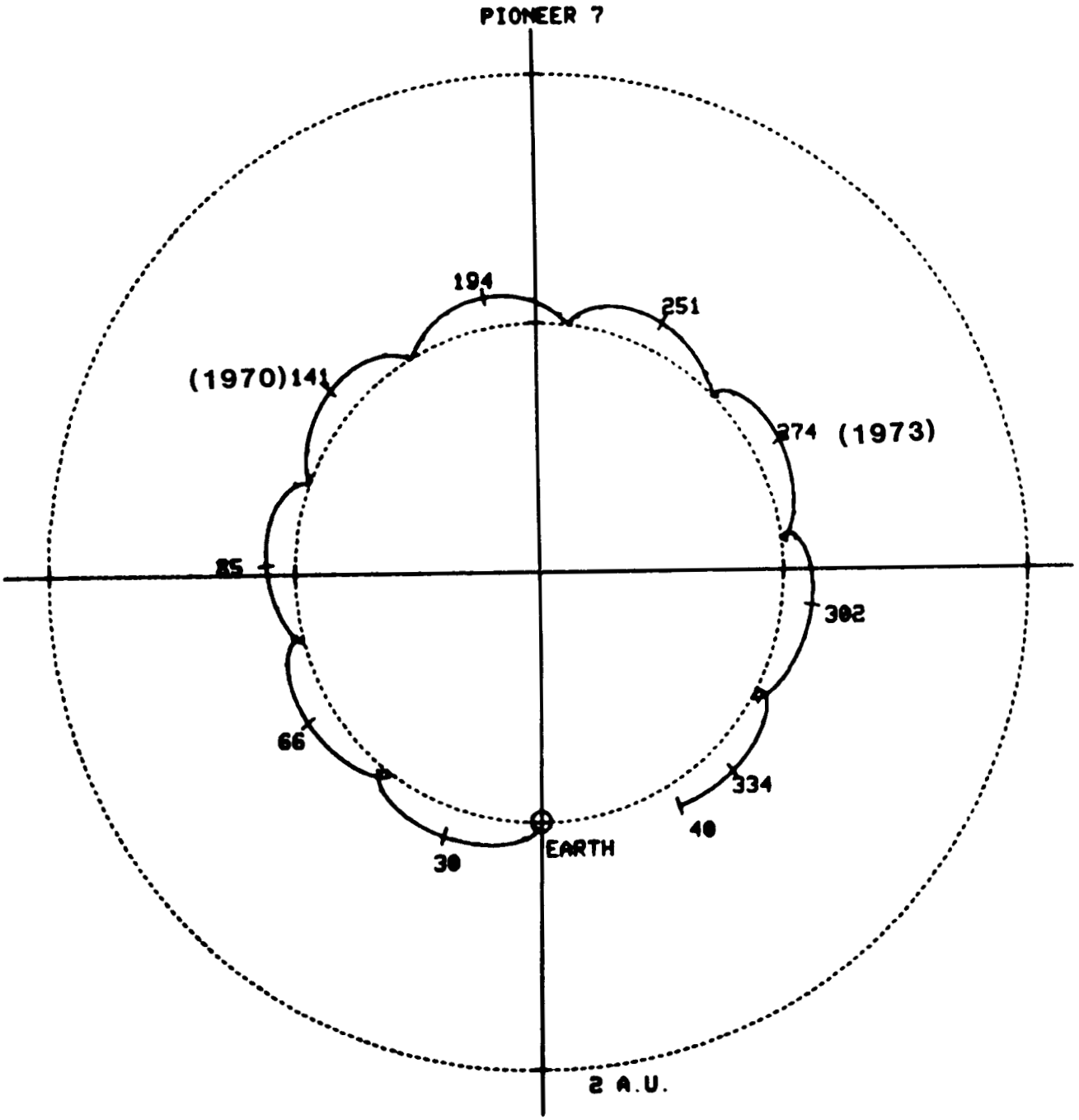

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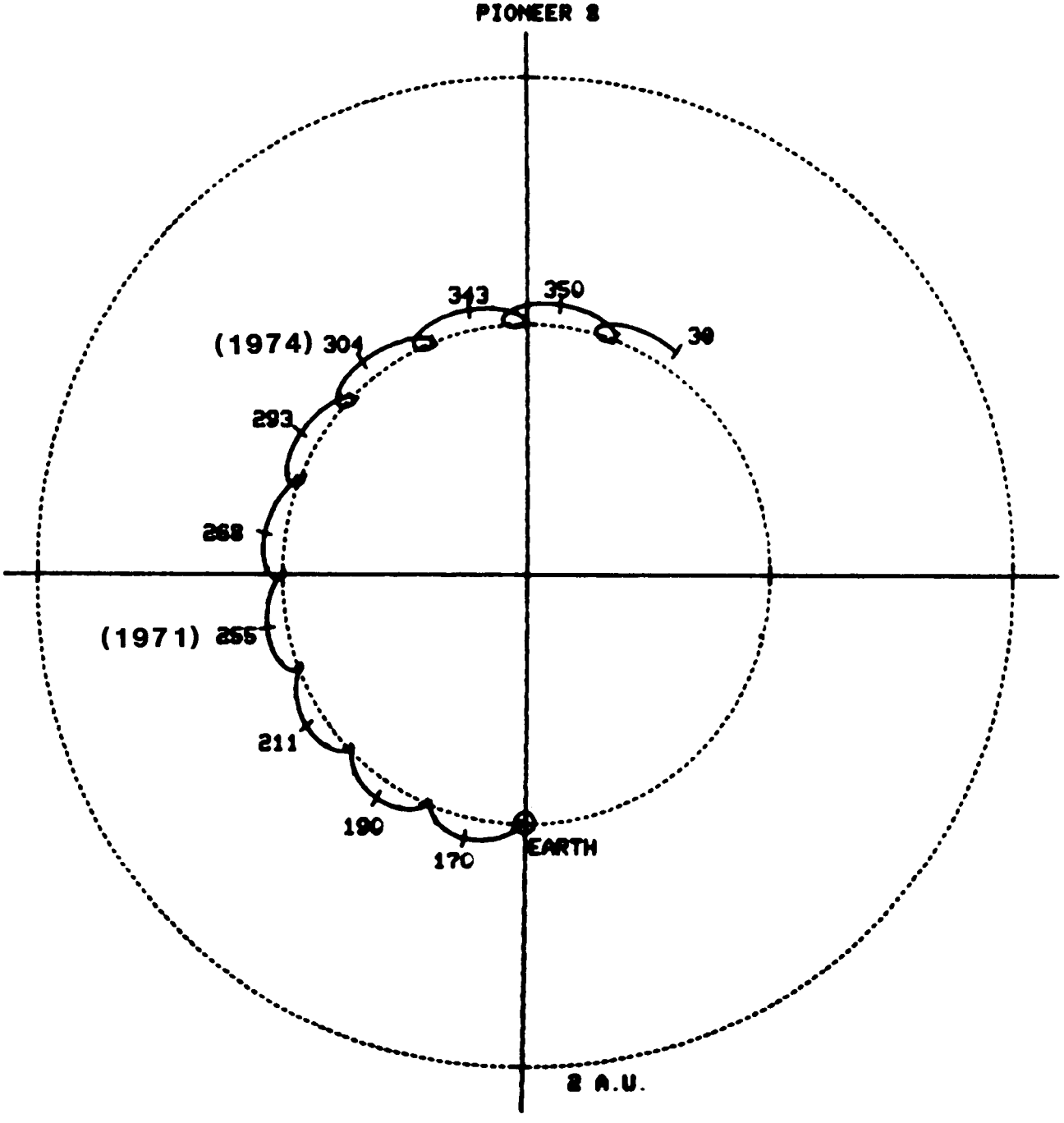

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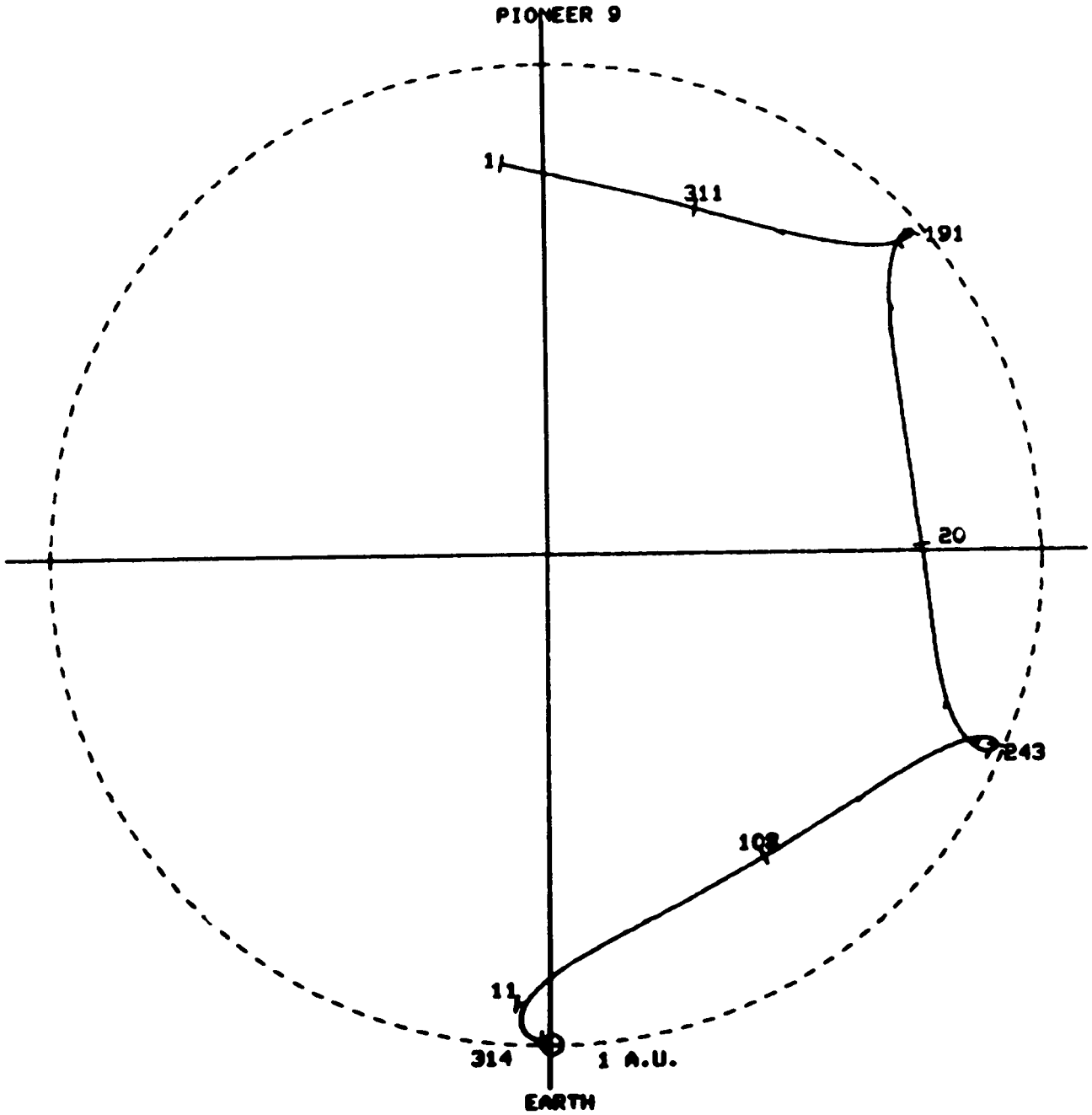

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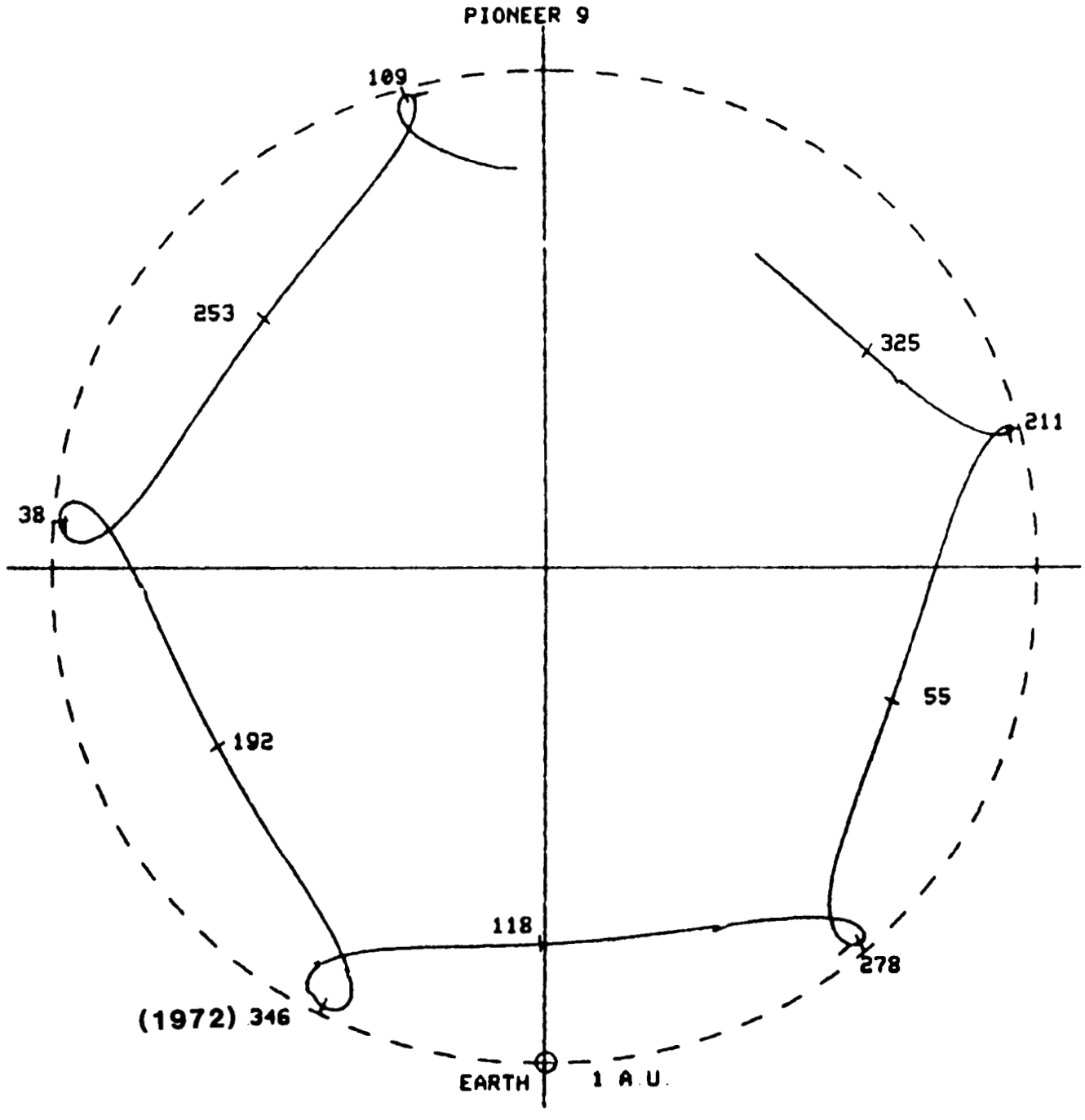

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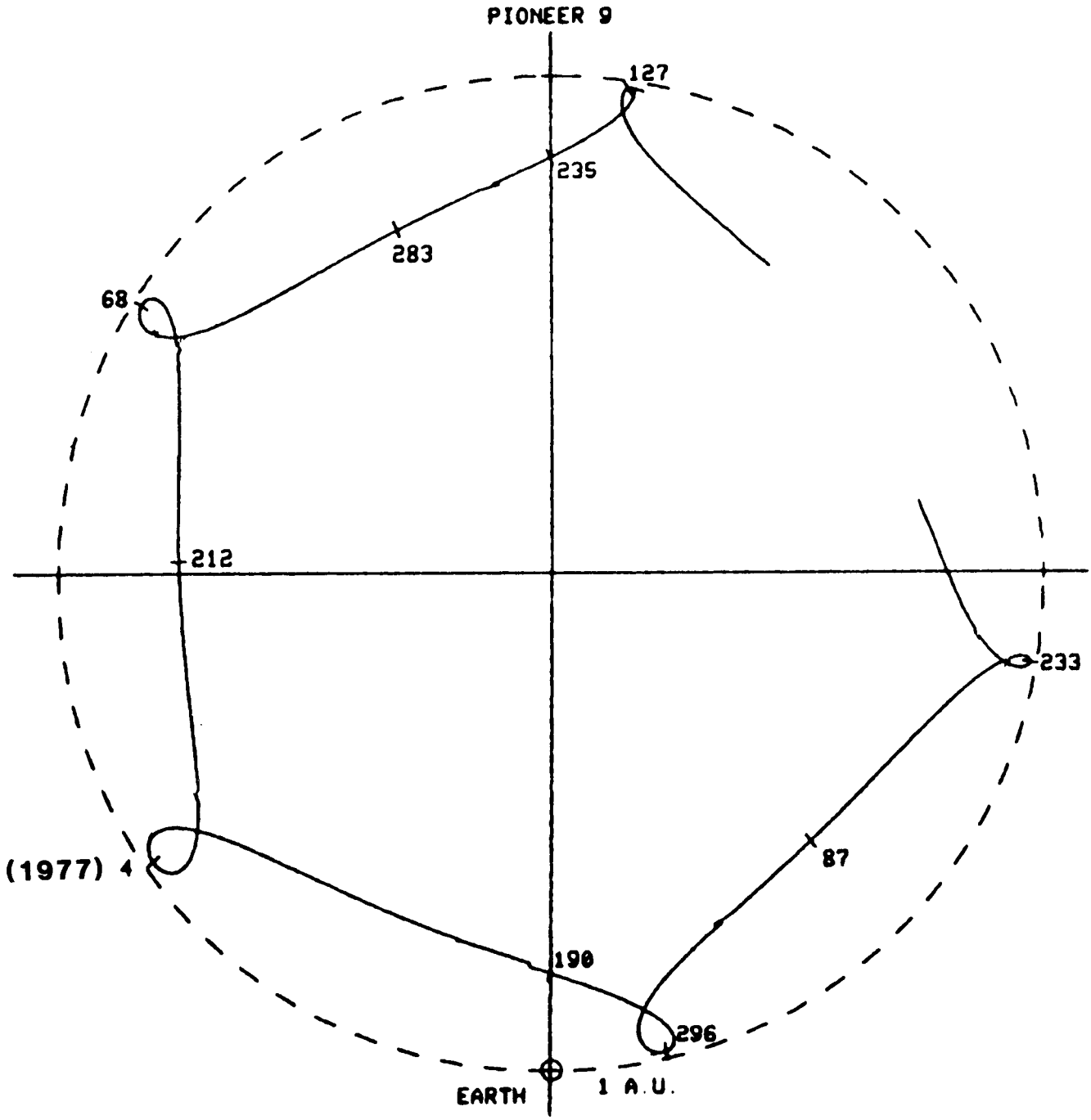

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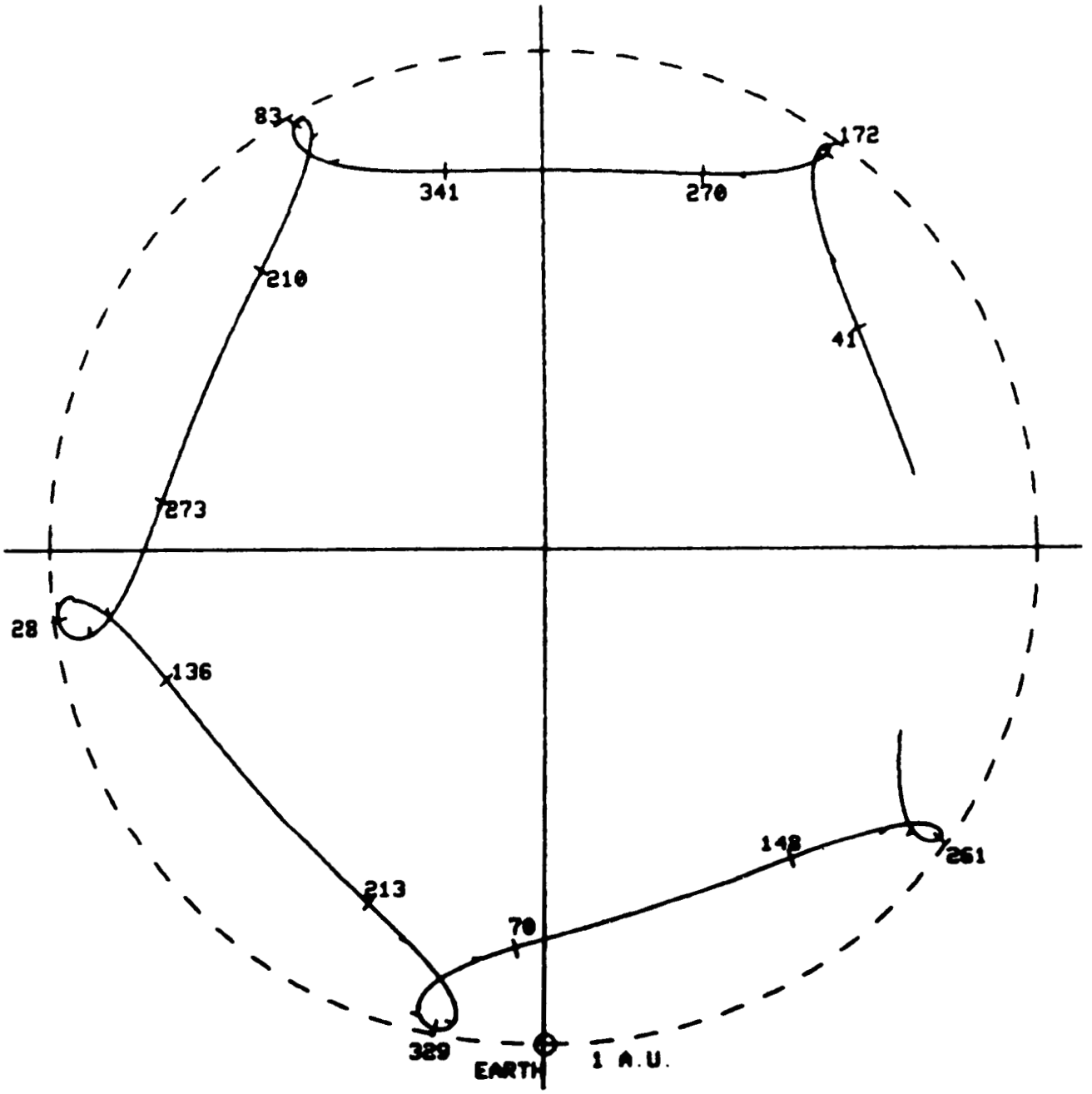
PIONEER 9



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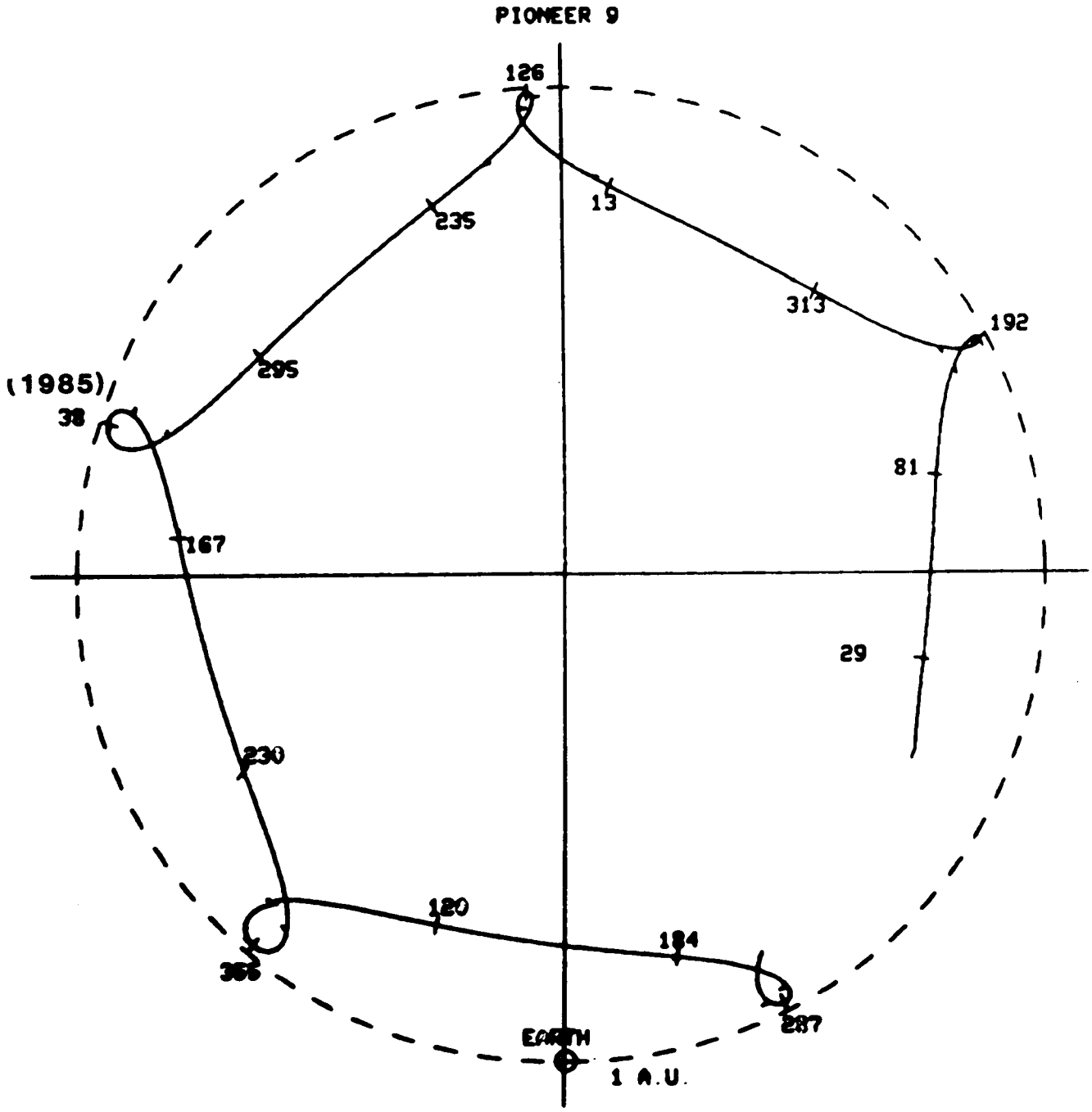

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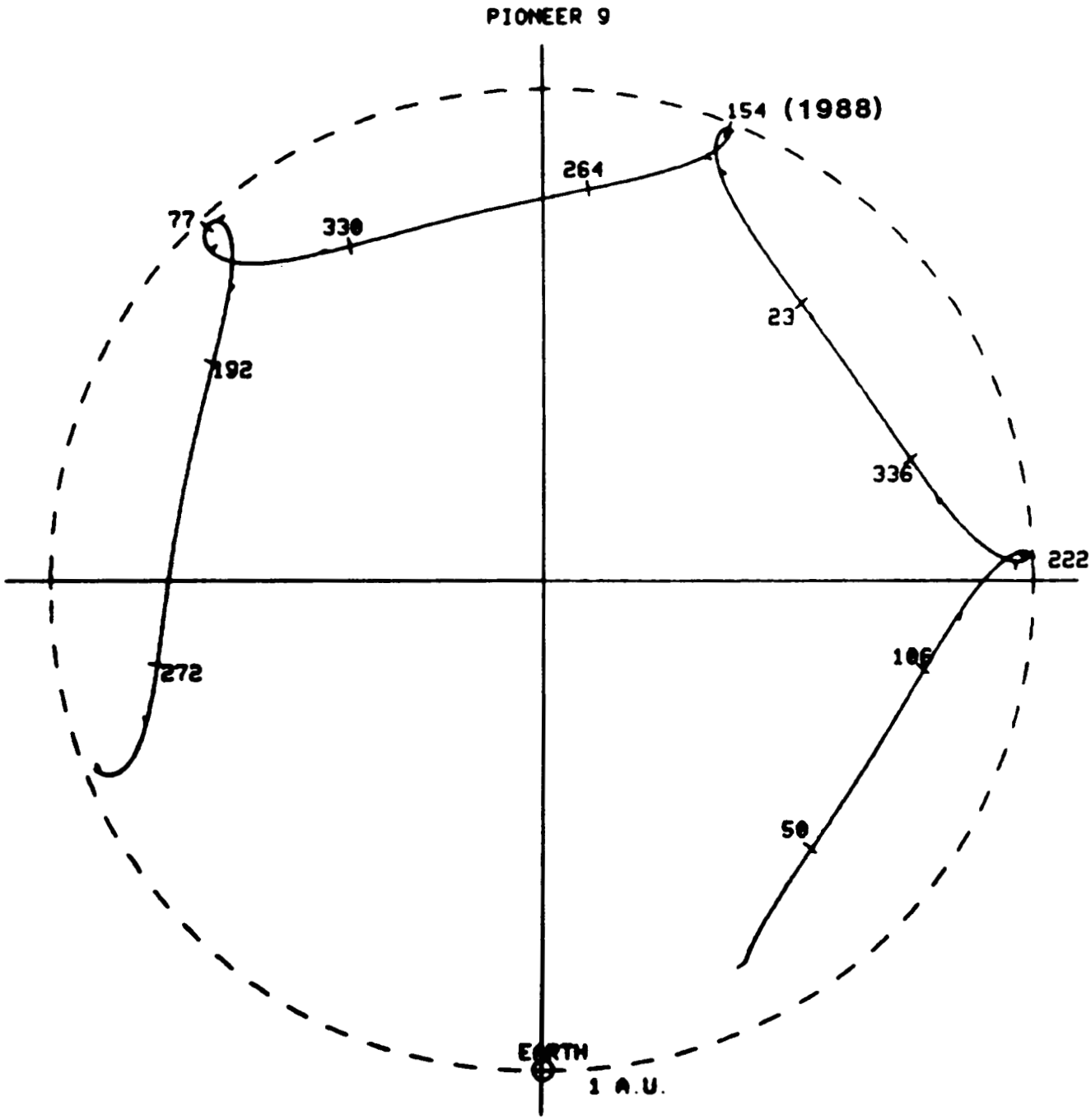

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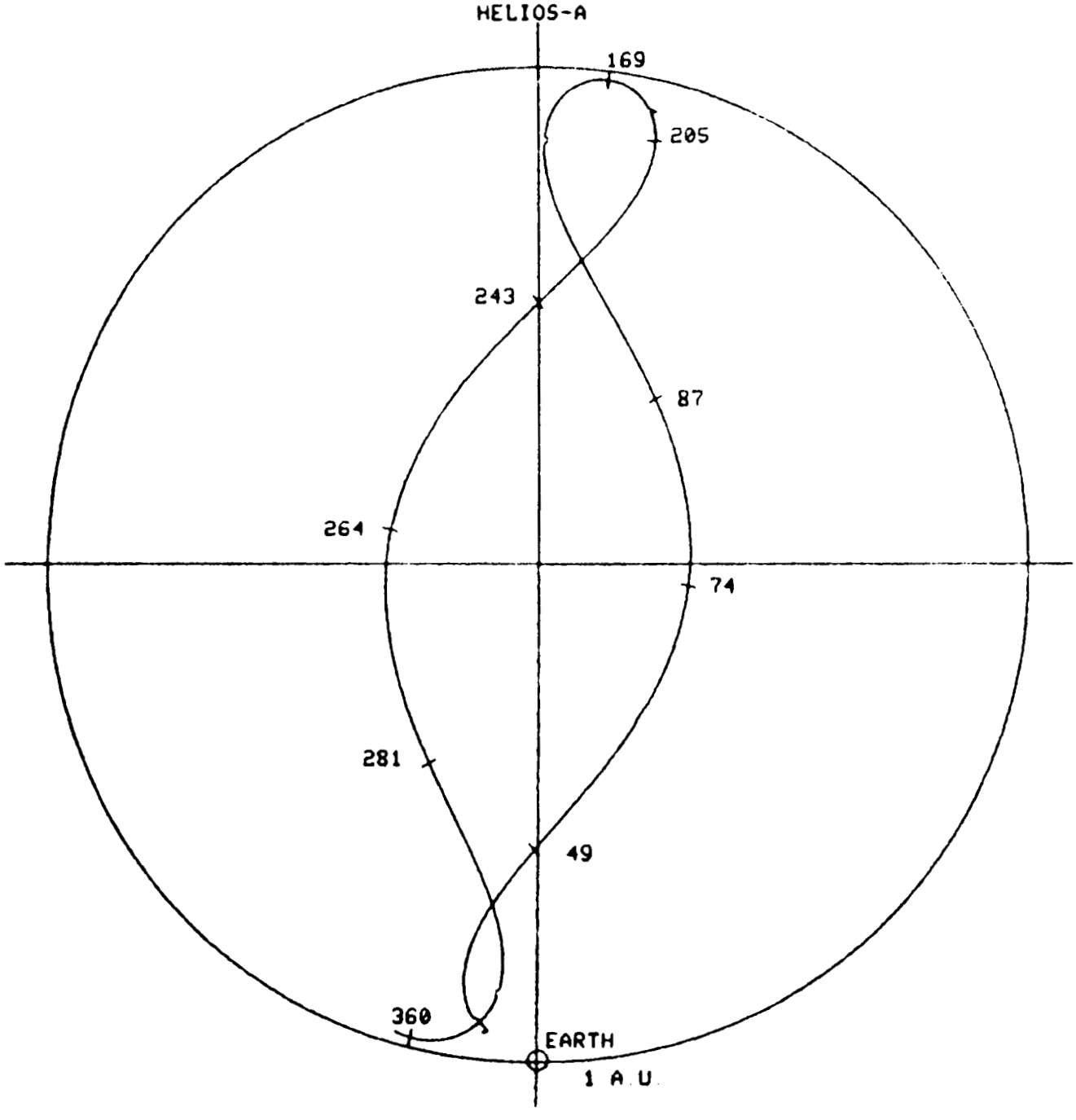

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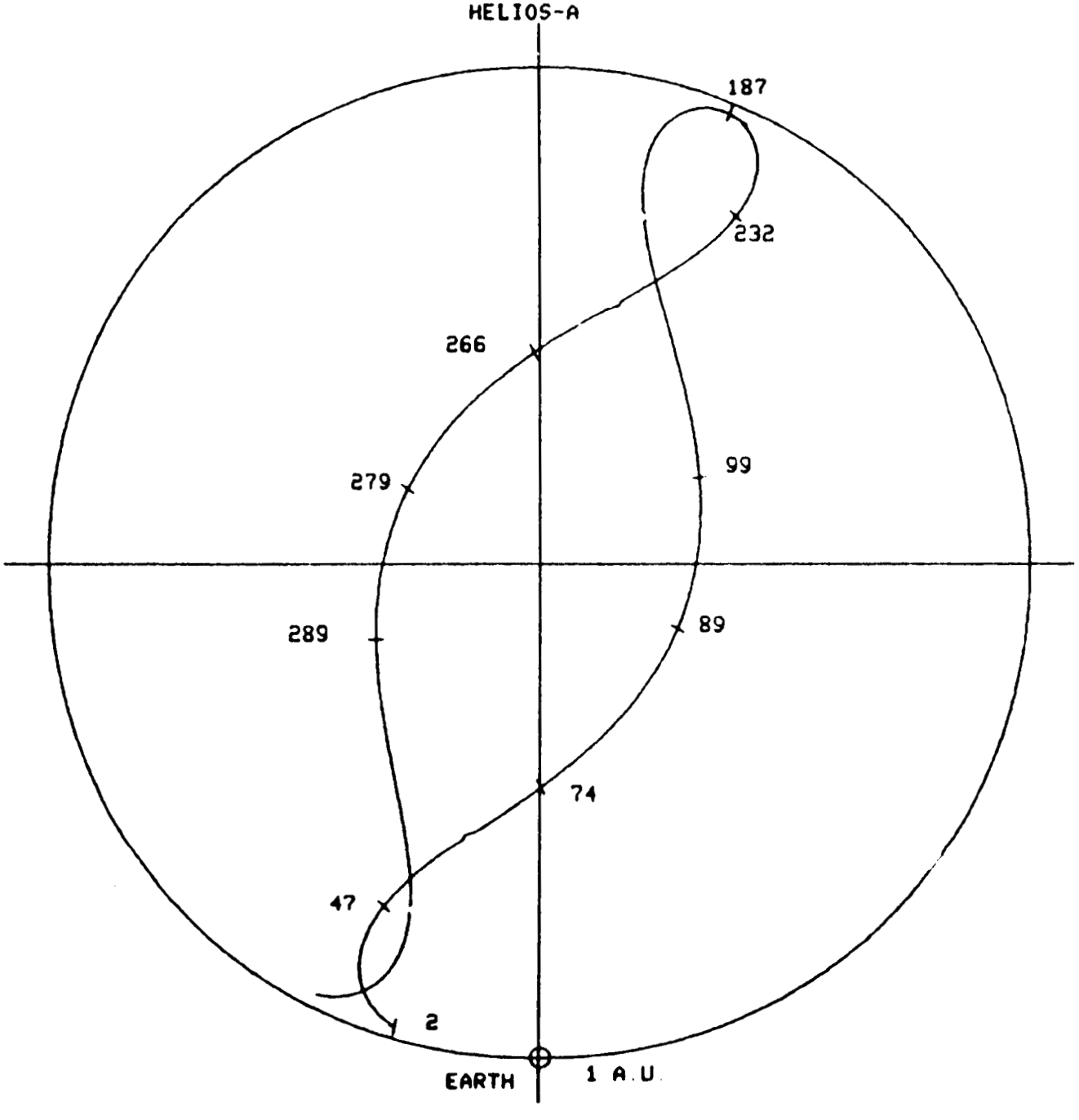

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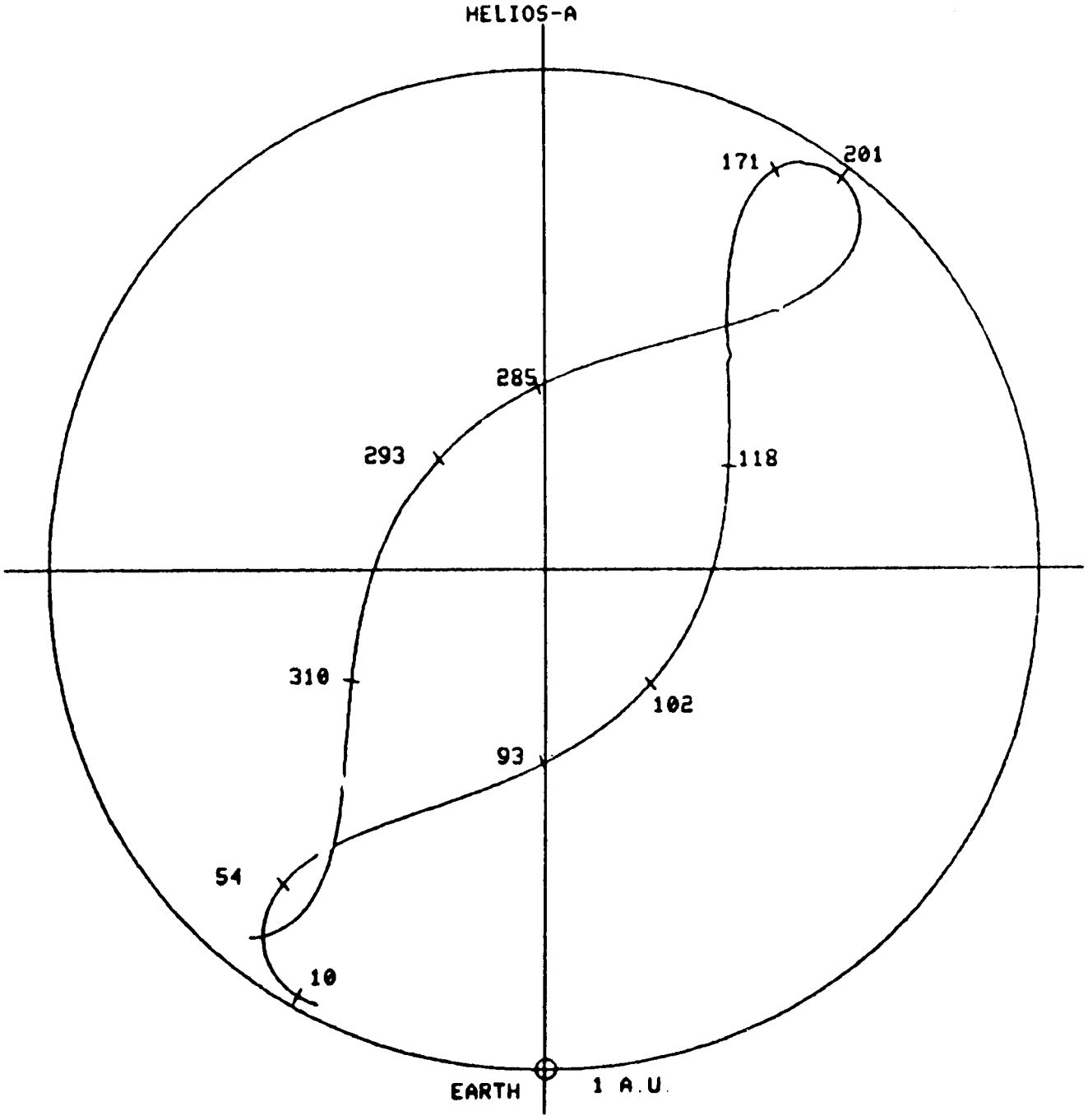

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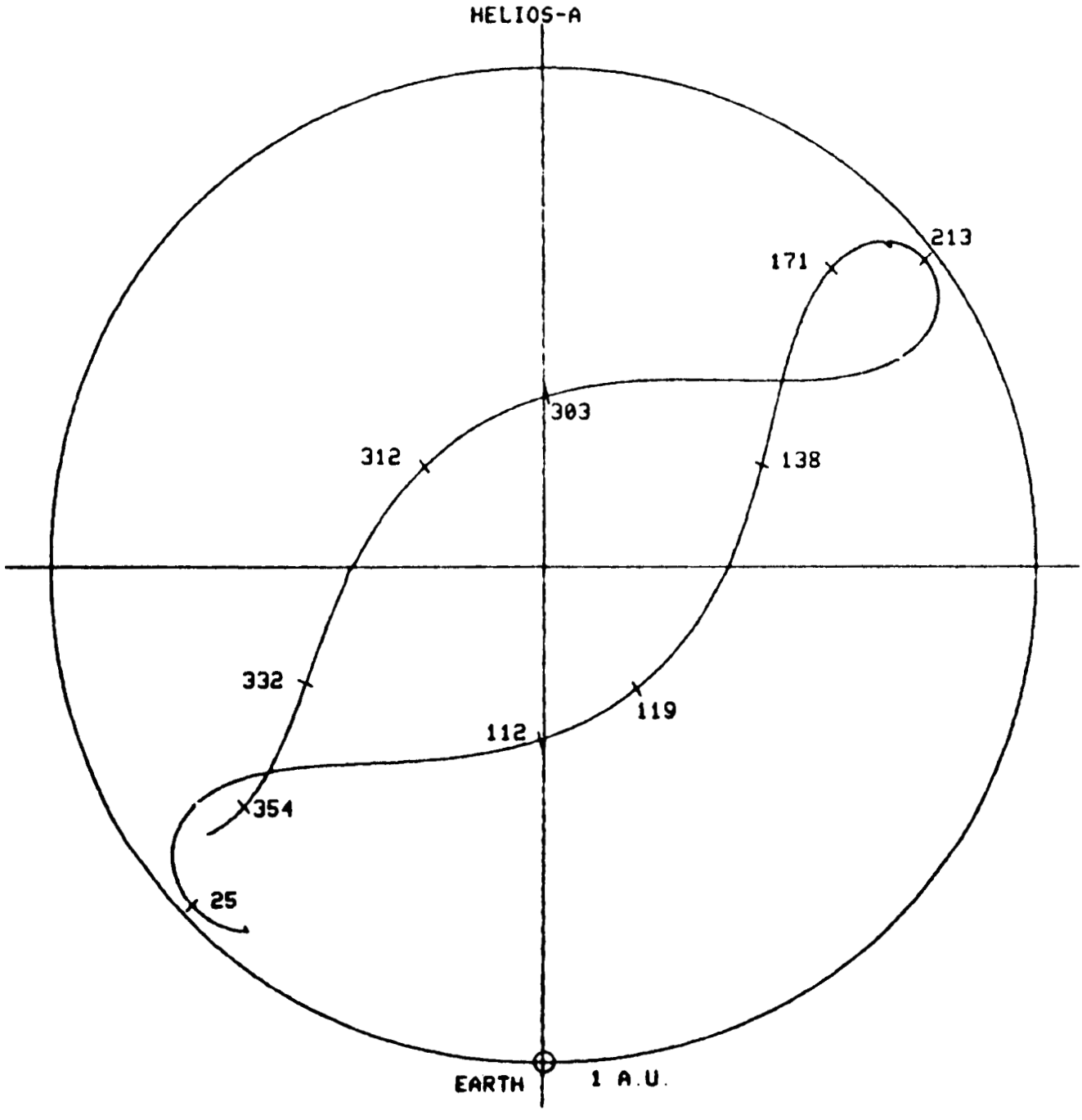

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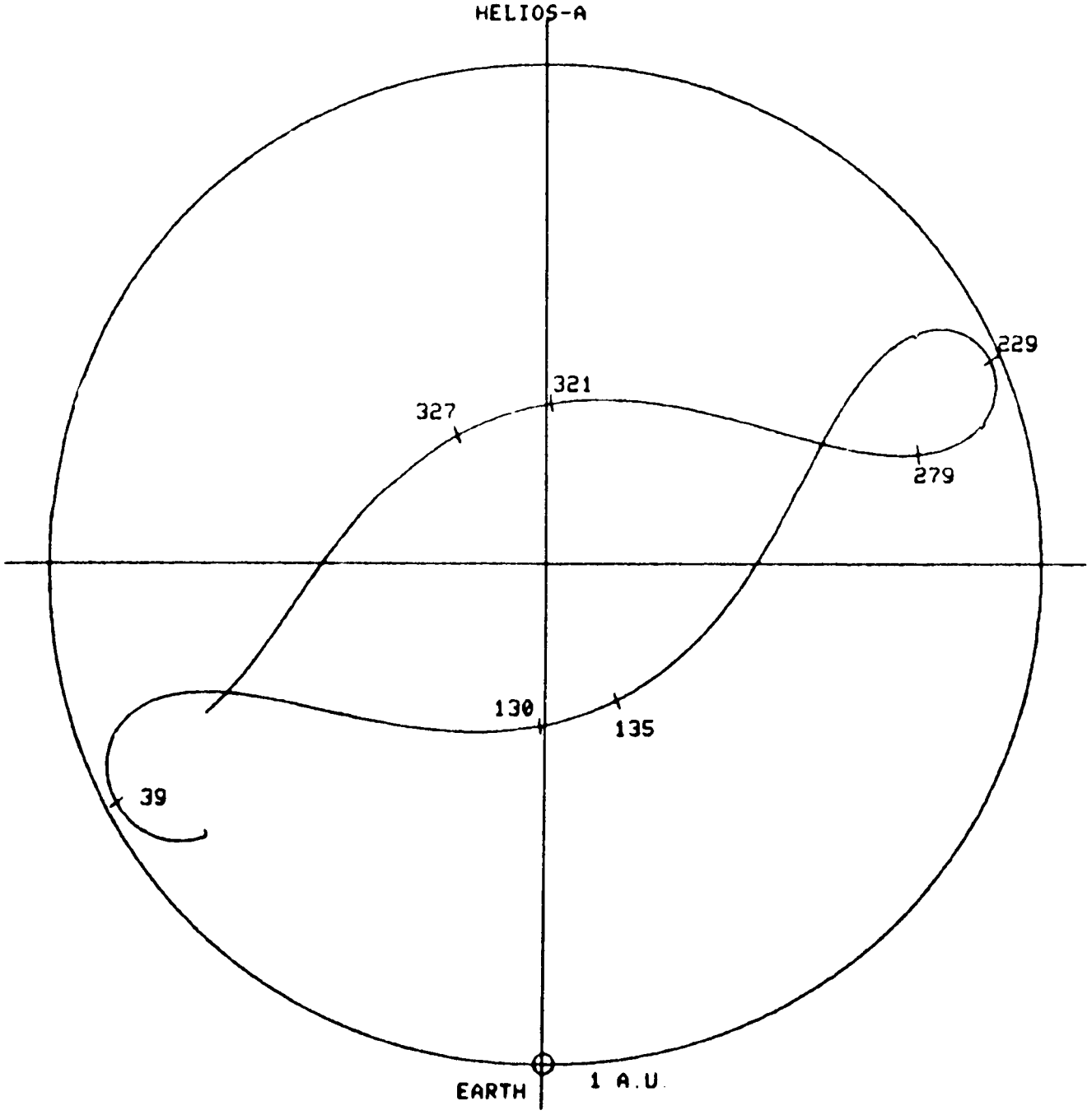

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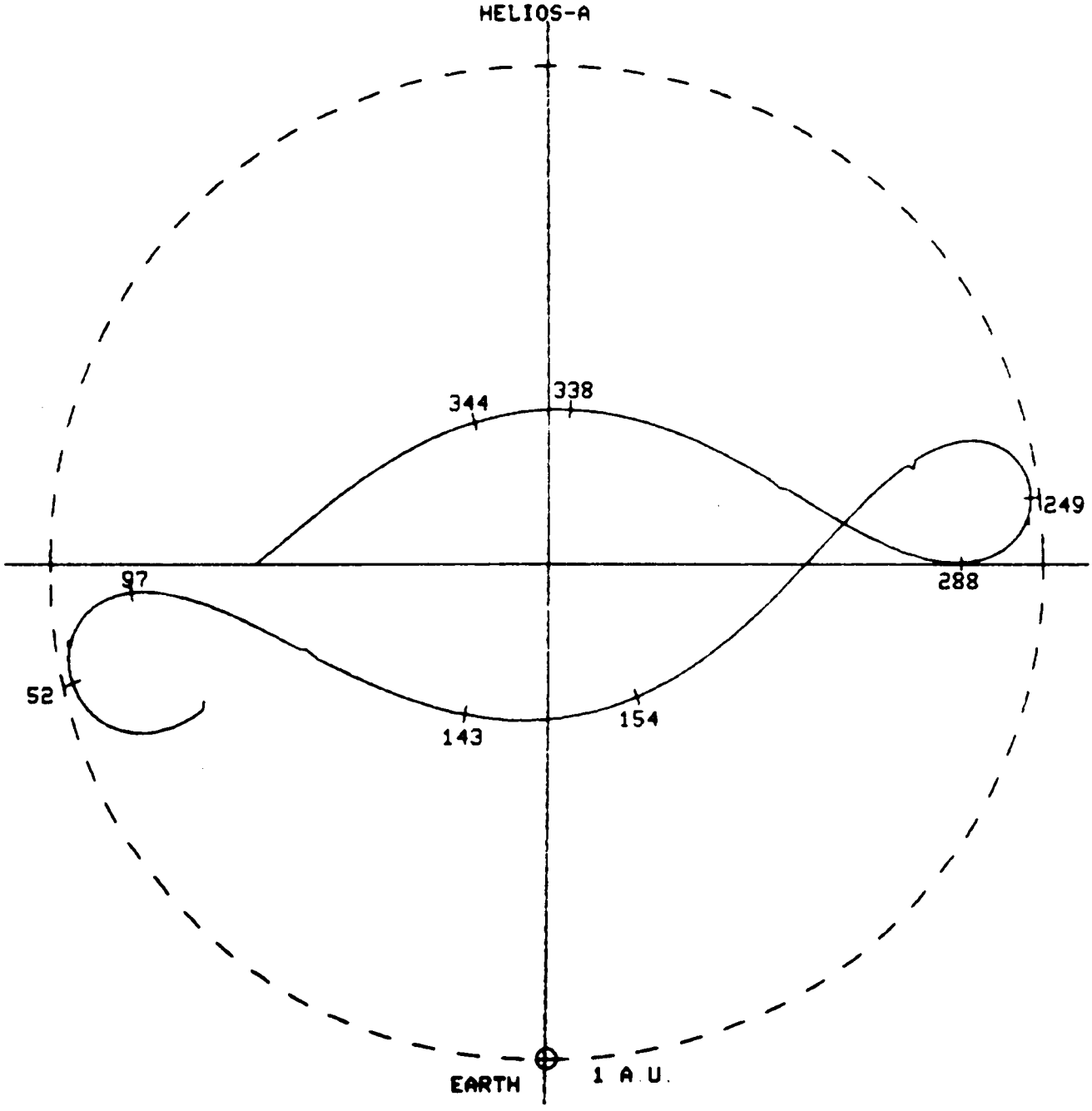

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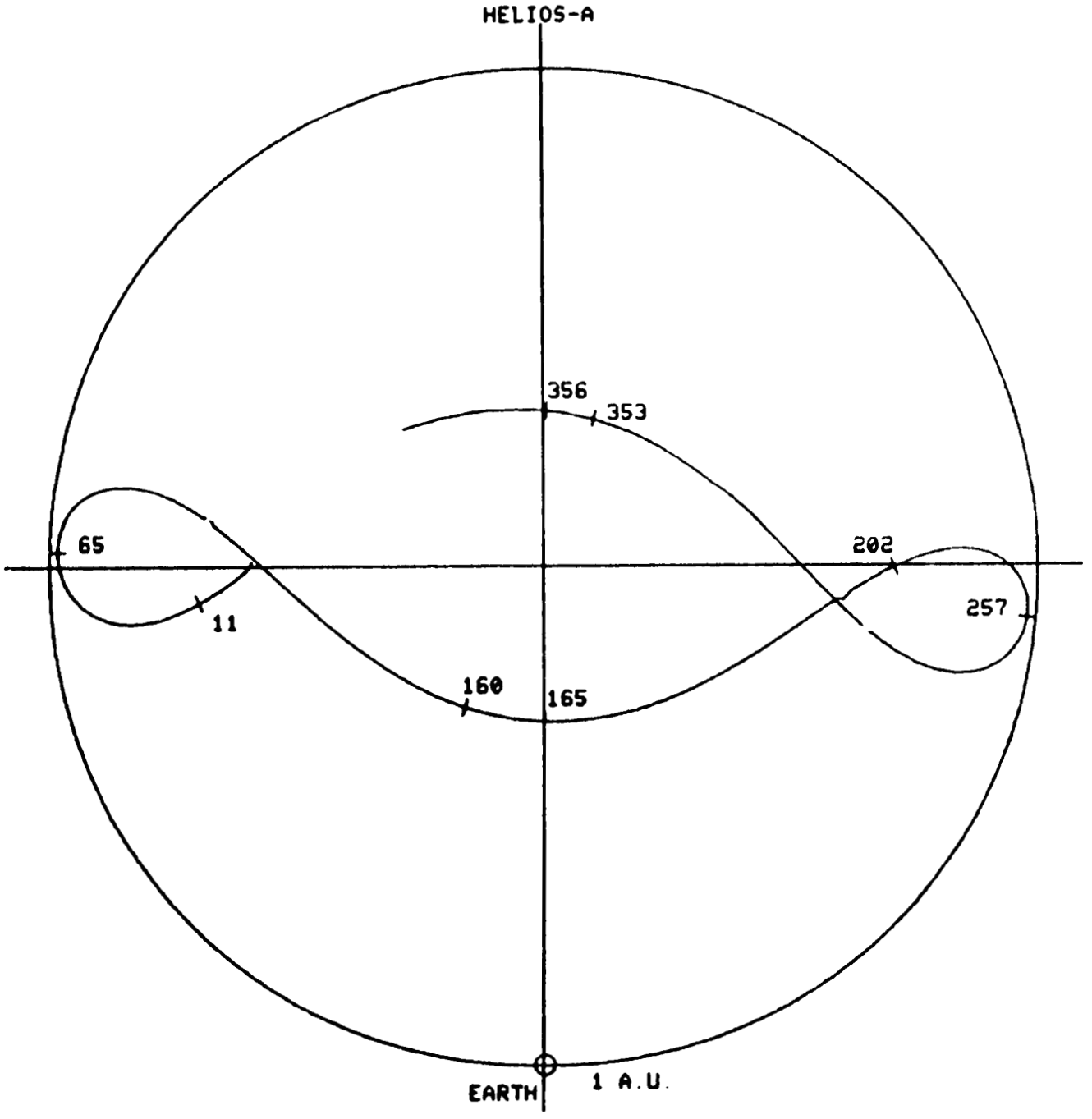

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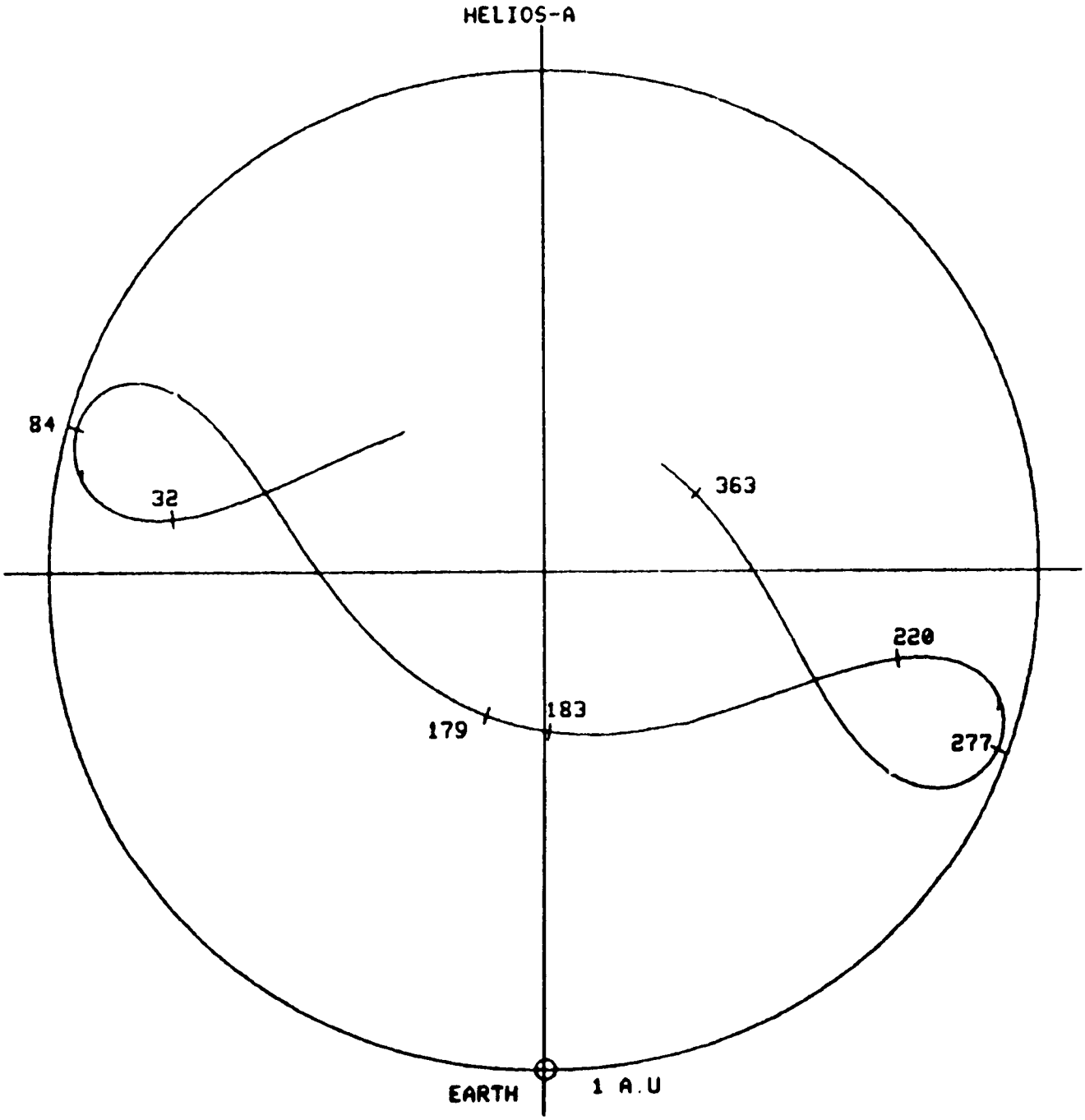

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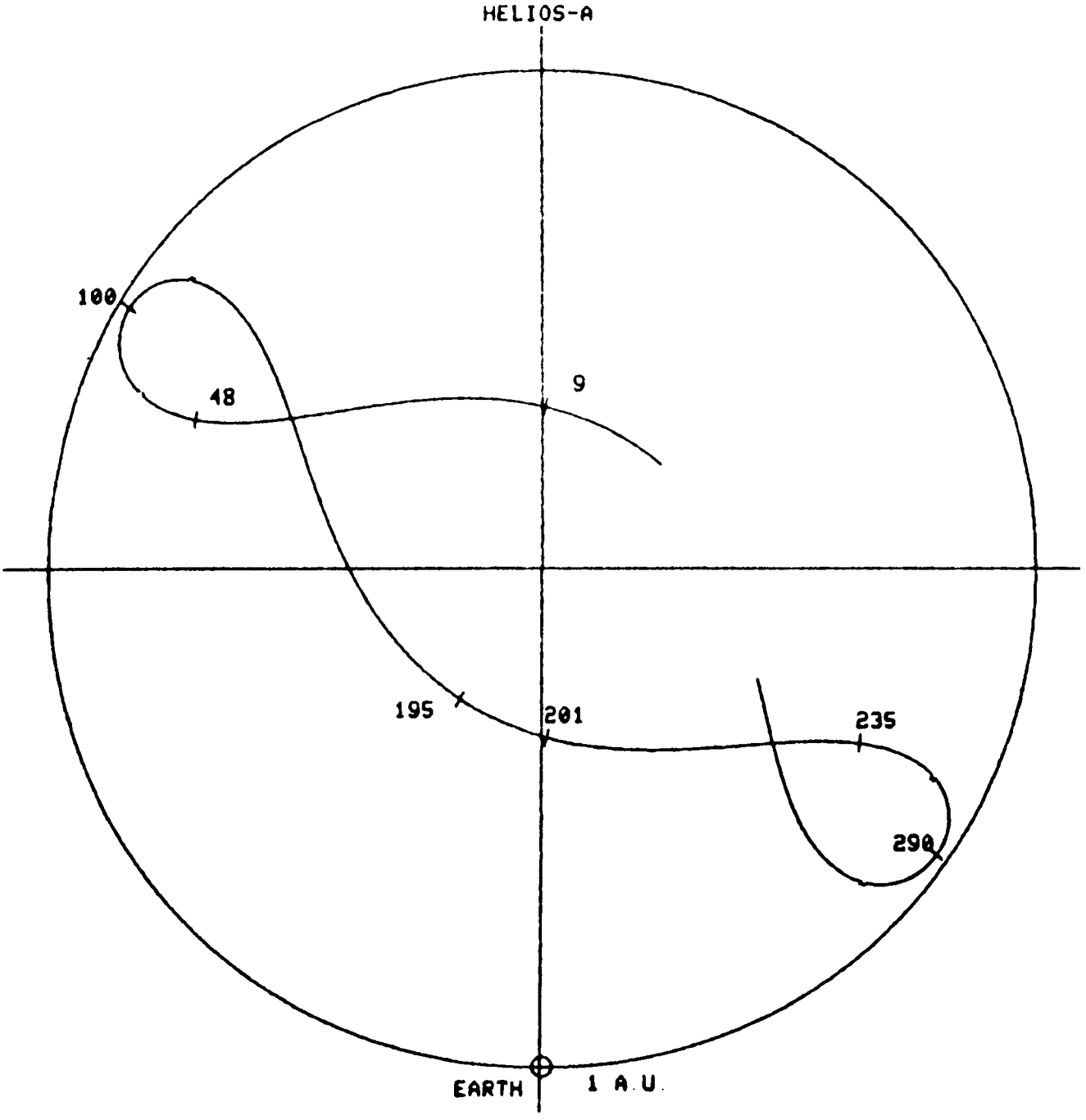

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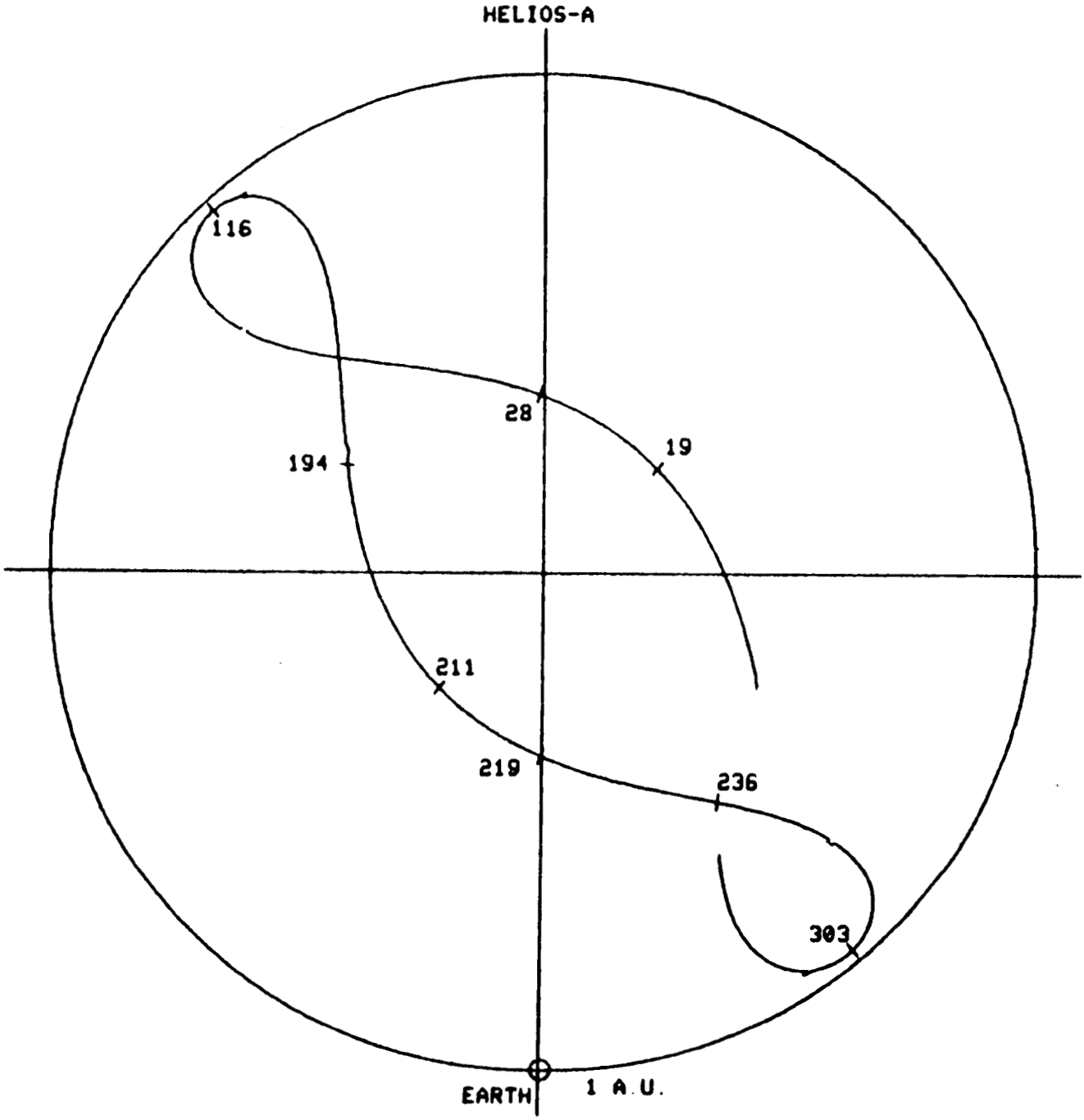

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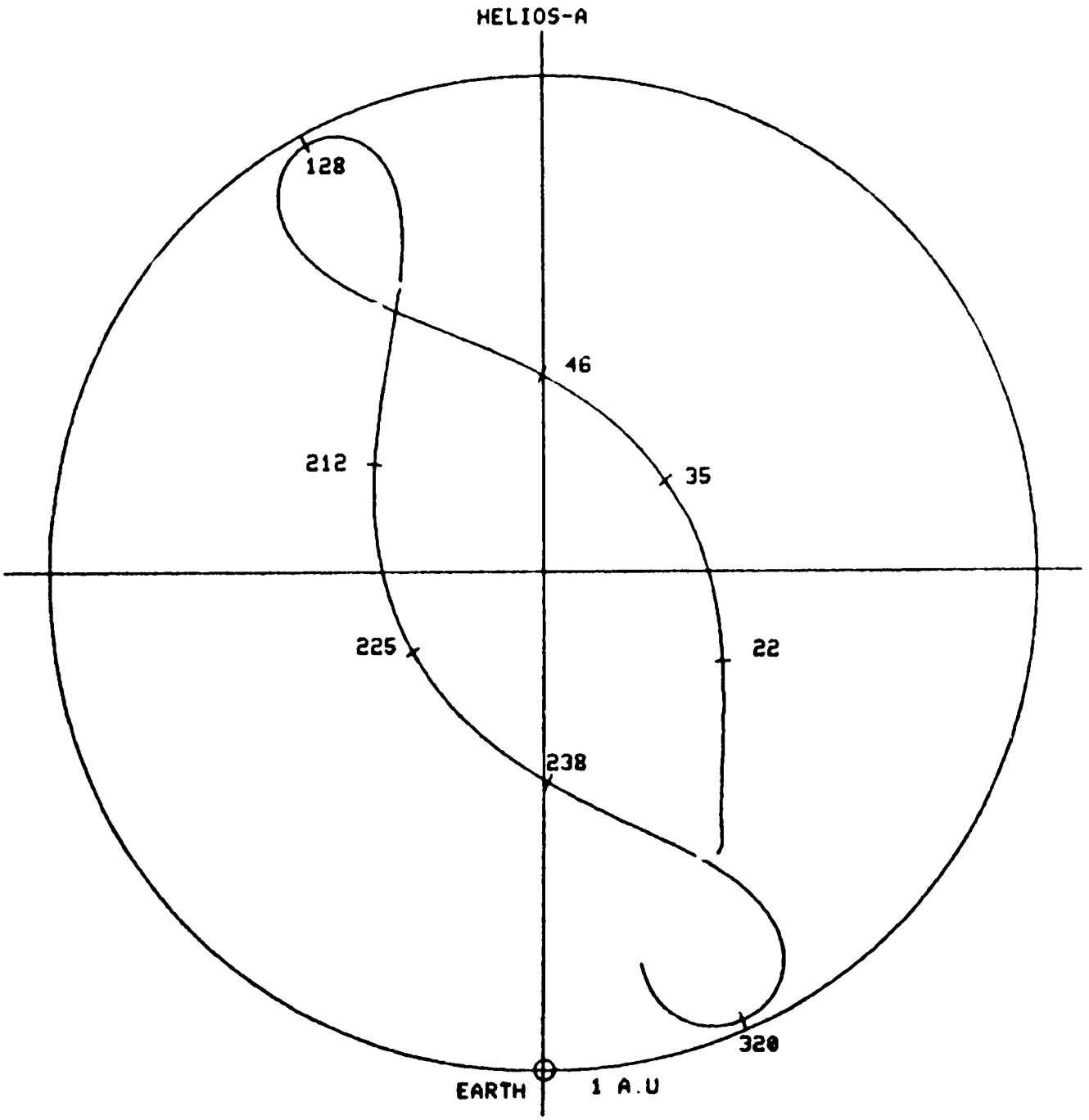

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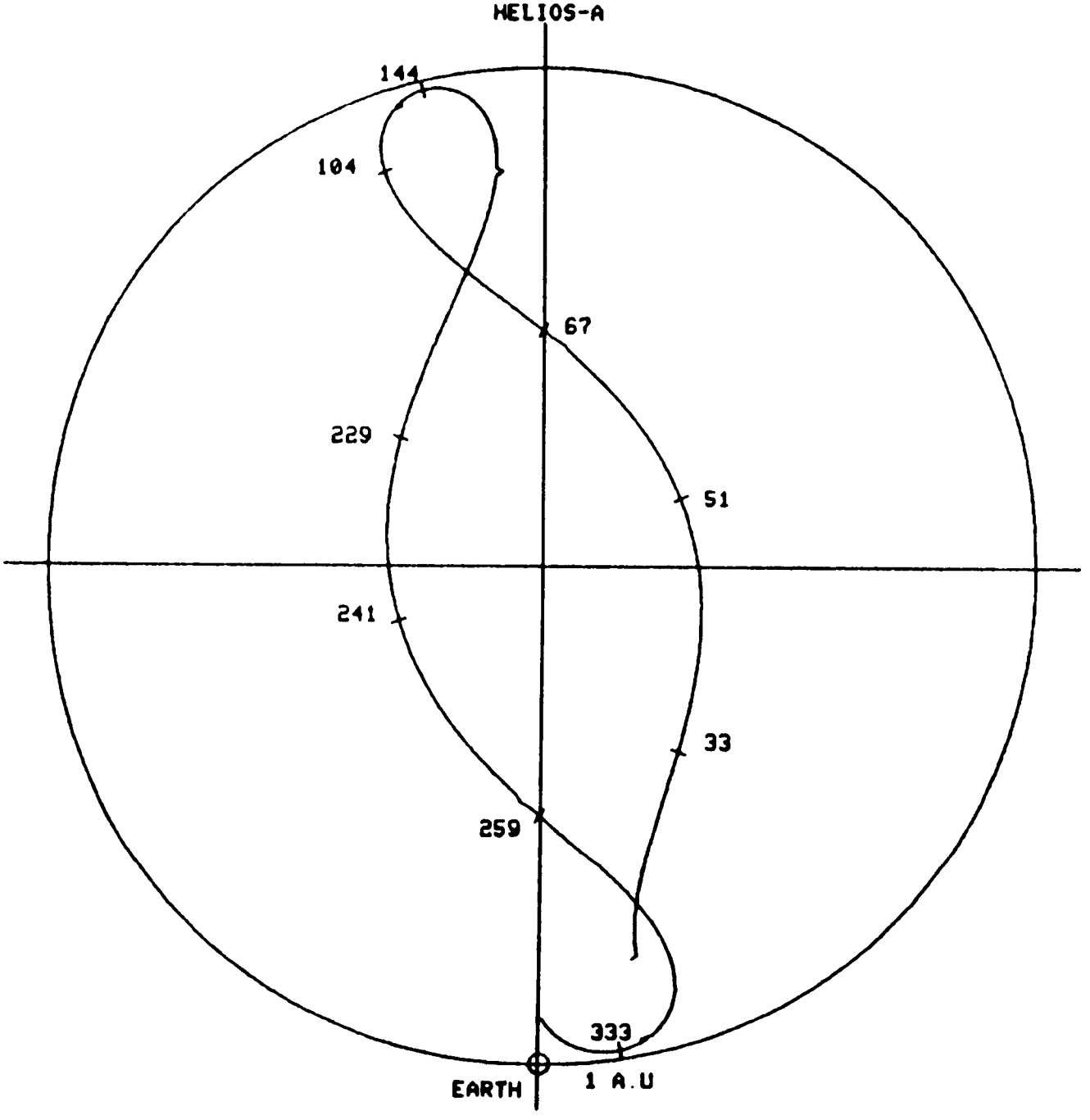

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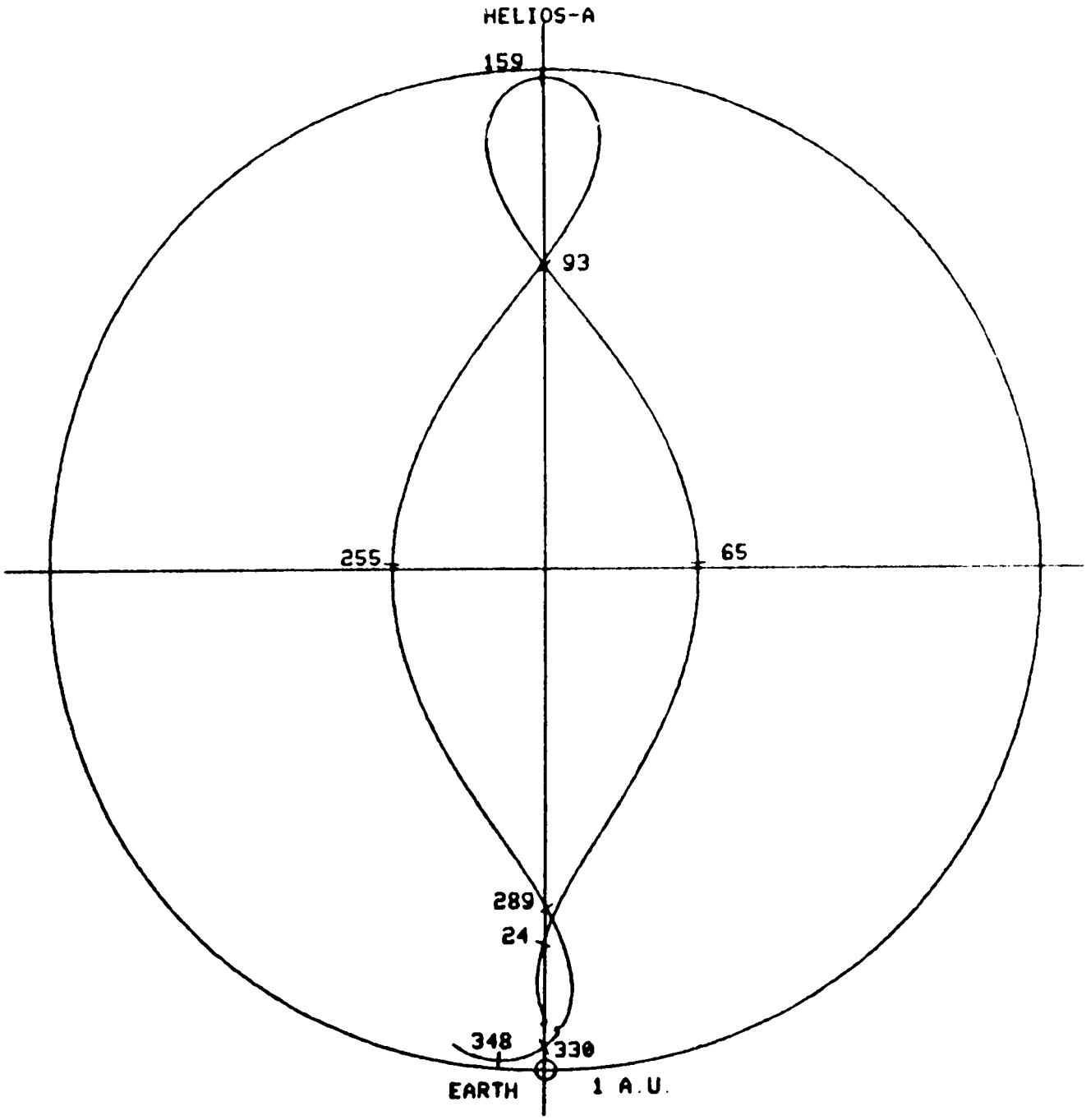

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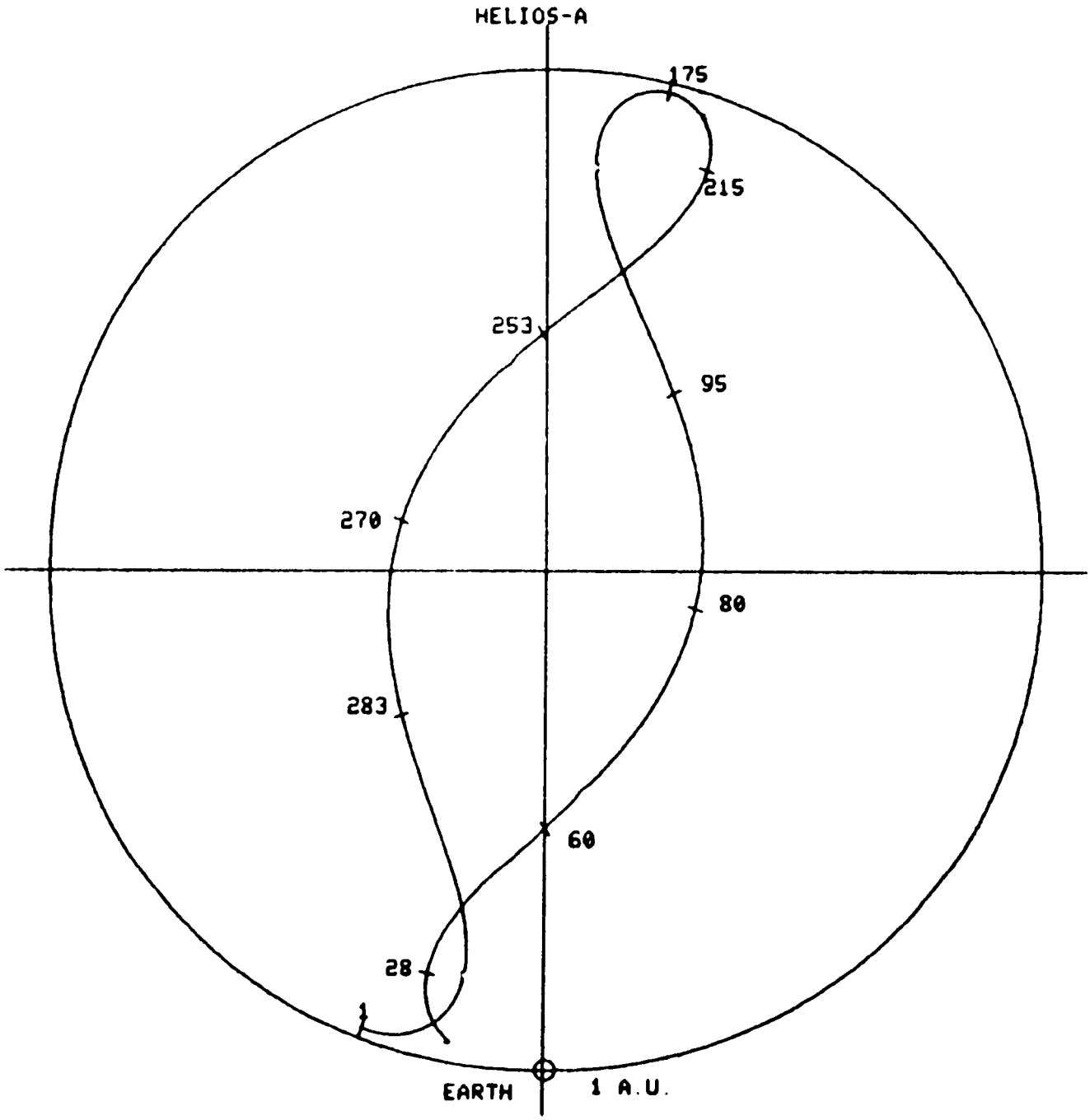

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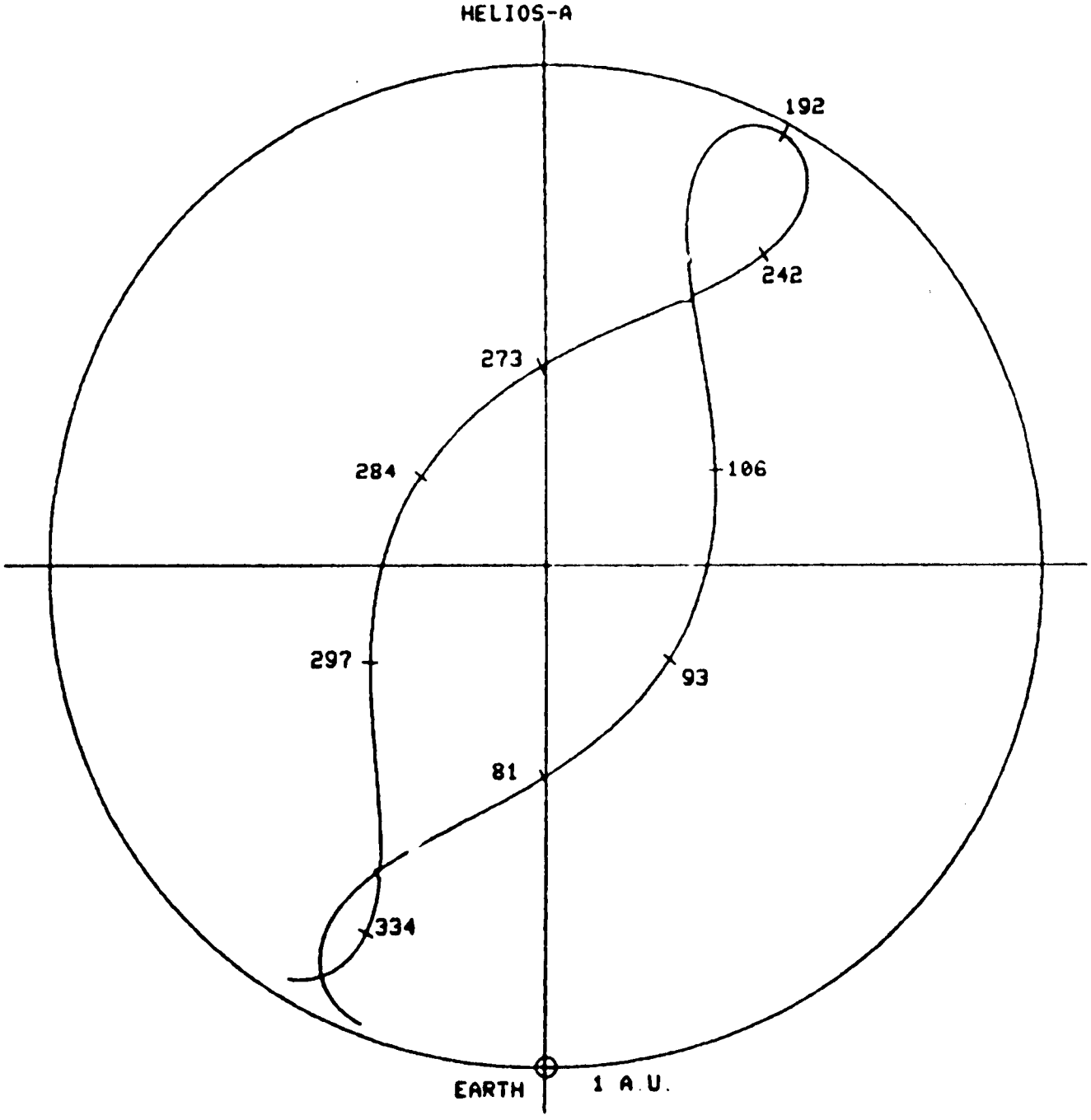

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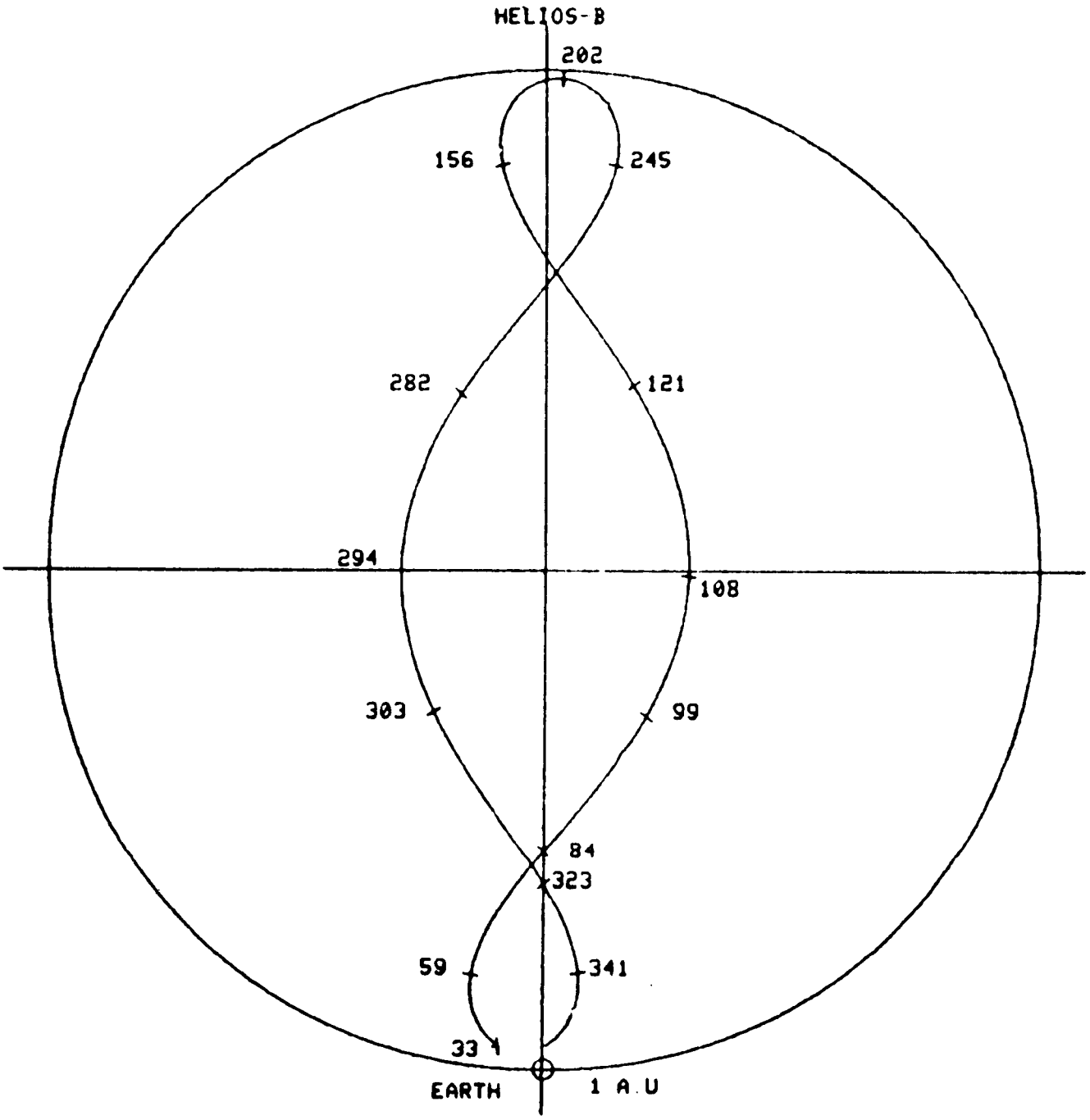

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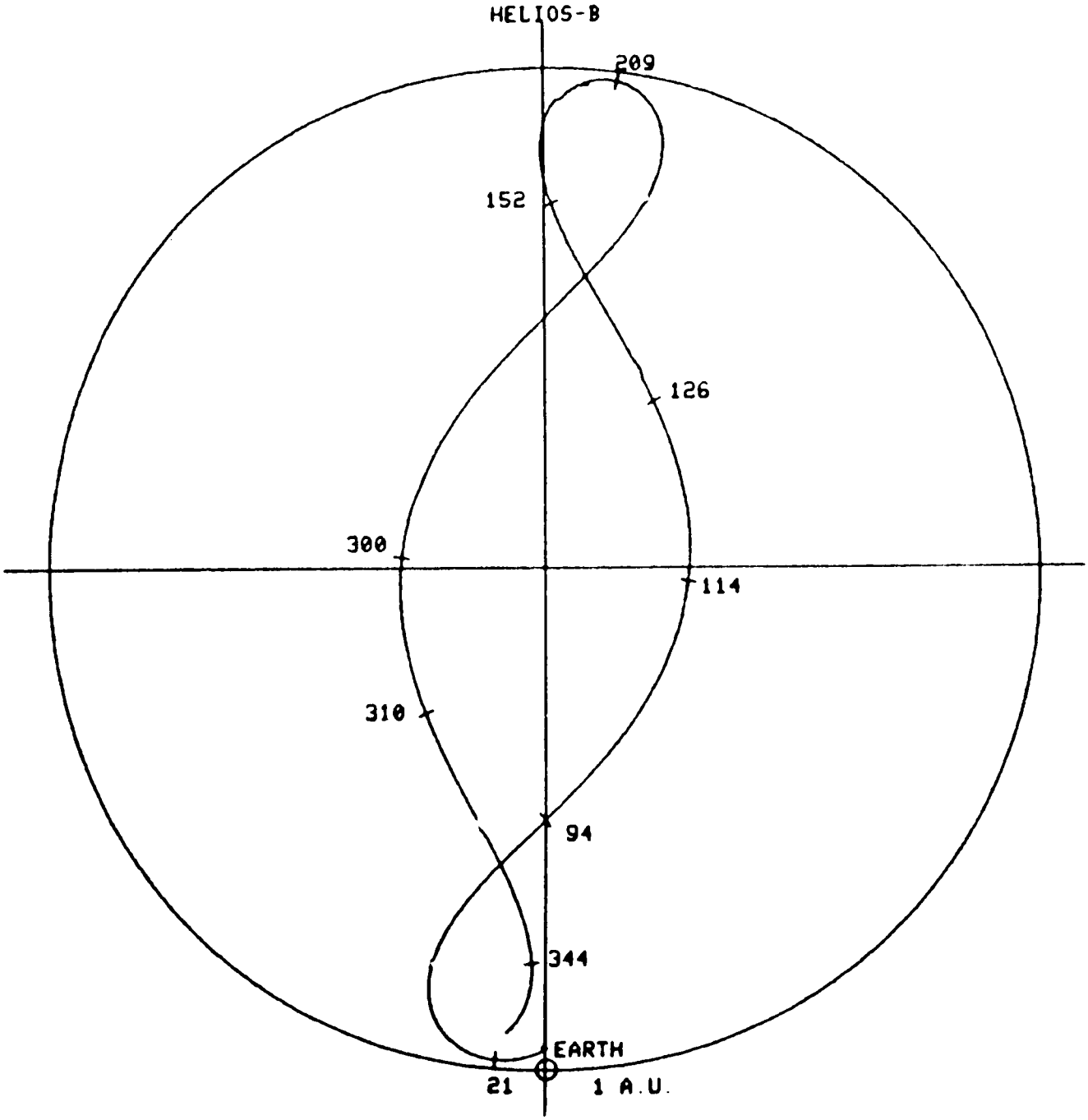

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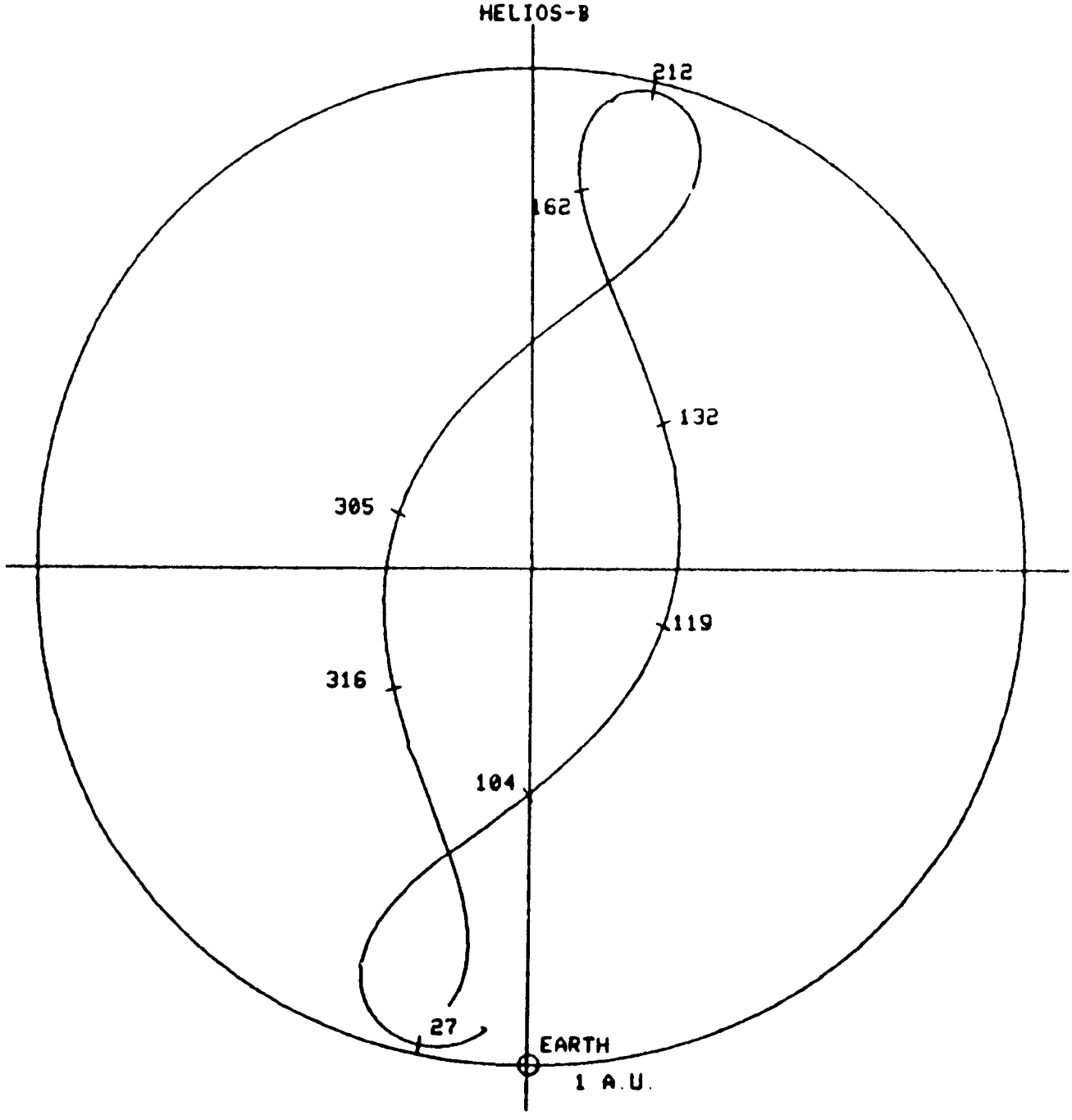

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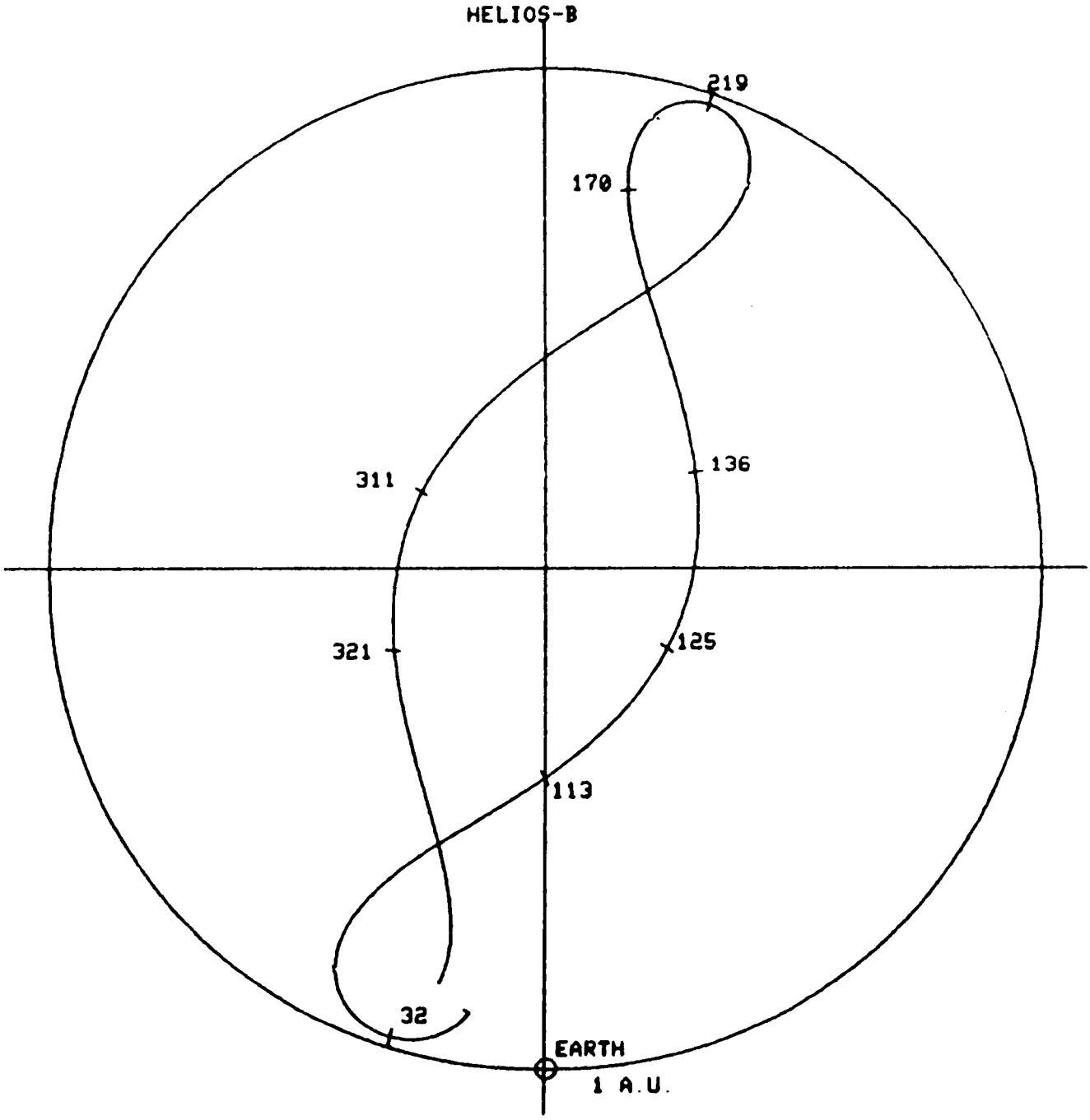

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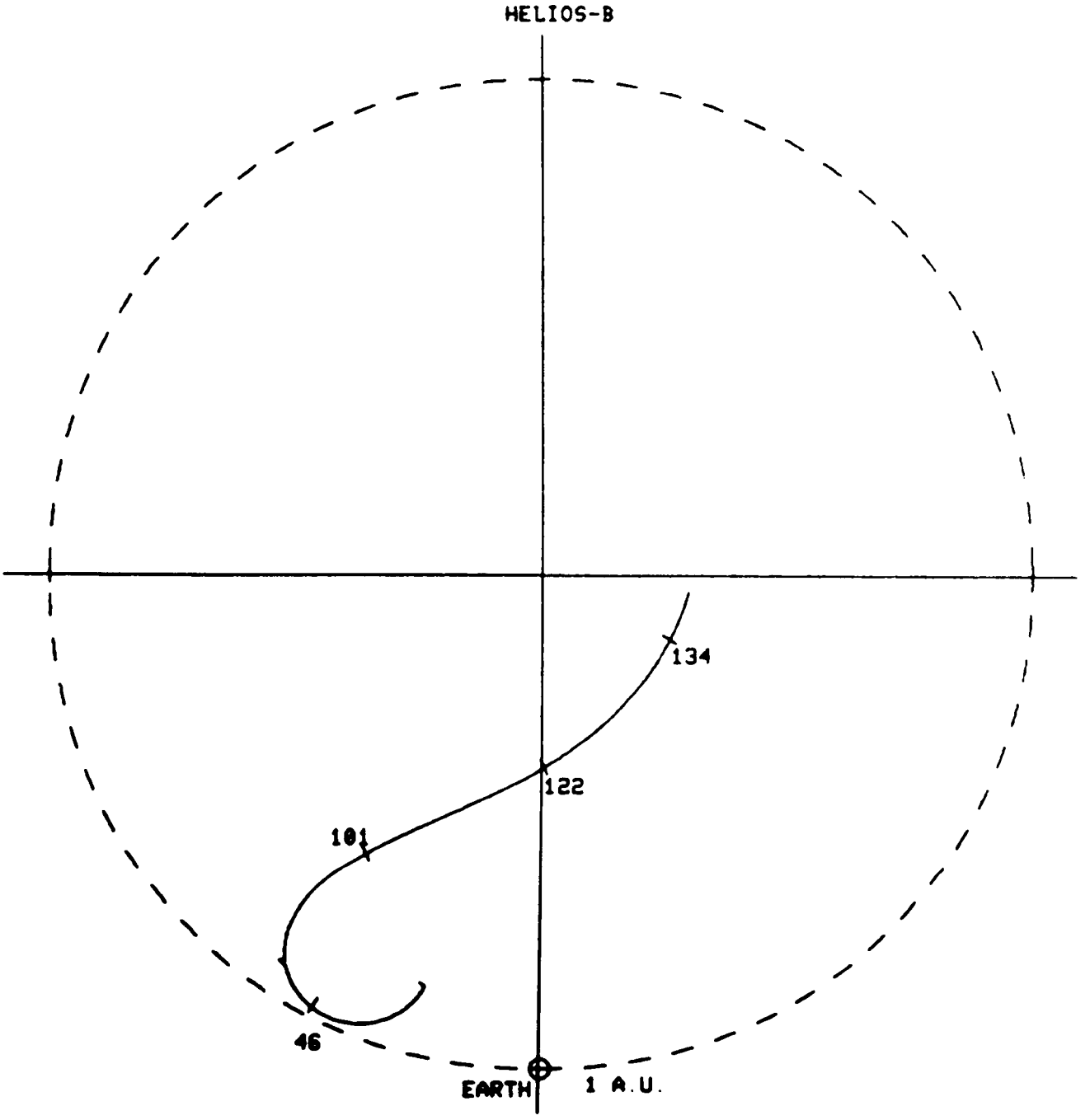

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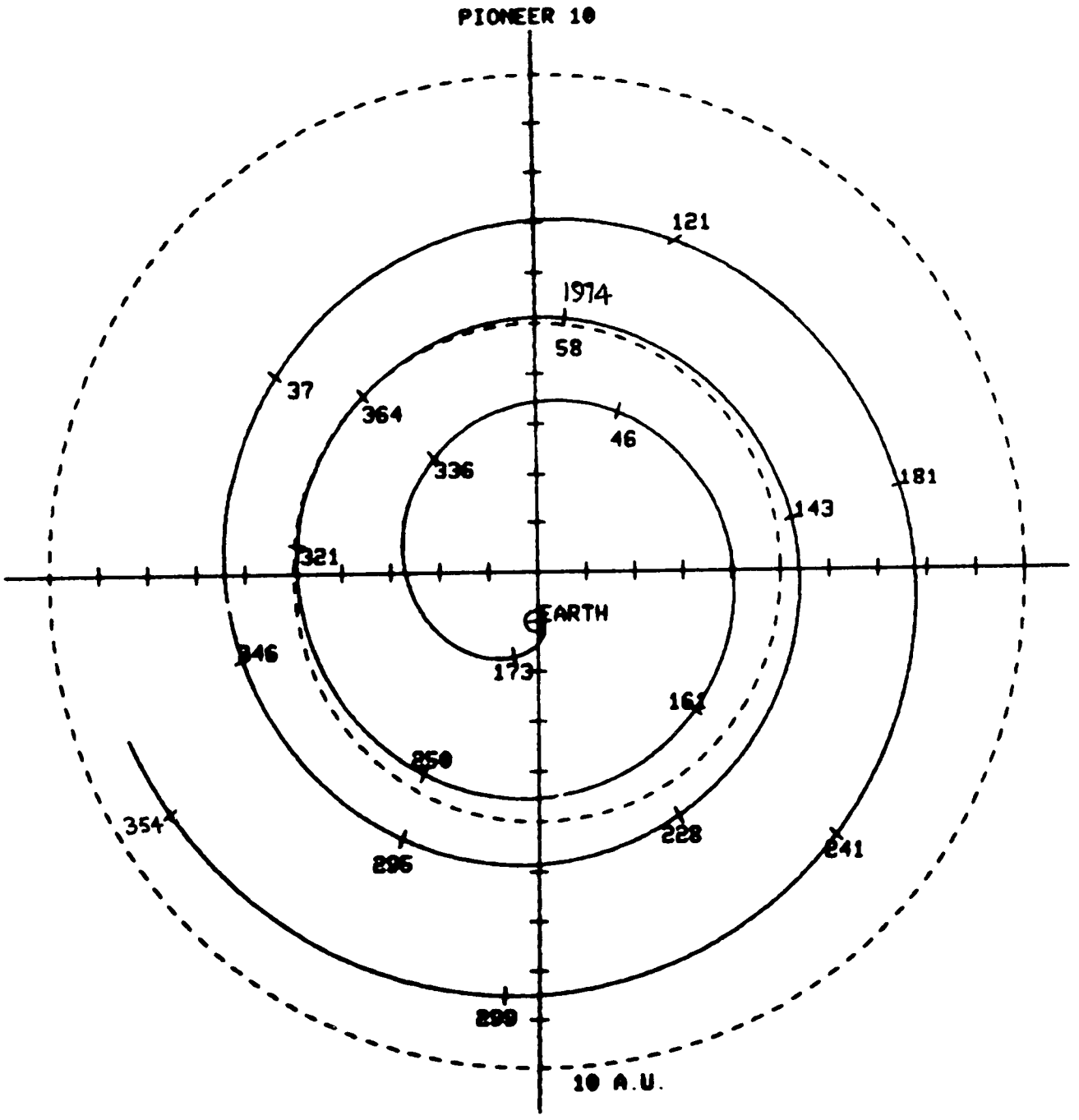

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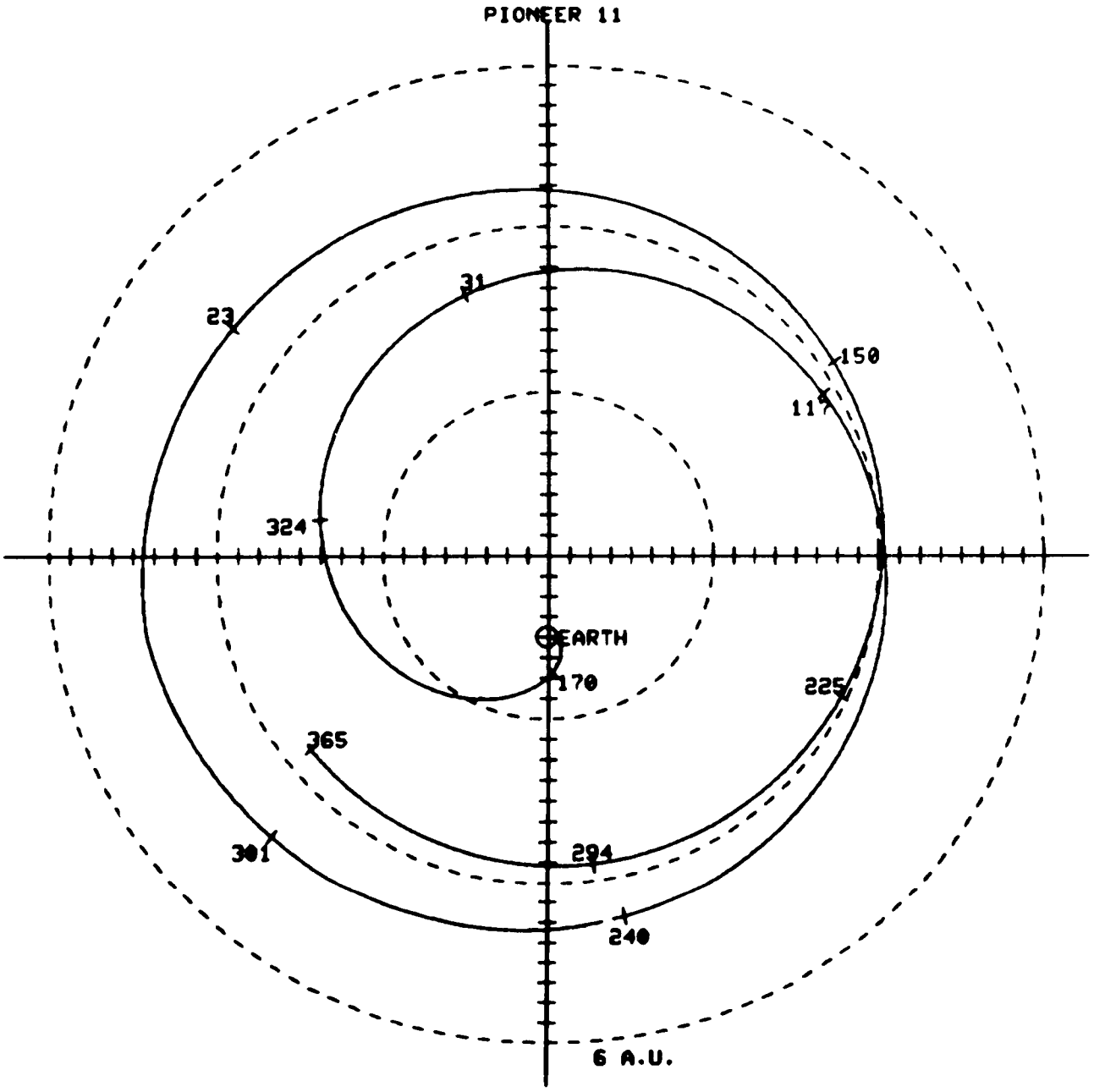

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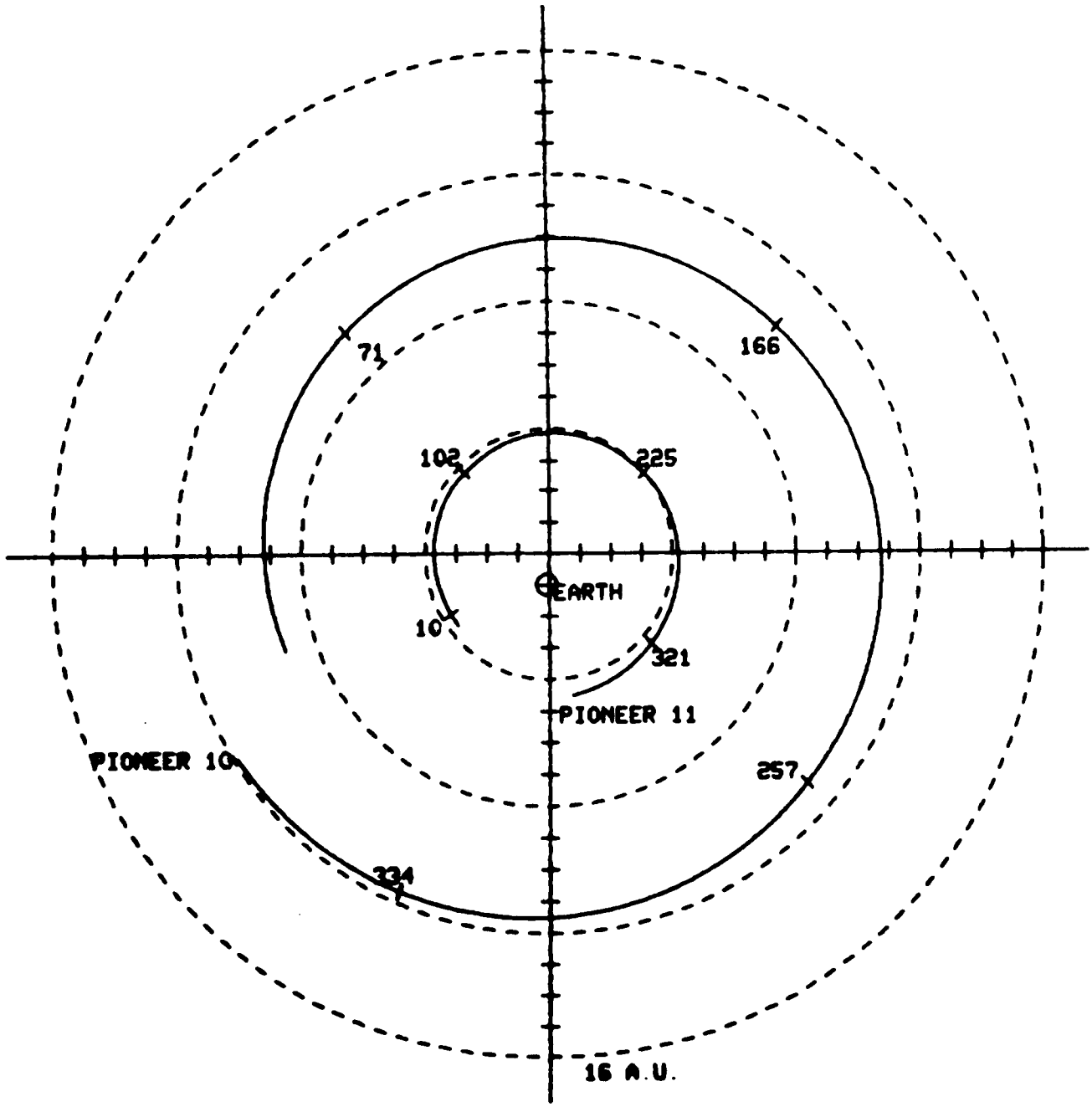

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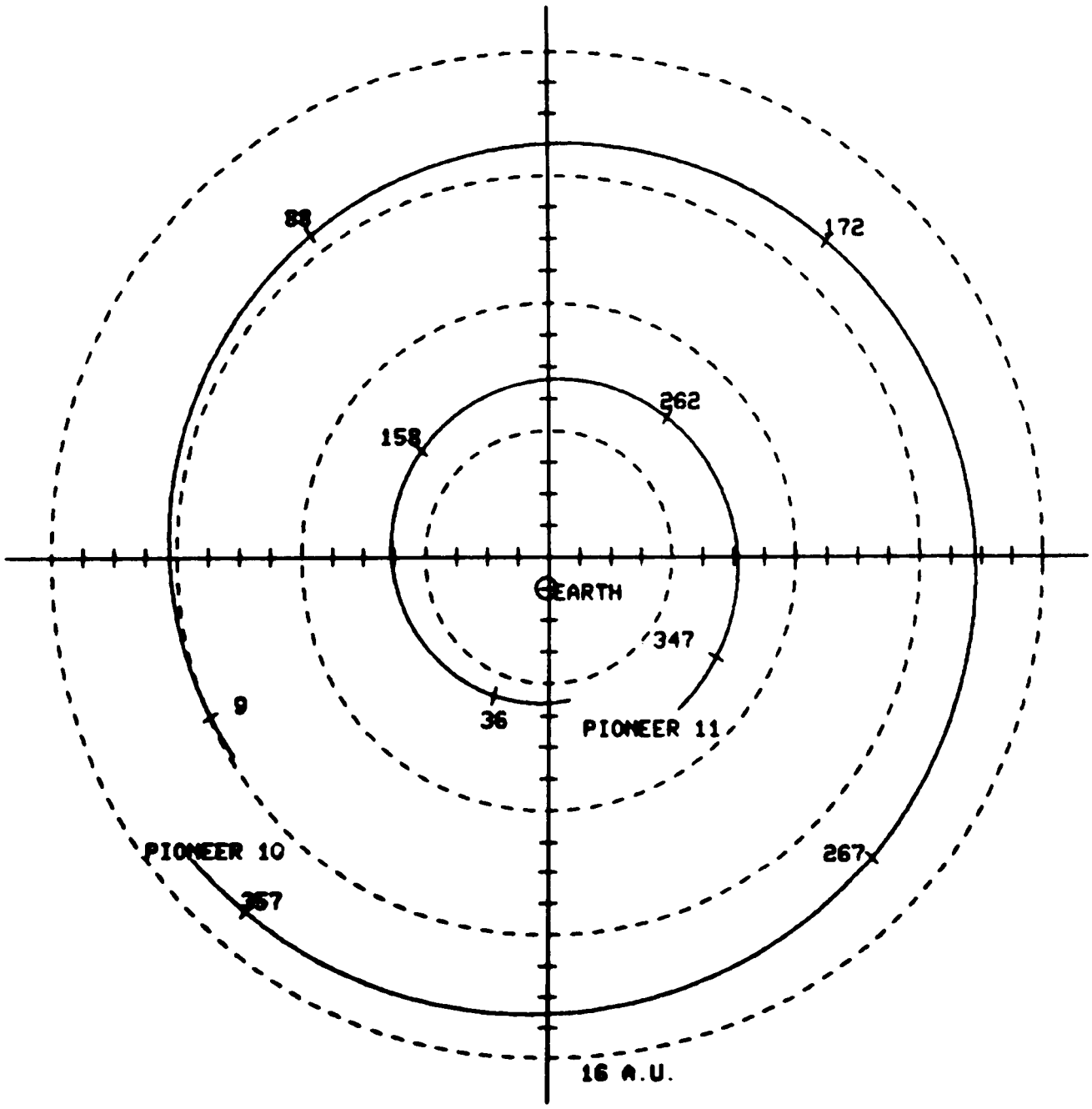

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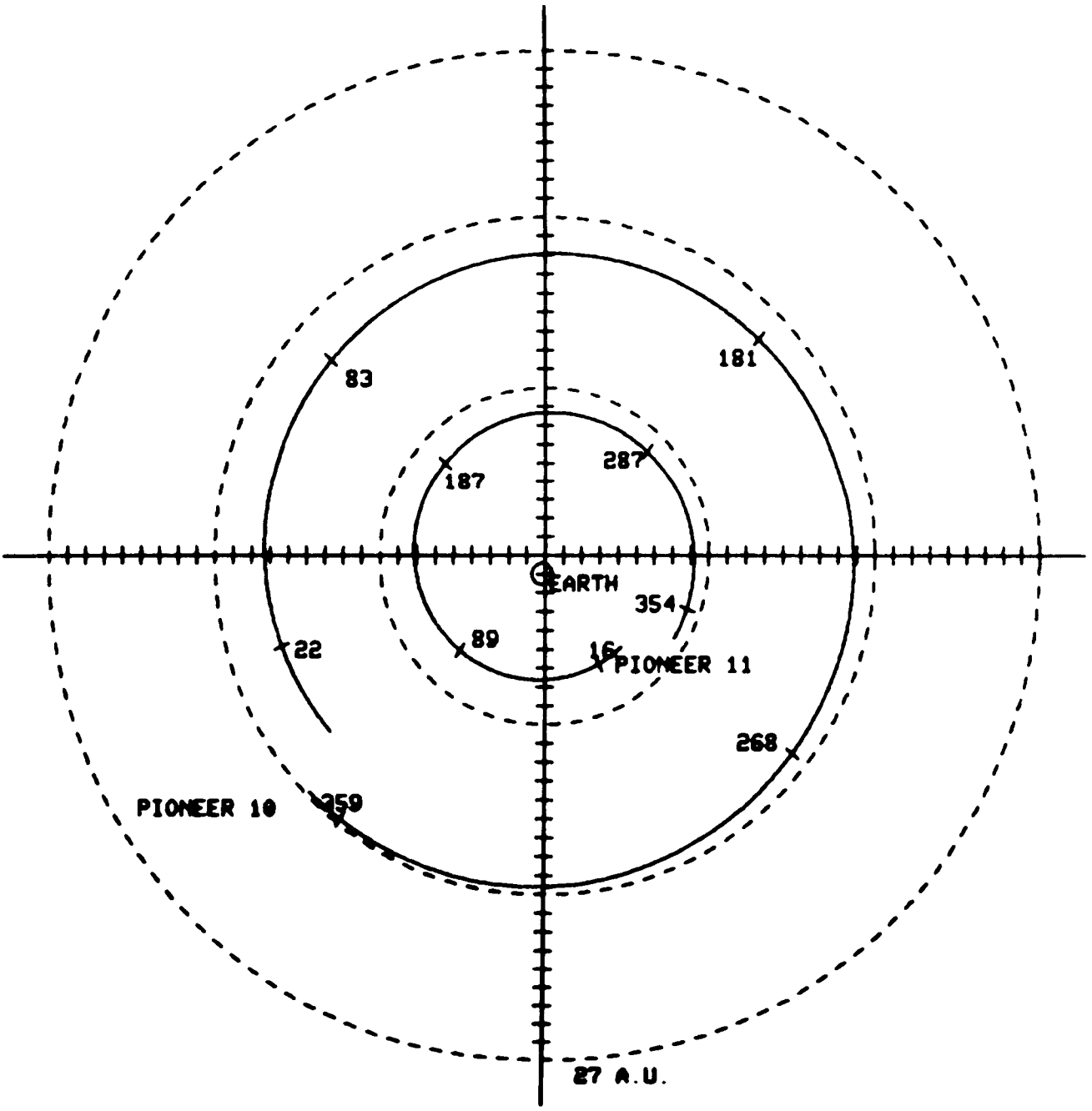
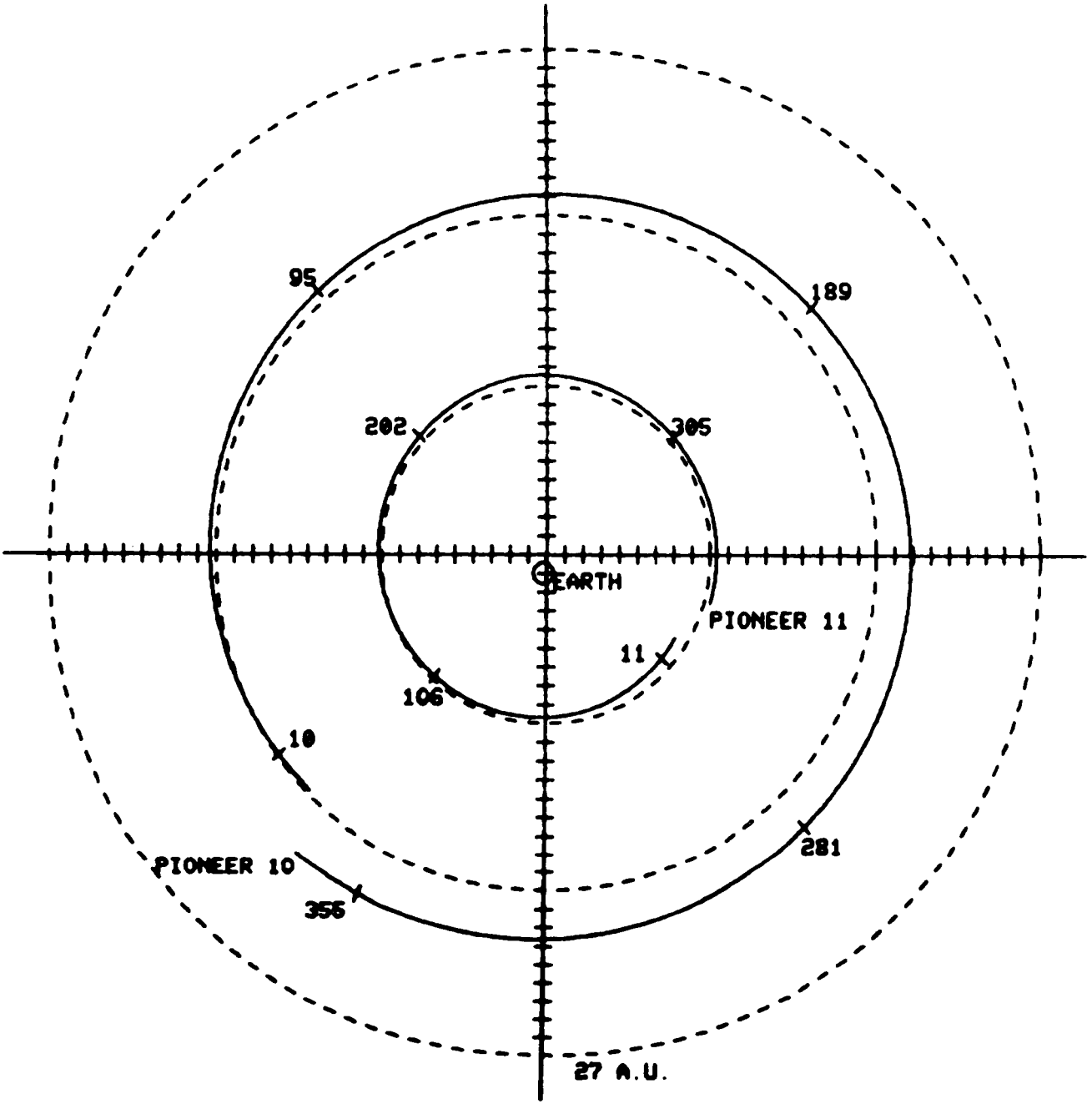


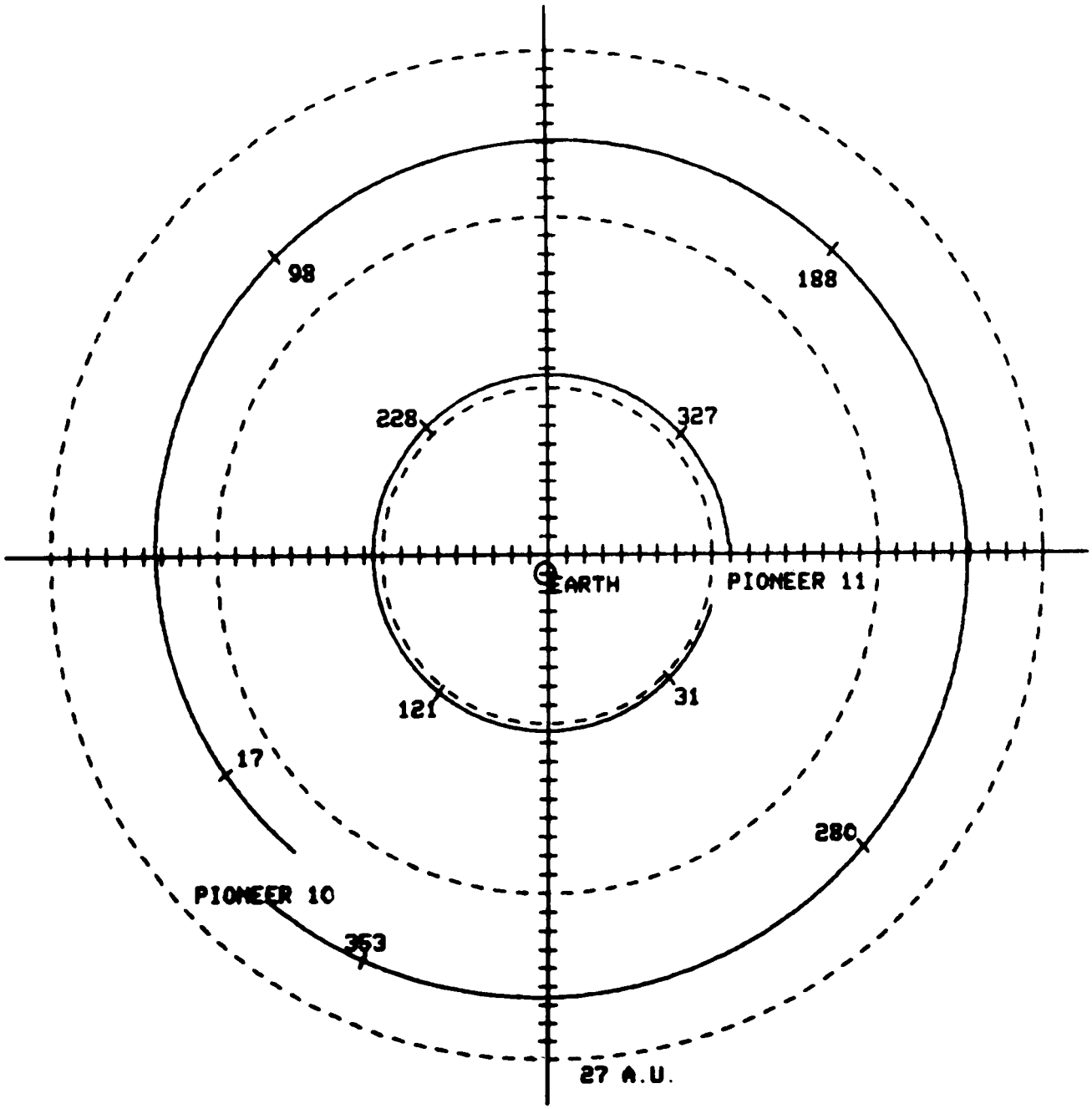
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1979/ 1/ 0.00 STOP TIME = 1980/ 1/ 0 00



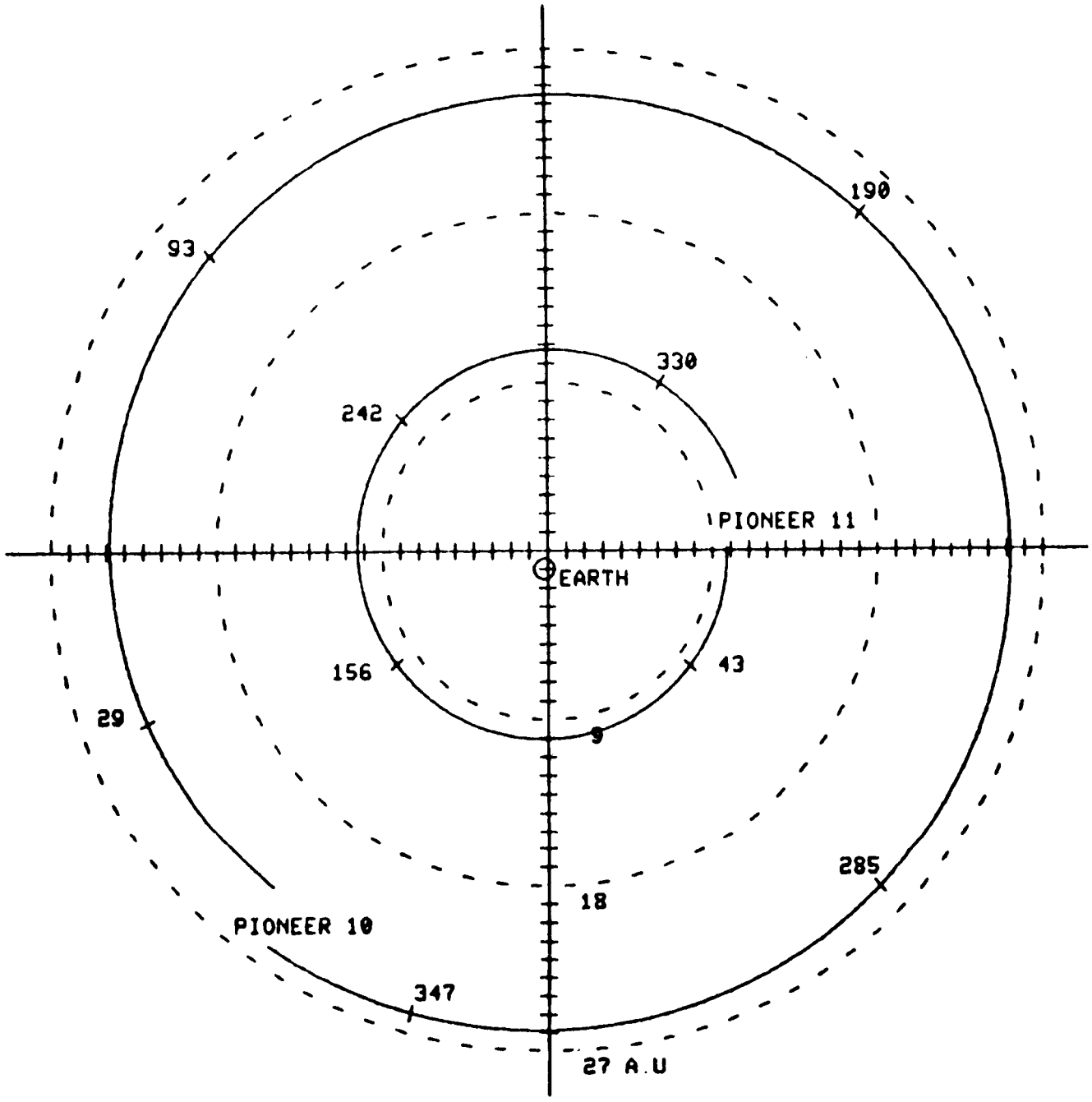
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1980/ 1/ 0 00 STOP TIME = 1981/ 1/ 0.00



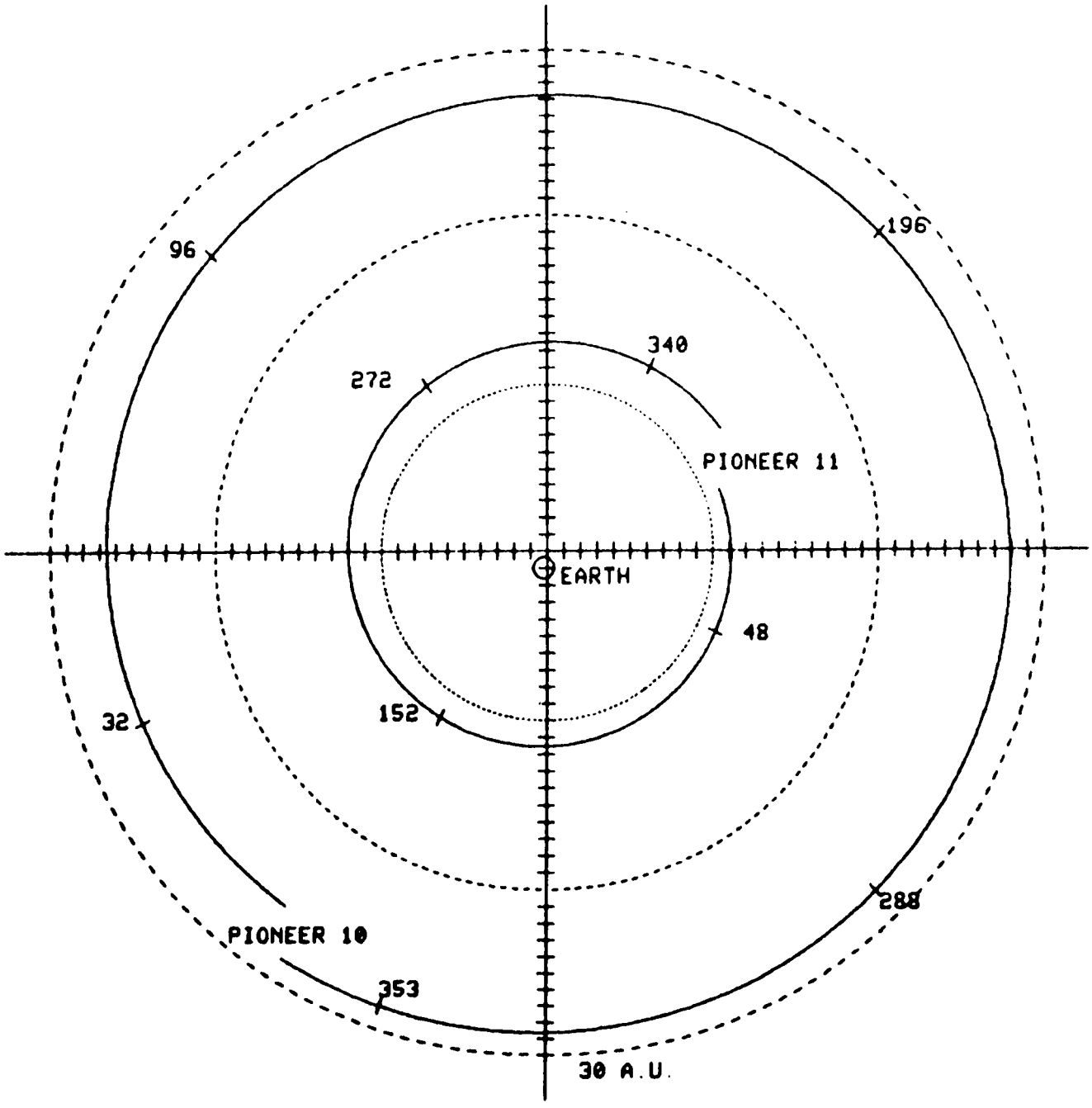
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME • 1981/ 1/ 0.00 STOP TIME • 1982/ 1/ 0.00



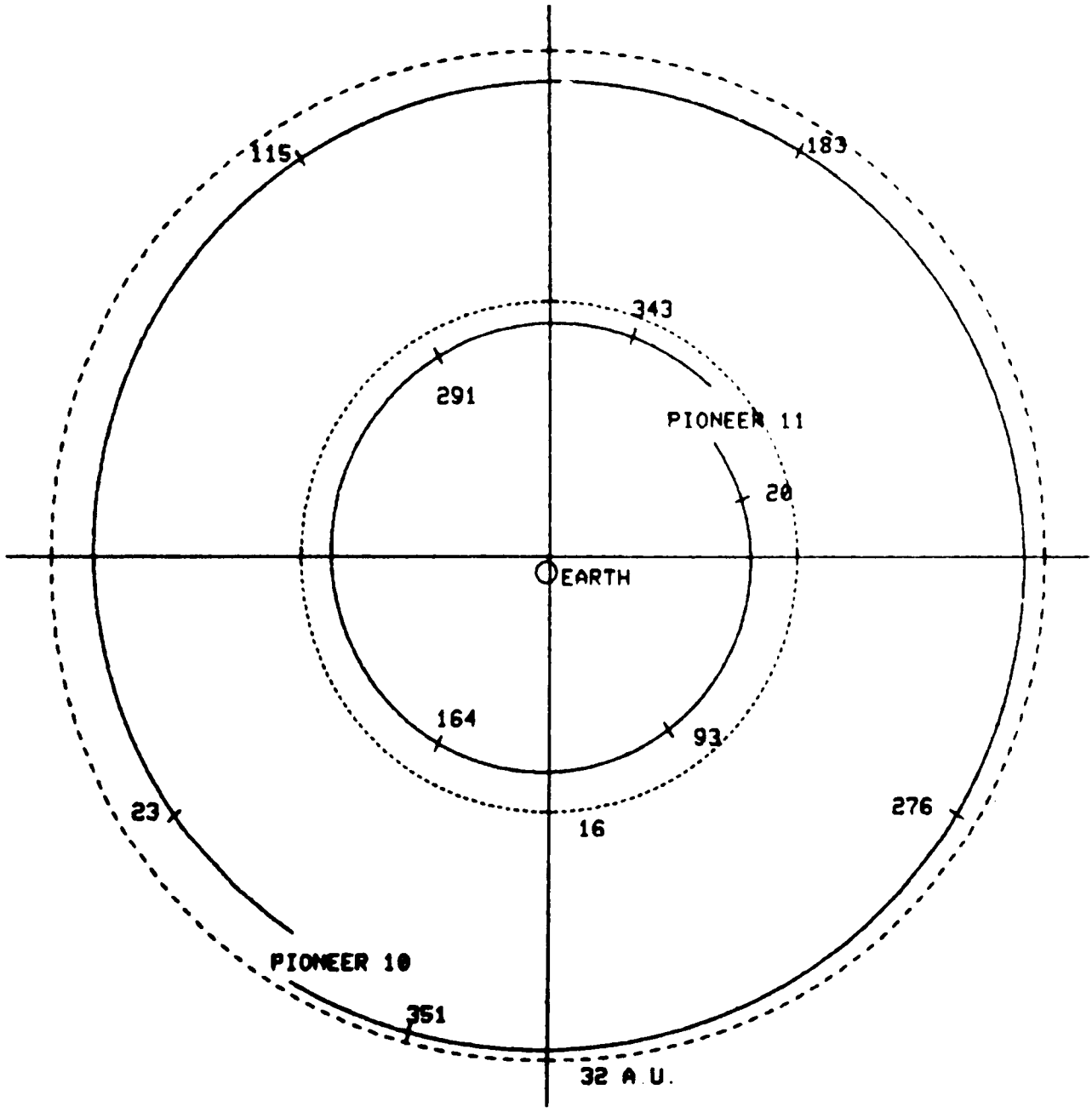
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1982/ 1/ 0.00 STOP TIME = 1983/ 1/ 0.00



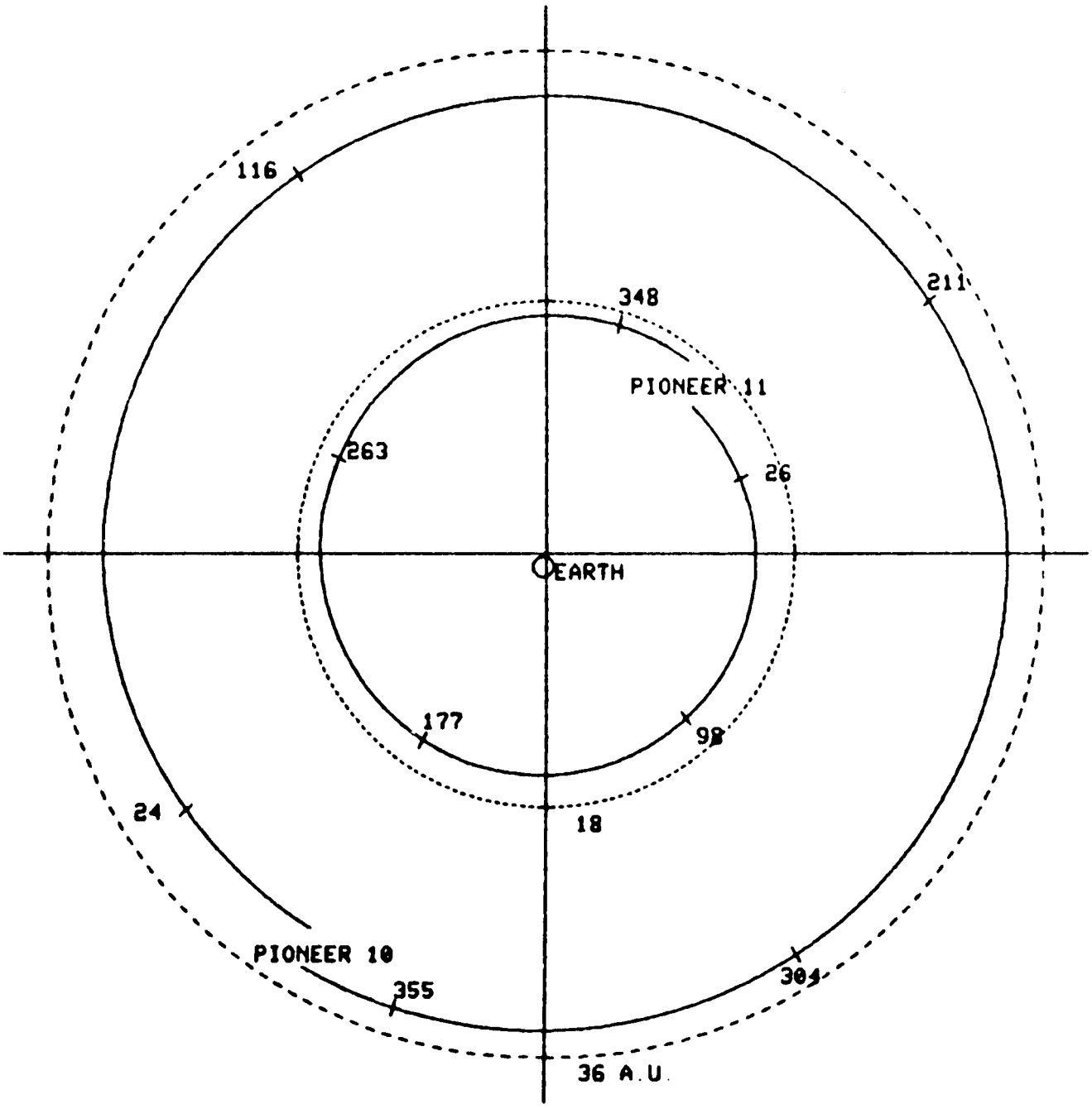
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1983/ 1/ 0.00 STOP TIME = 1984/ 1/ 0.00



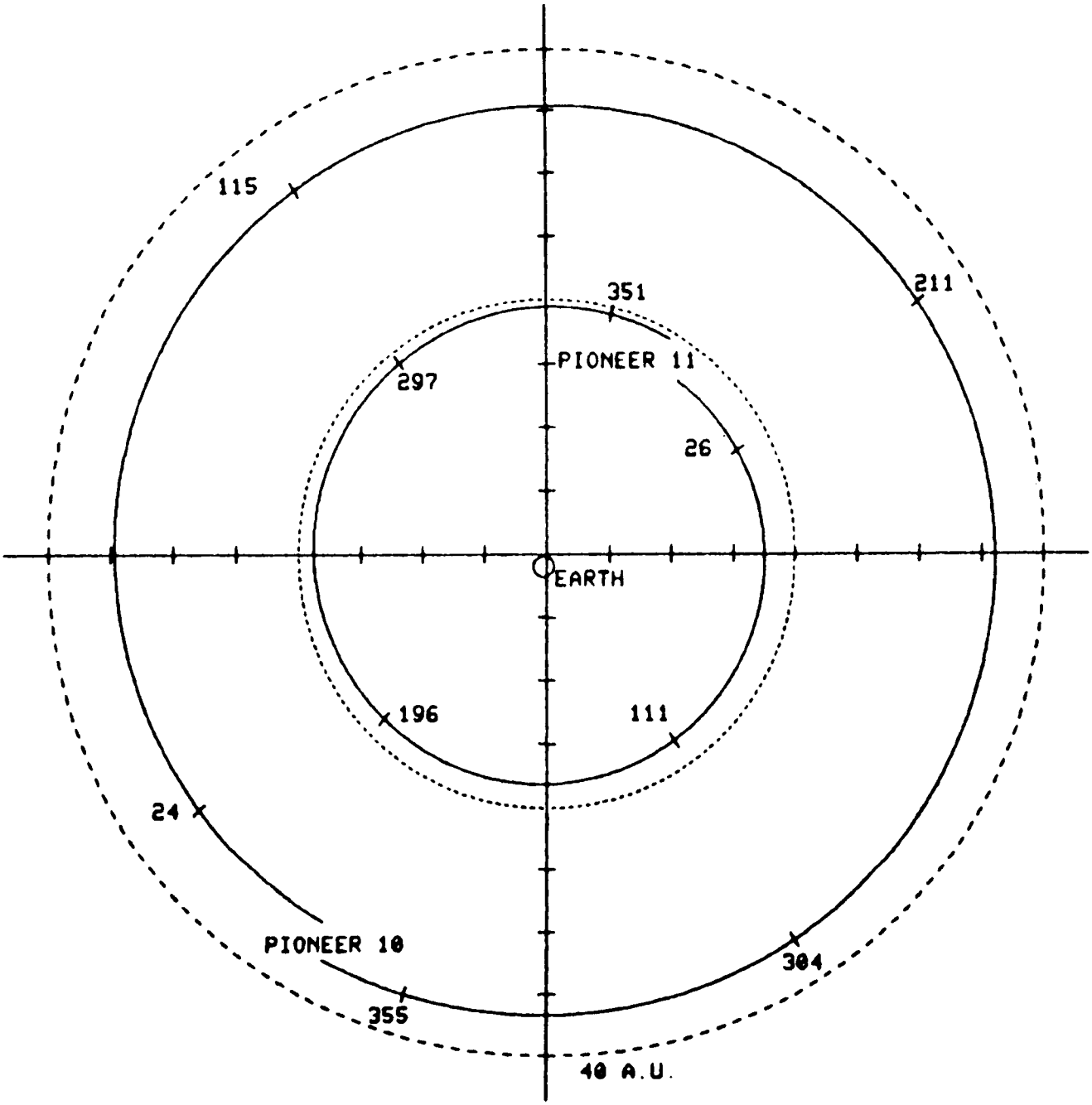
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1984/ 1/ 0 00 STOP TIME = 1985/ 1/ 0 00



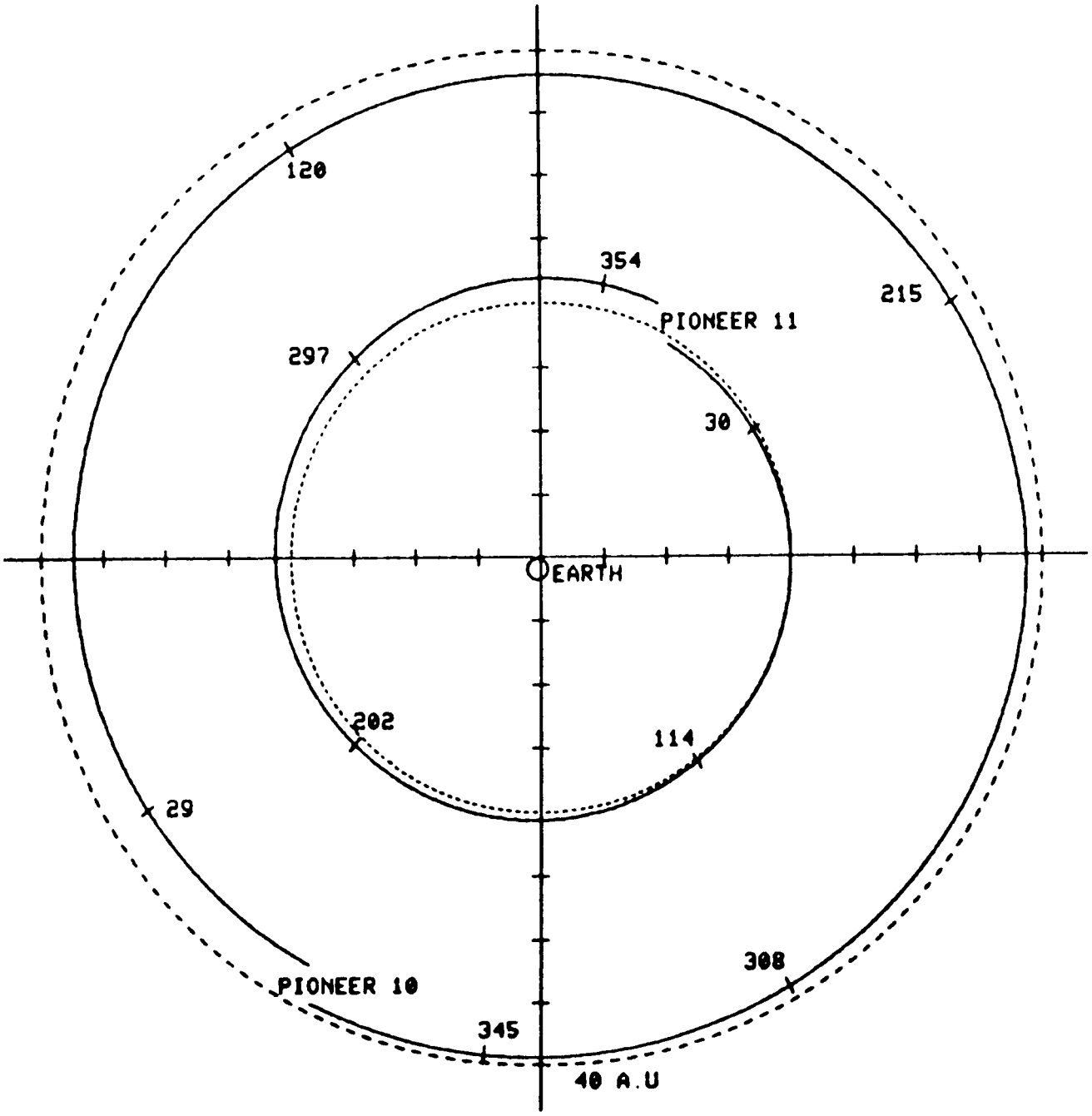
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME • 1985/ 1/ 0 00 STOP TIME • 1986/ 1/ 0.00



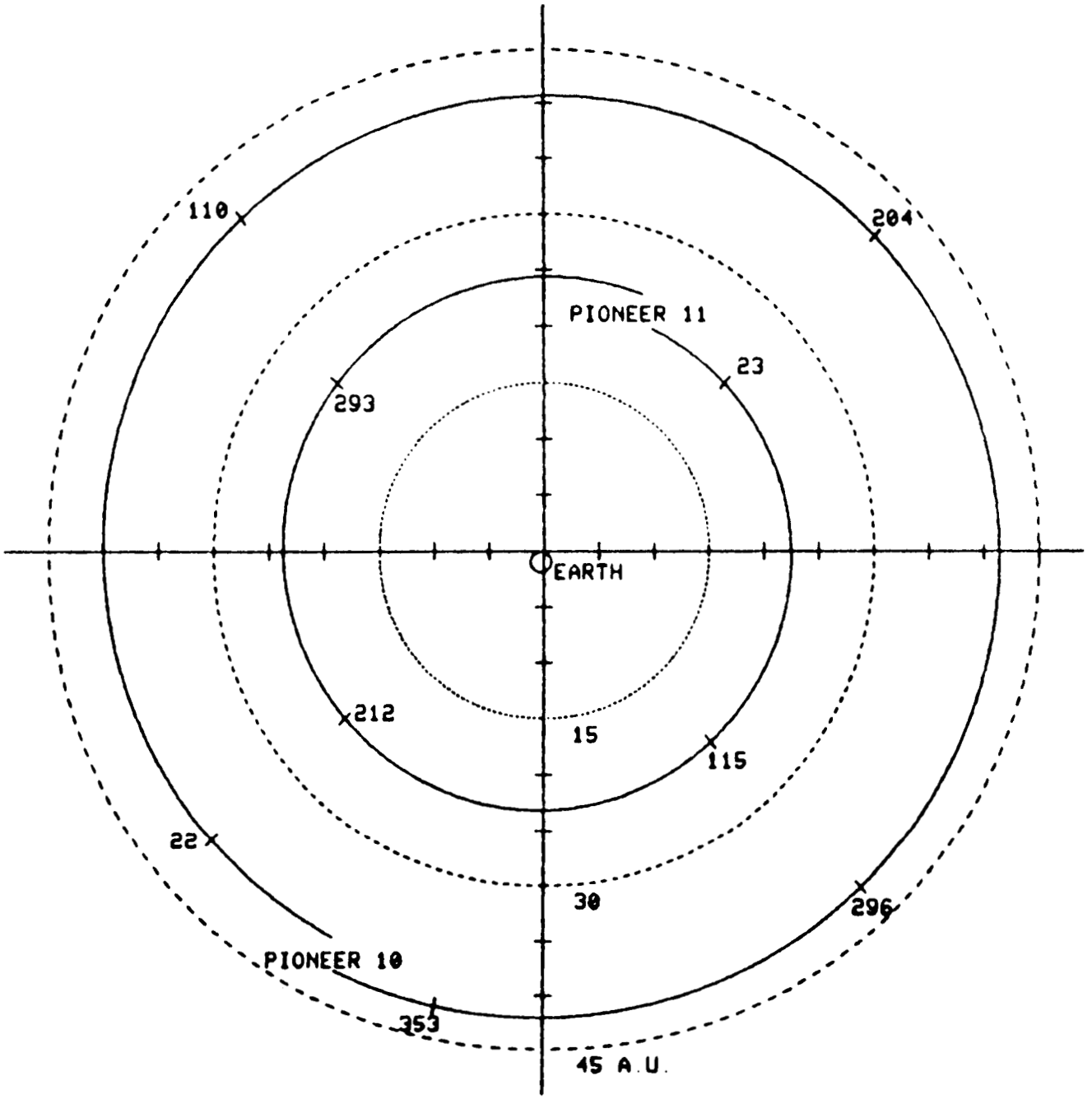
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1986/ 1/ 0.00 STOP TIME = 1987/ 1/ 0.00



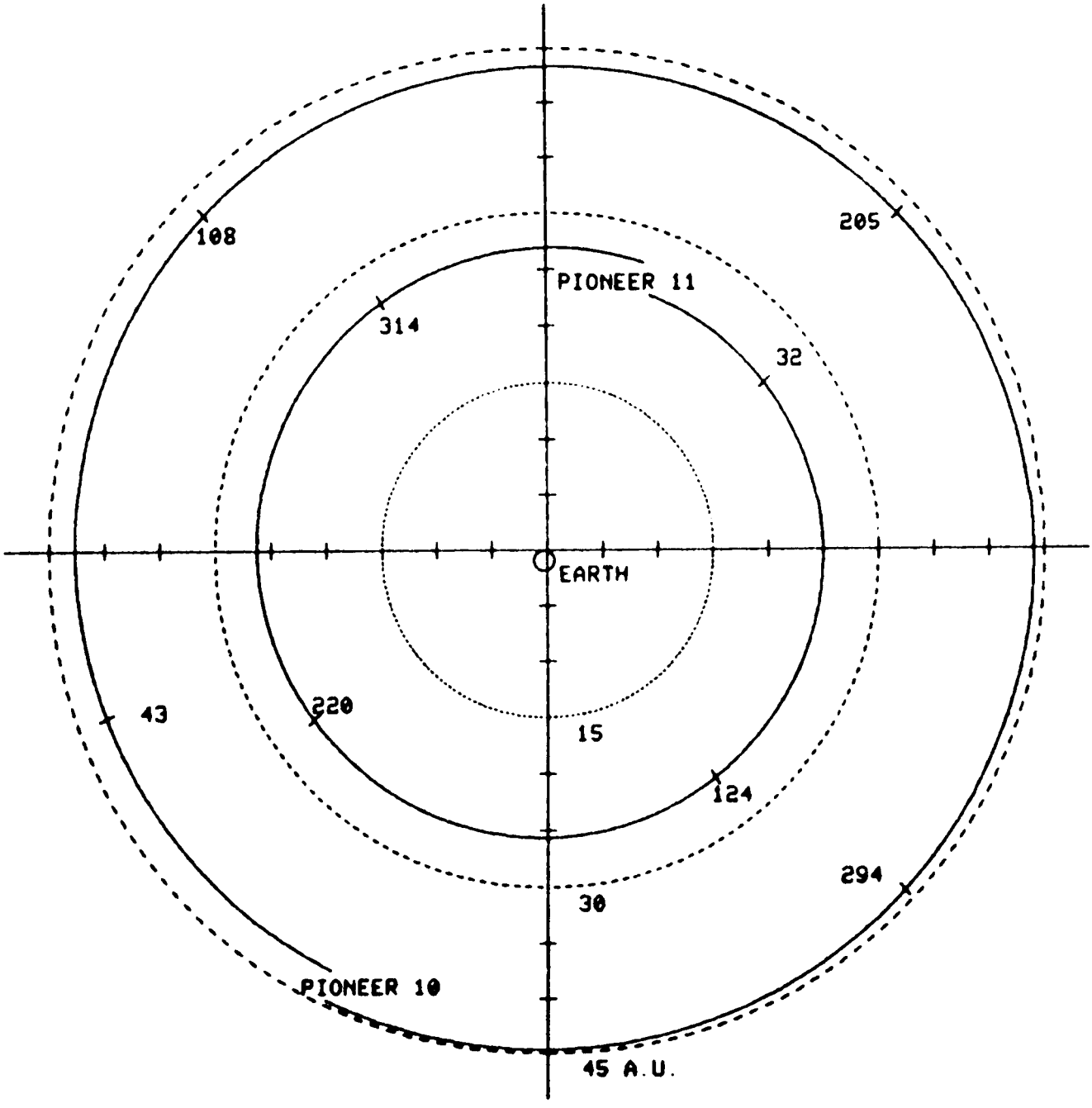
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1987/ 1/ 0.00 STOP TIME = 1988/ 1/ 0.00



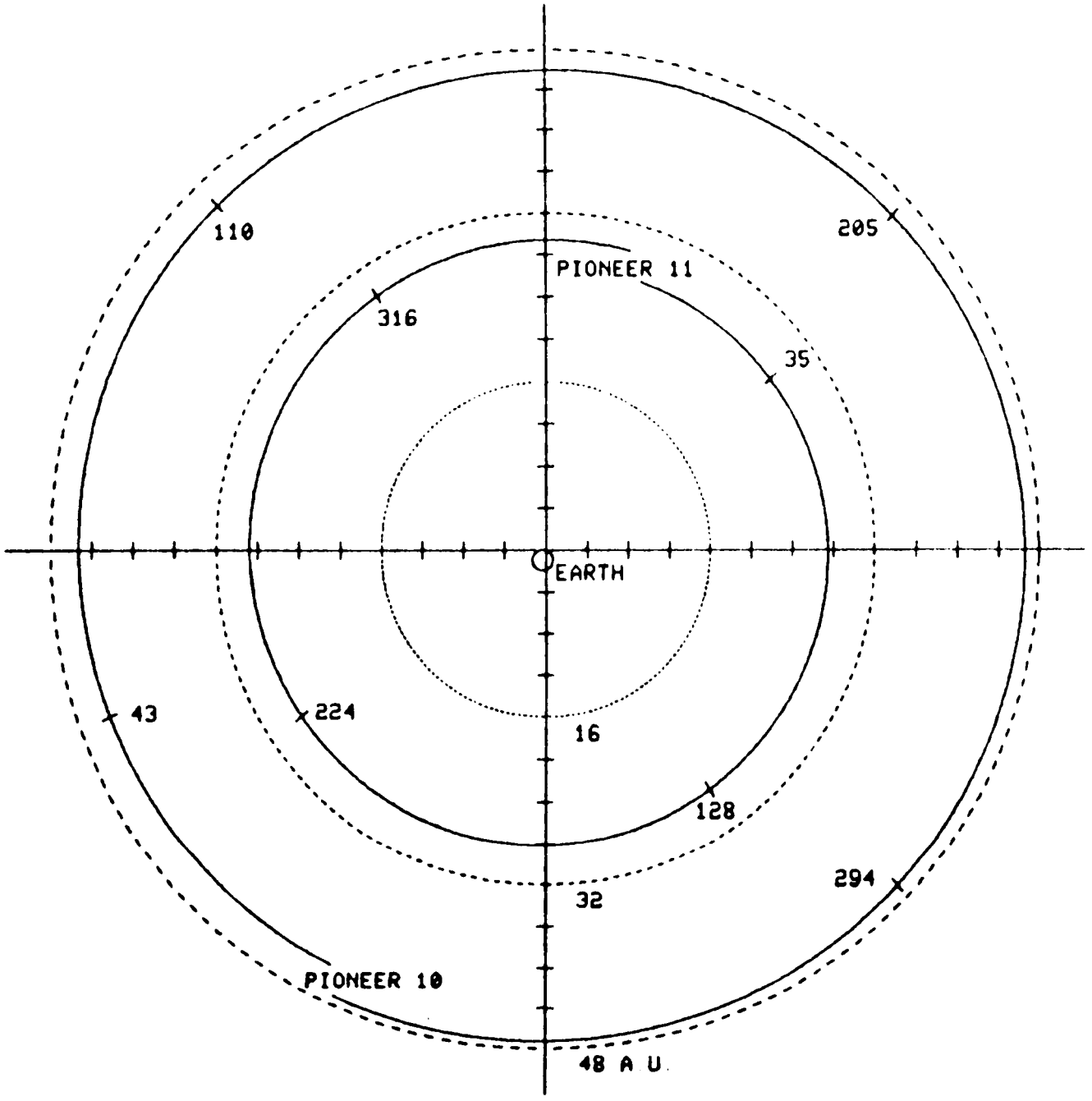
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1988/ 1/ 0.00 STOP TIME = 1989/ 1/ 0 00



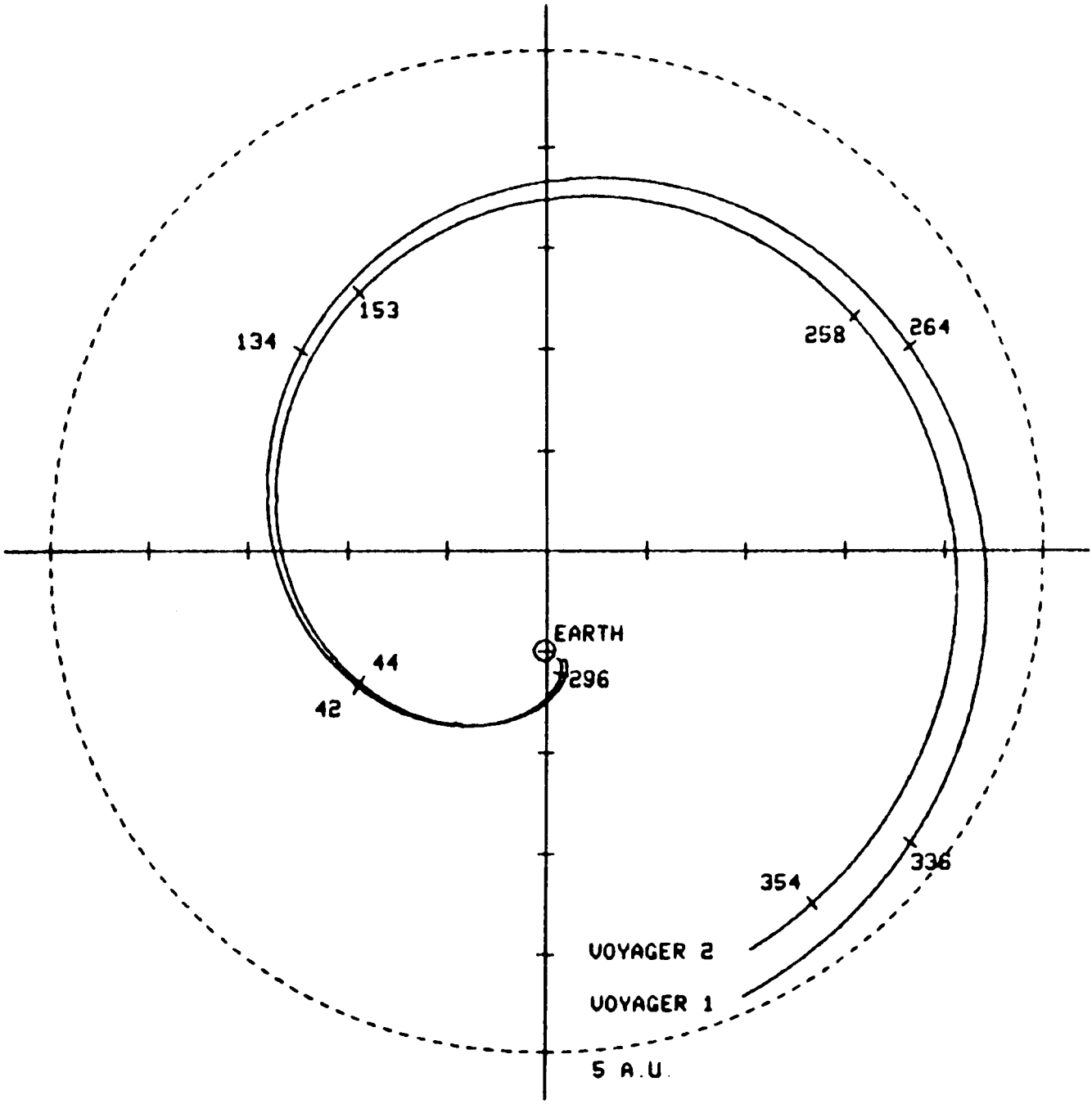
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1989/ 1/ 0 00 STOP TIME = 1990/ 1/ 0 00



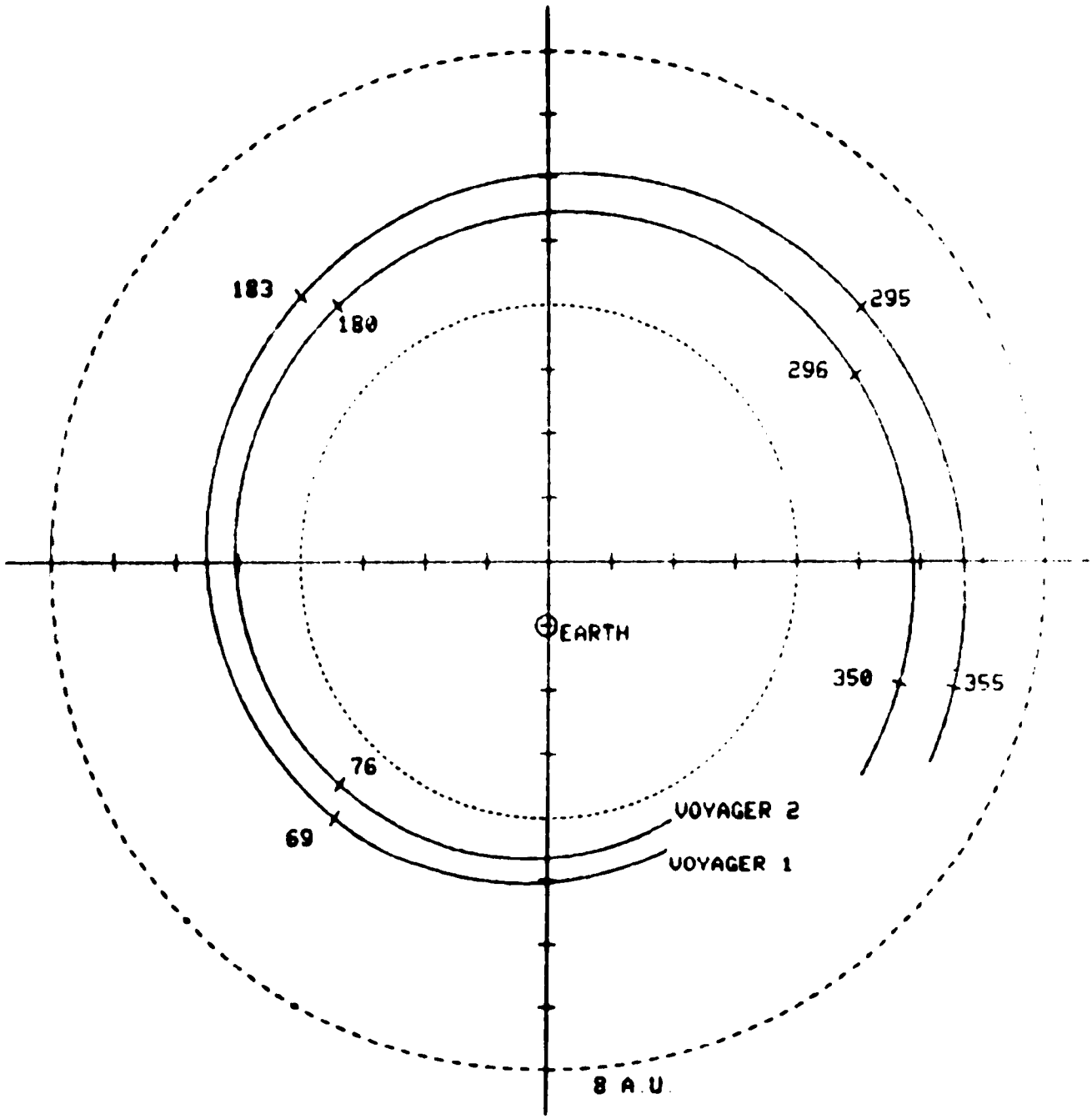
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME • 1977/274/ 0.00 STOP TIME • 1979/ 1/ 0 00



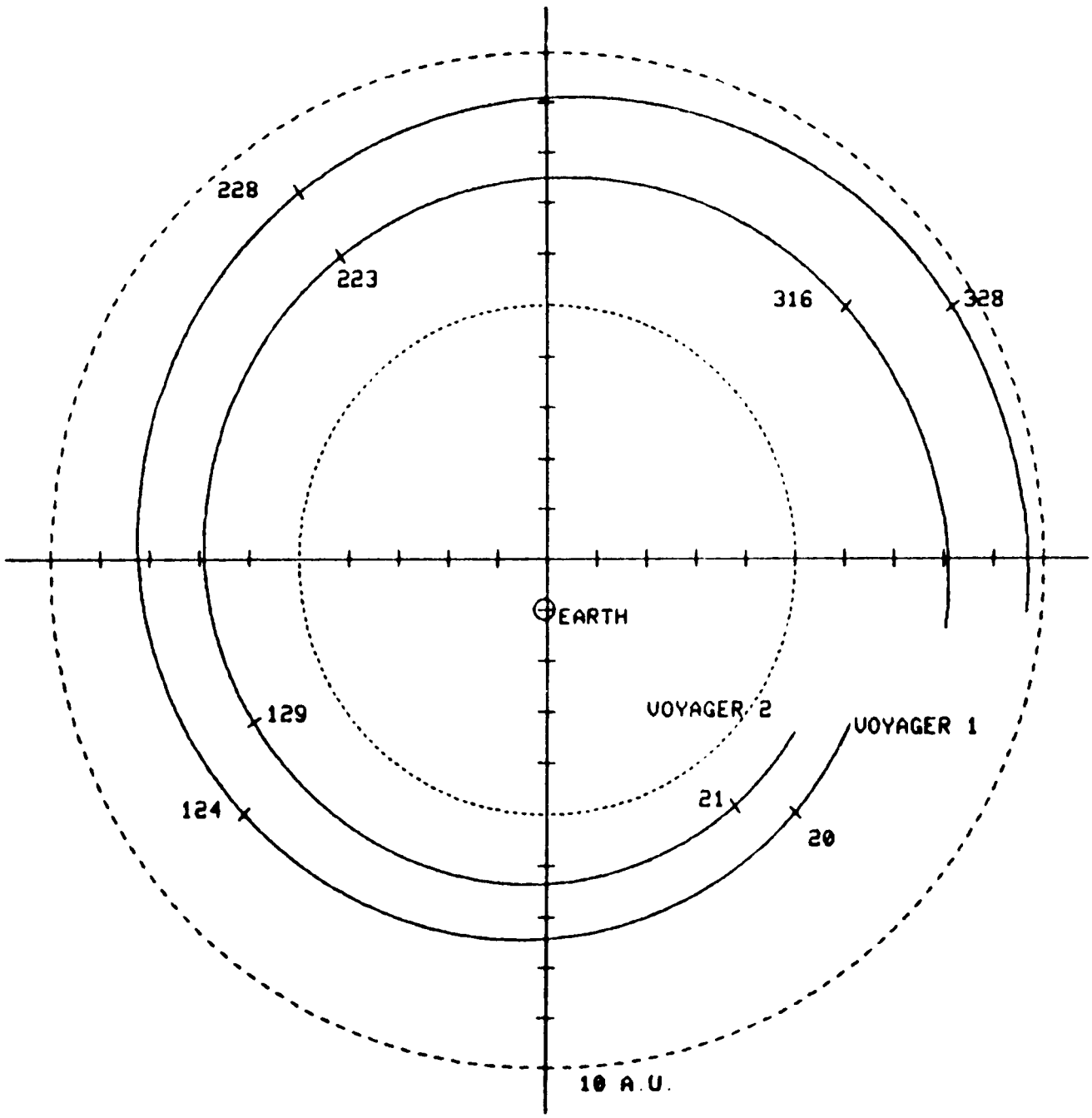
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1979/ 1/ 0.00 STOP TIME = 1980/ 1/ 0 00



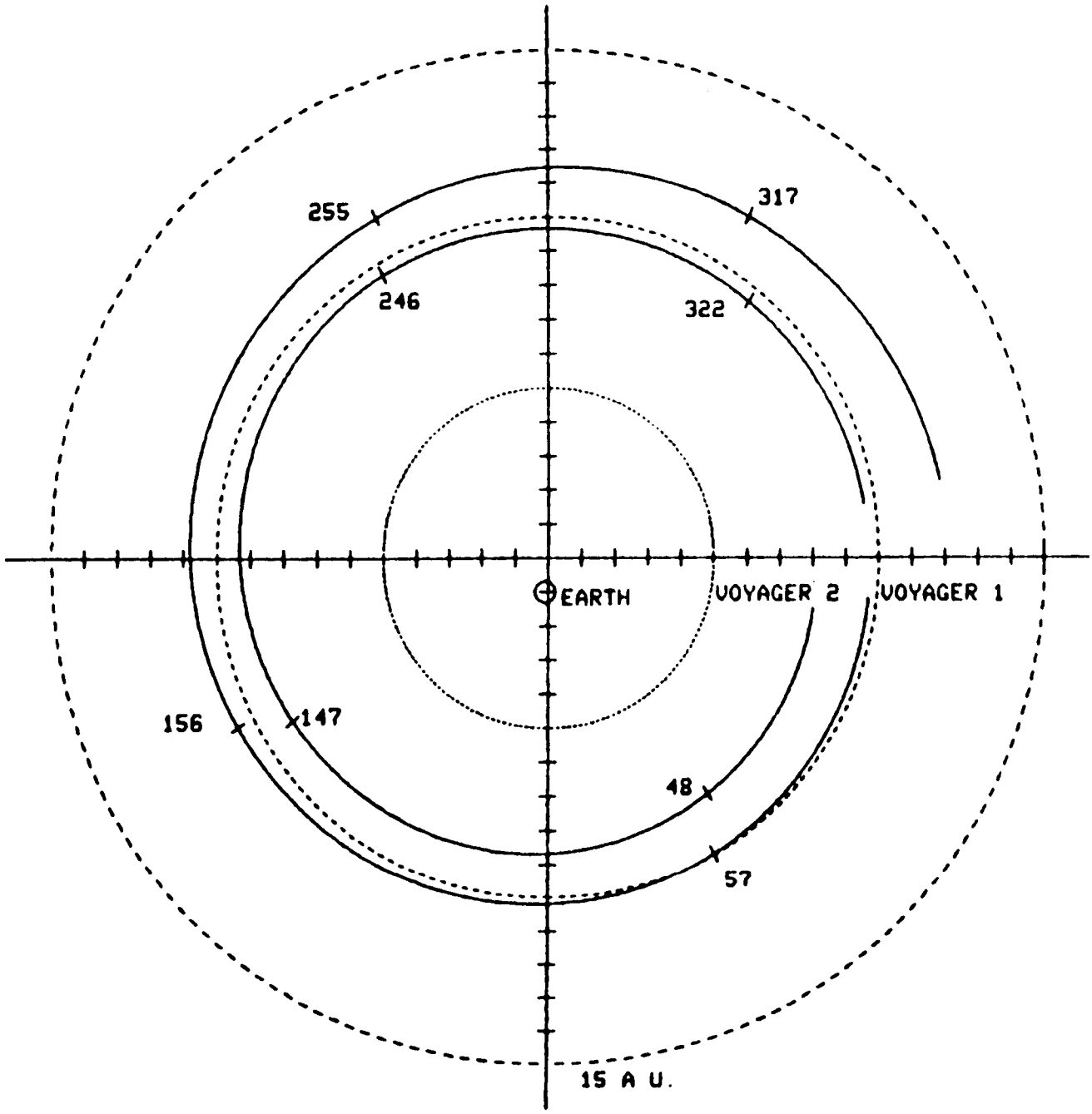
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1980/ 1/ 0.00 STOP TIME = 1981/ 1/ 0 00



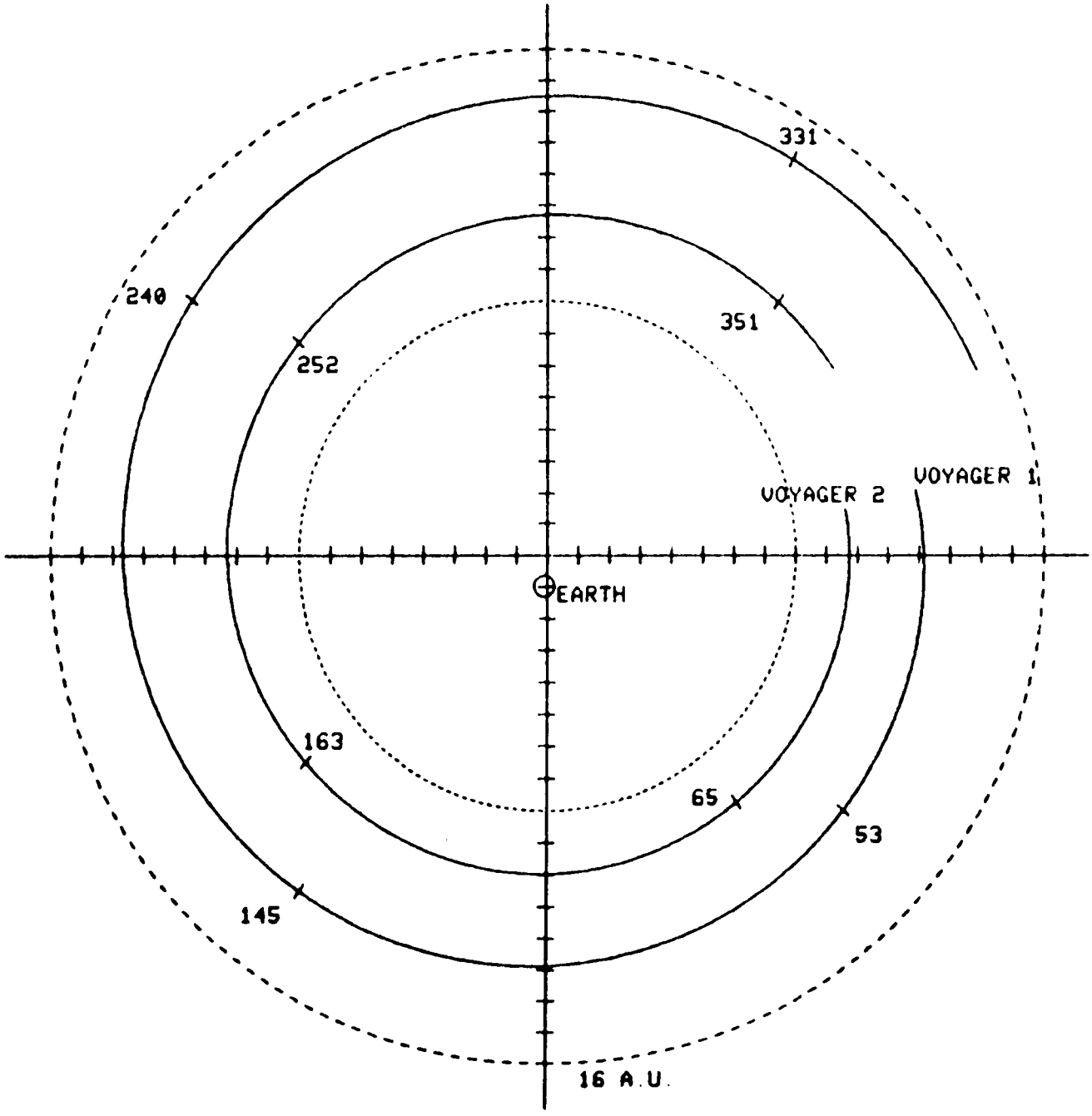
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1981/ 1/ 0.00 STOP TIME = 1982/ 1/ 0 00



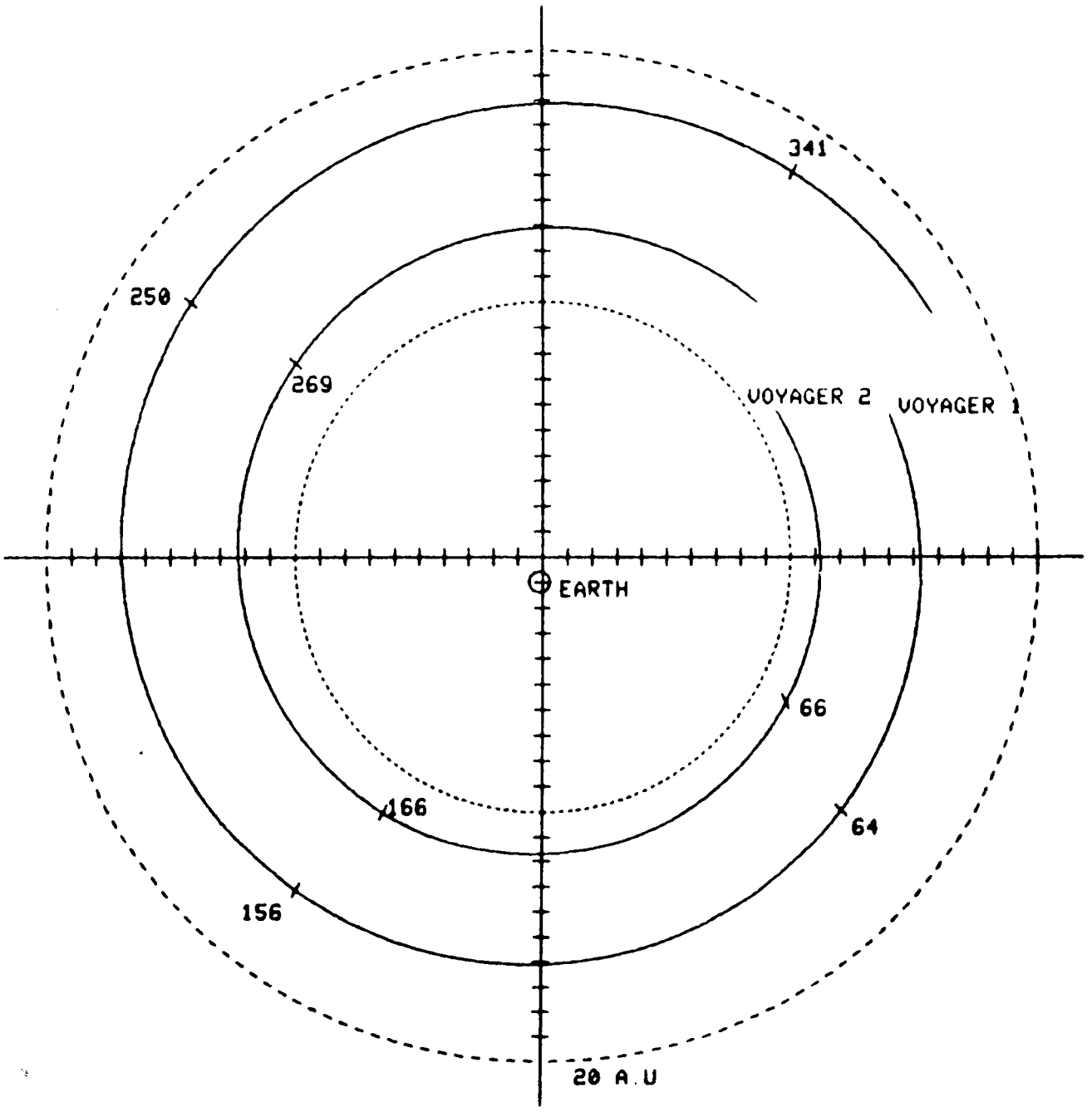
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME • 1982/ 1/ 0.00 STOP TIME • 1983/ 1/ 0.00



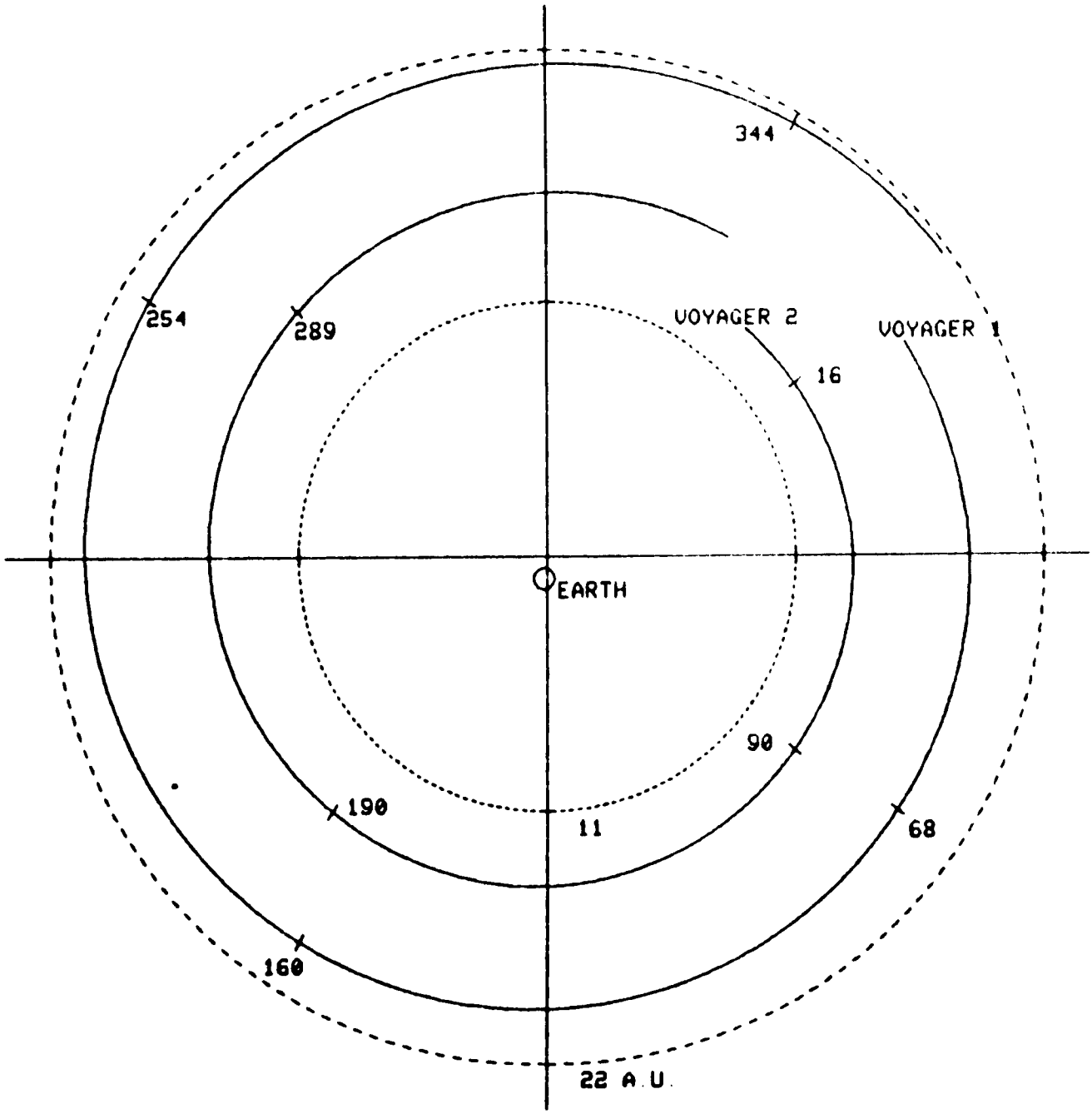
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1983/ 1/ 0 00 STOP TIME = 1984/ 1/ 0 00



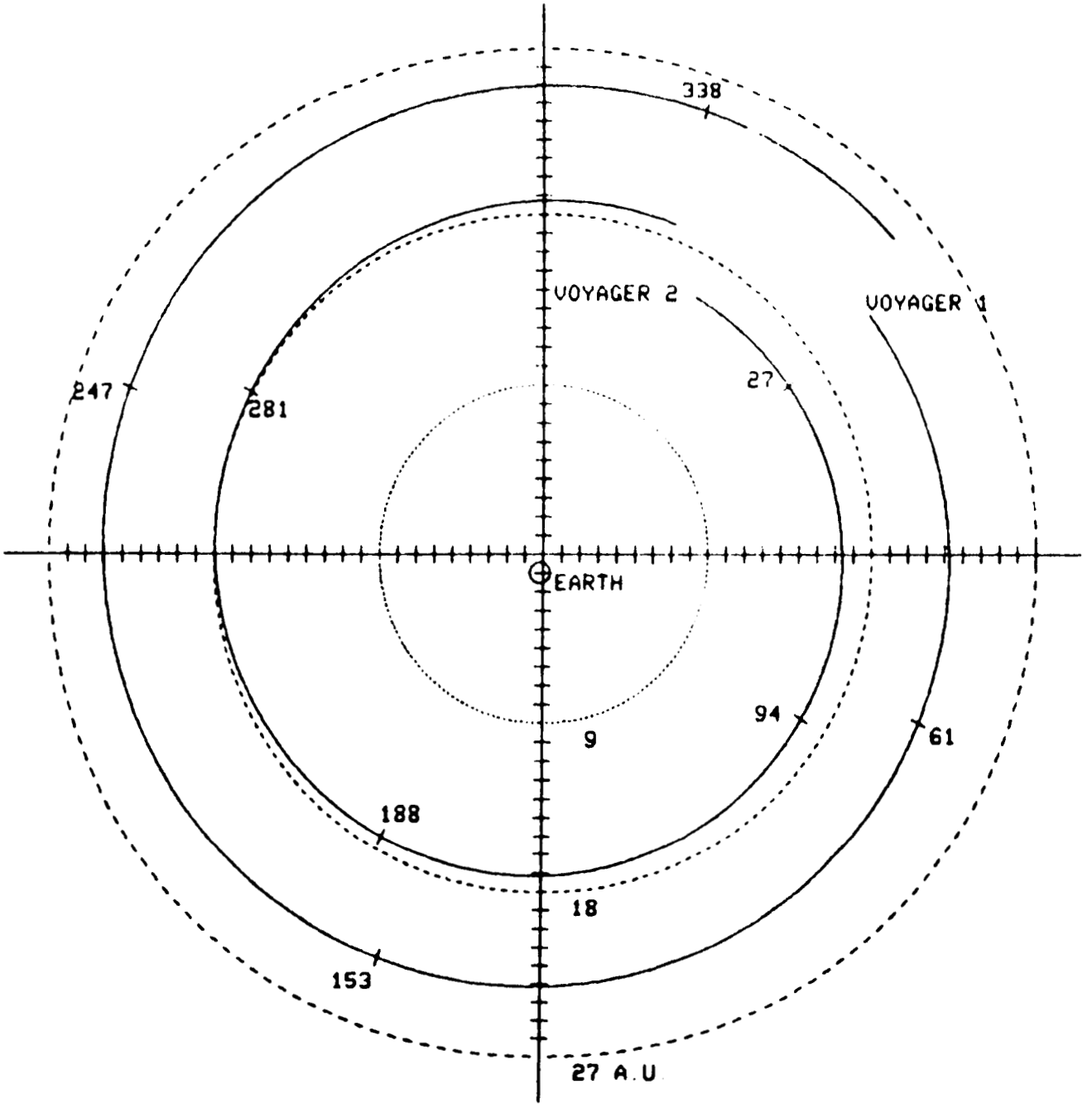
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME • 1984/ 1/ 0 00 STOP TIME • 1985/ 1/ 0 00



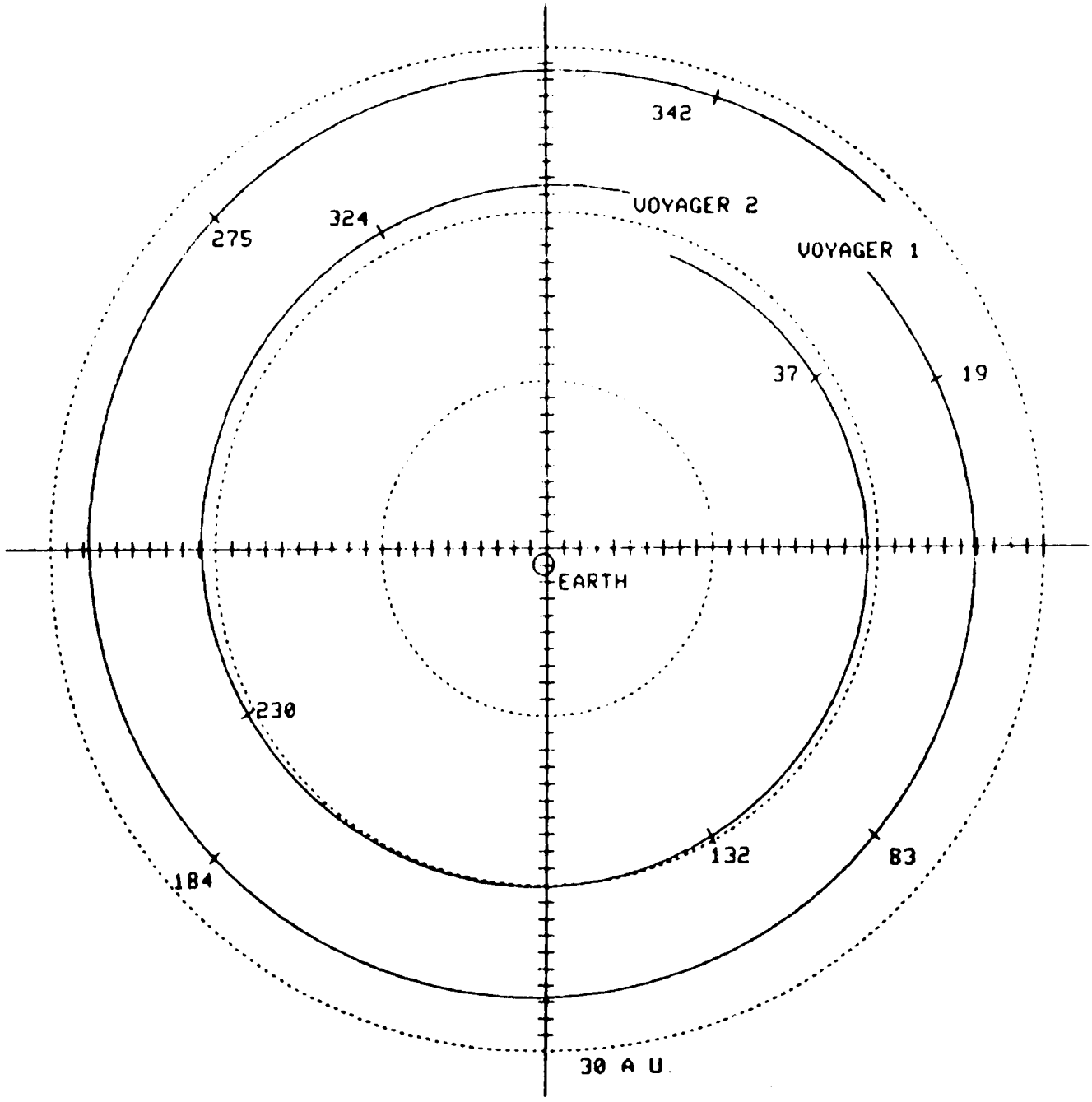
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1985/ 1/ 0 00 STOP TIME = 1986/ 1/ 0 00



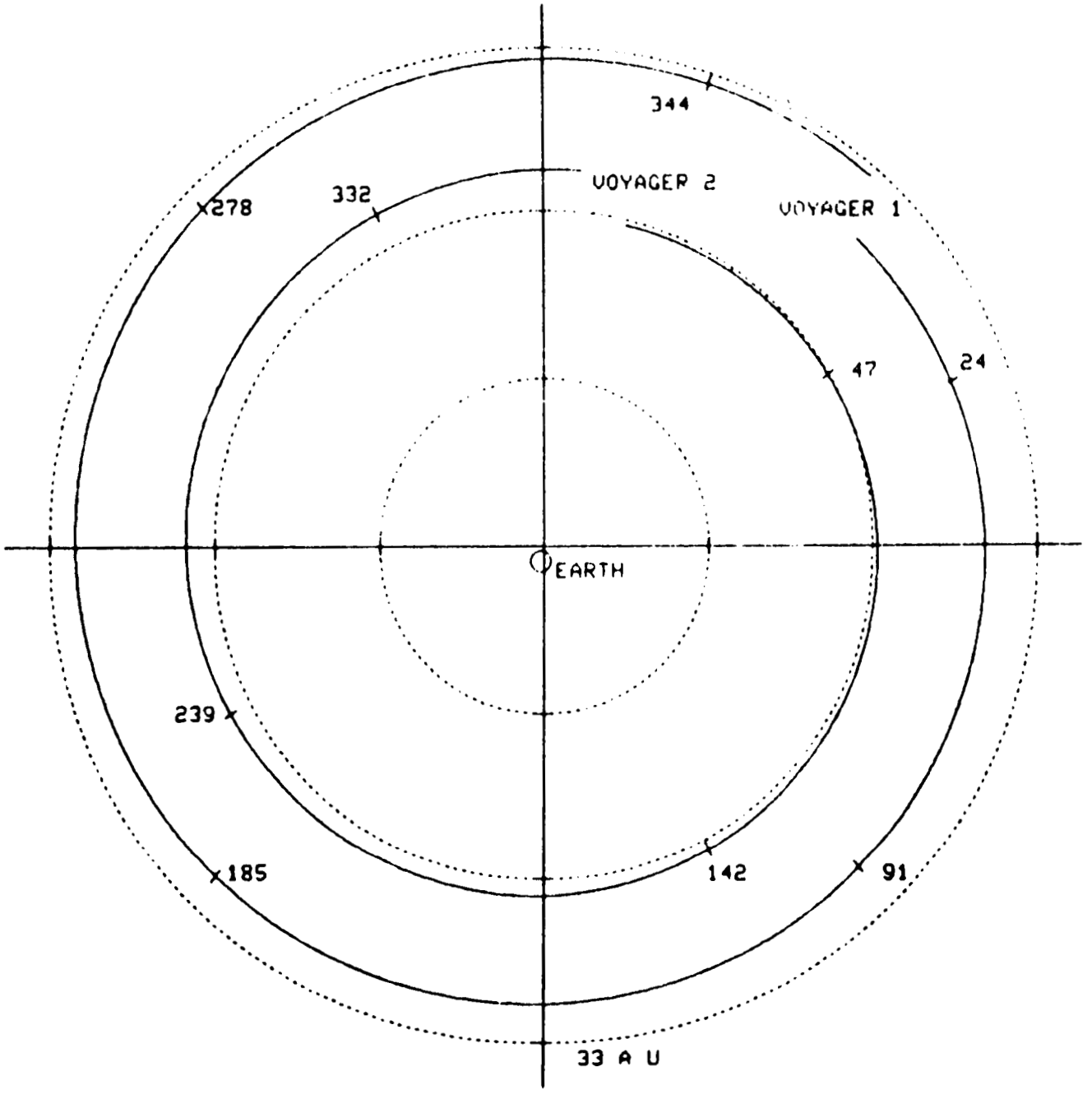
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1986/ 1/ 0 00 STOP TIME = 1987/ 1/ 0 00



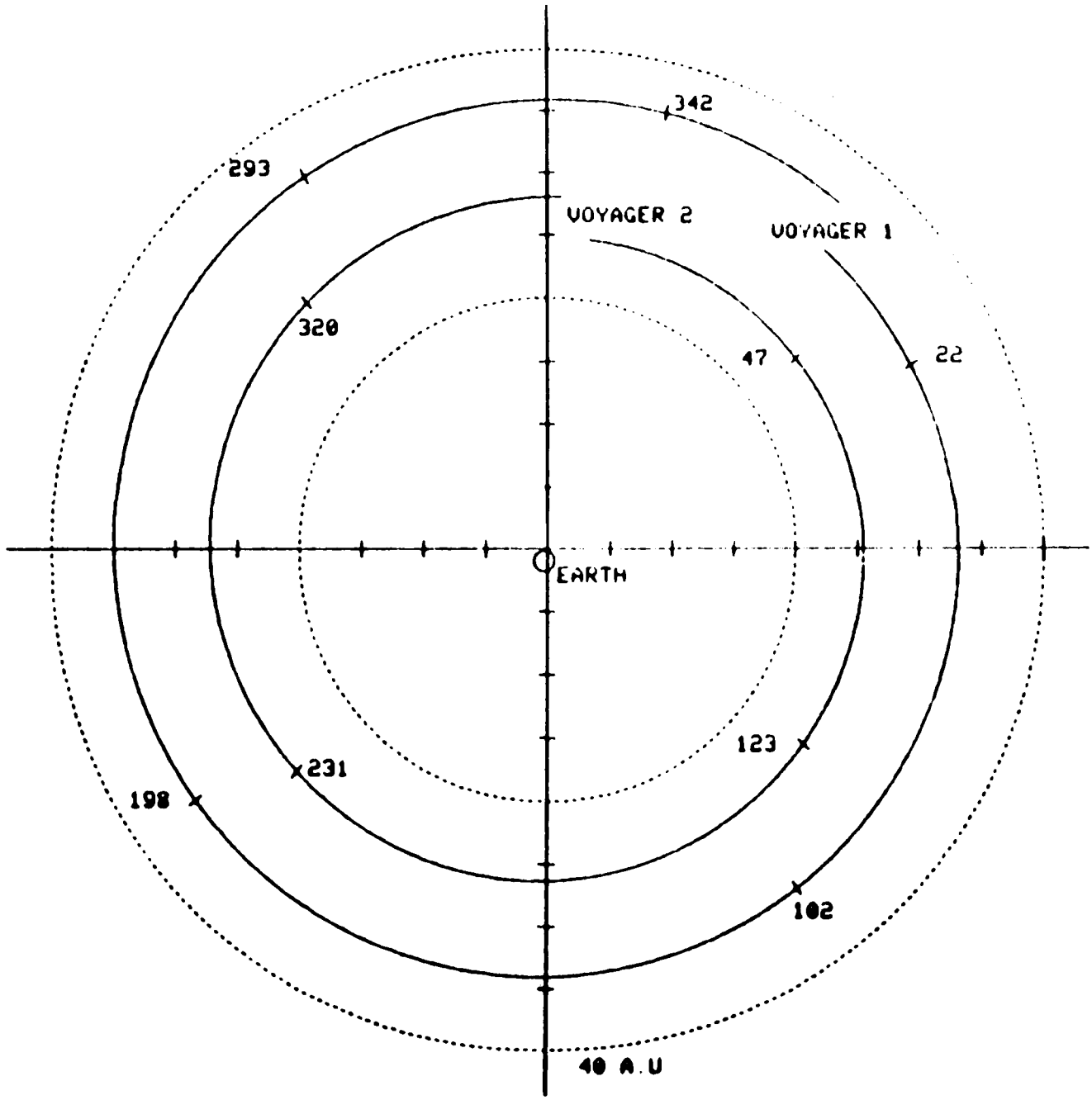
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME • 1987/ 1/ 0 00 STOP TIME • 1988/ 1/ 0 00



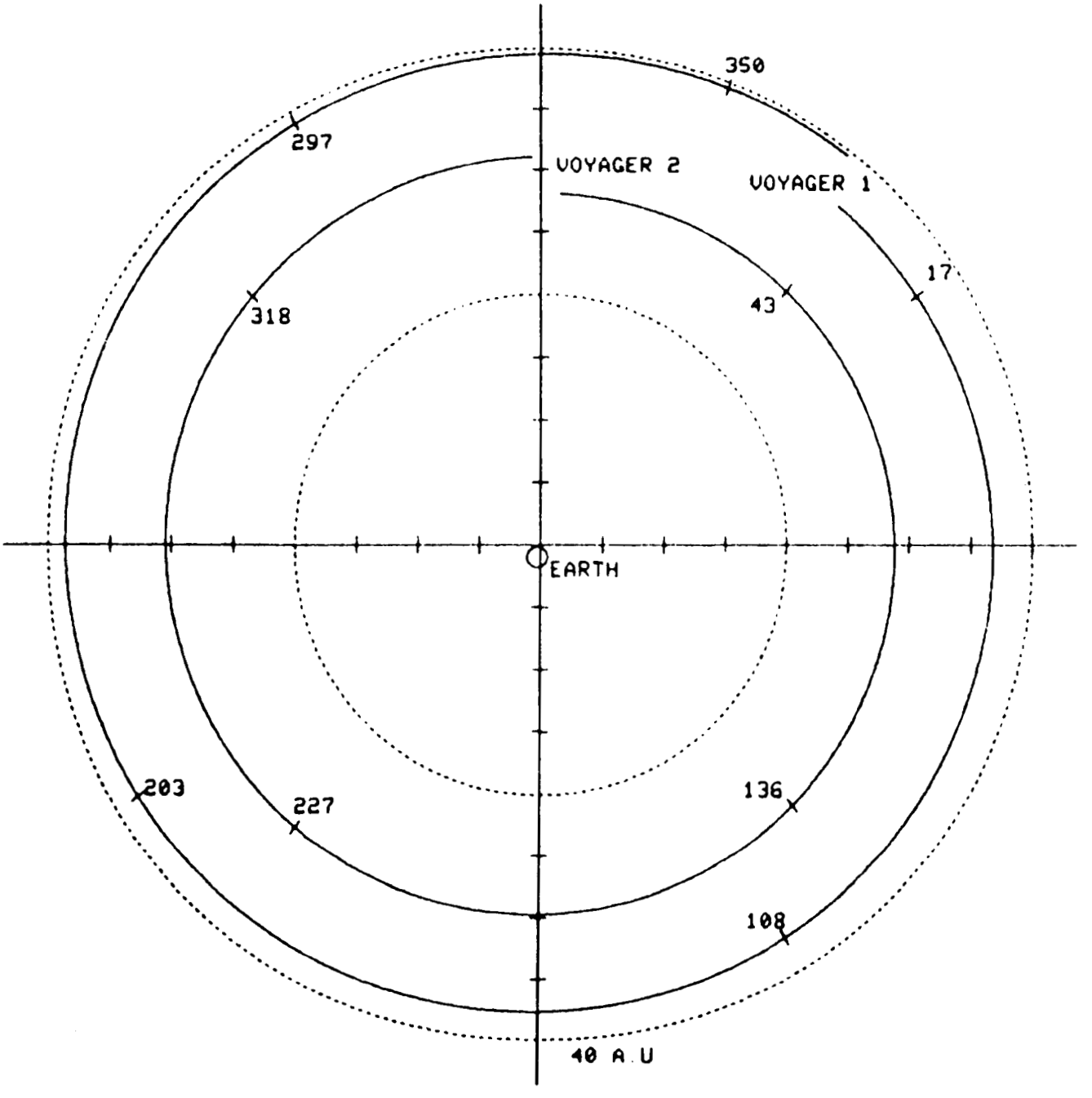
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME • 1988/ 1/ 0 00 STOP TIME • 1989/ 1 0 00



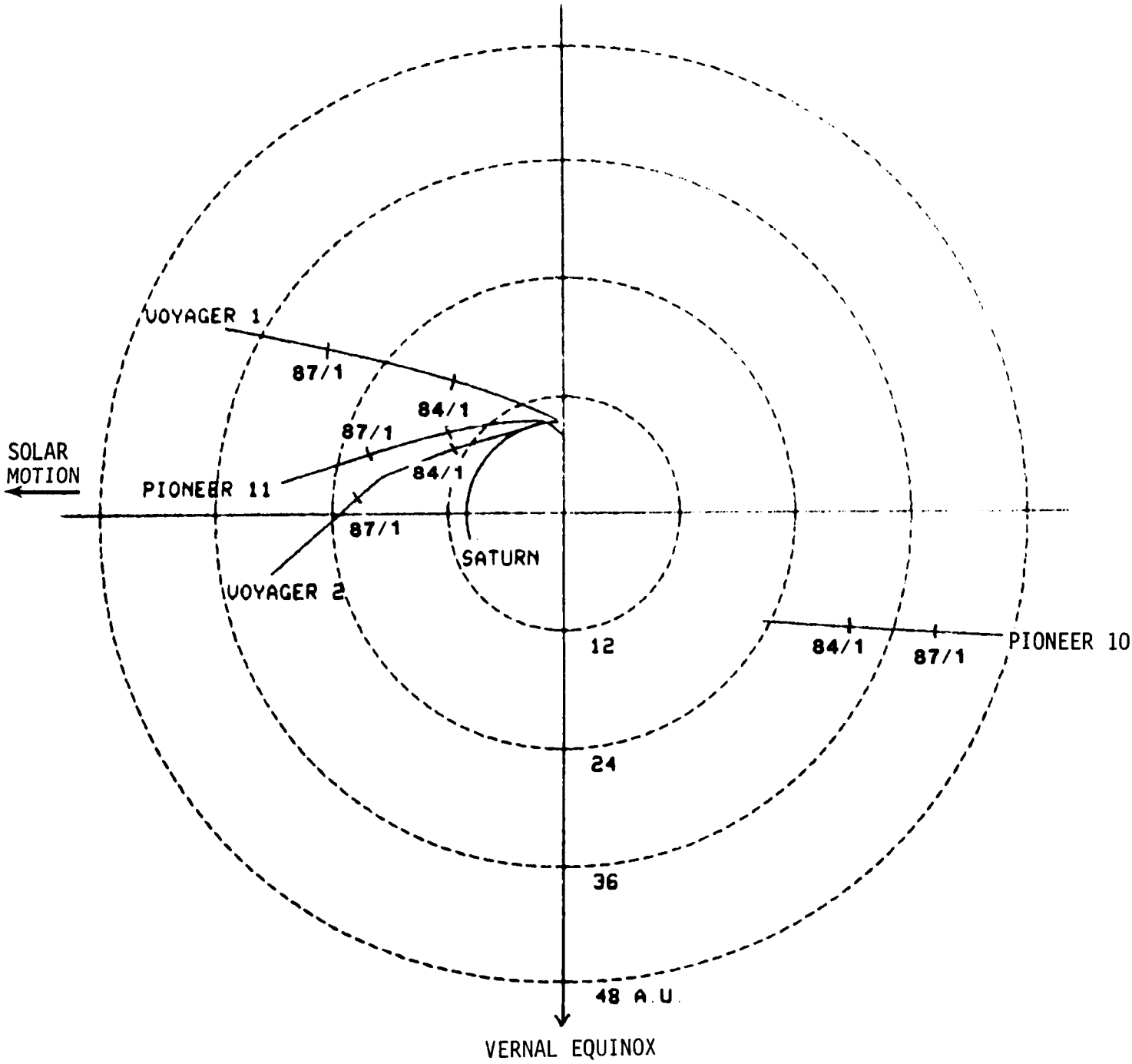
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1989/ 1/ 0 00 STOP TIME = 1990/ 1/ 0 00



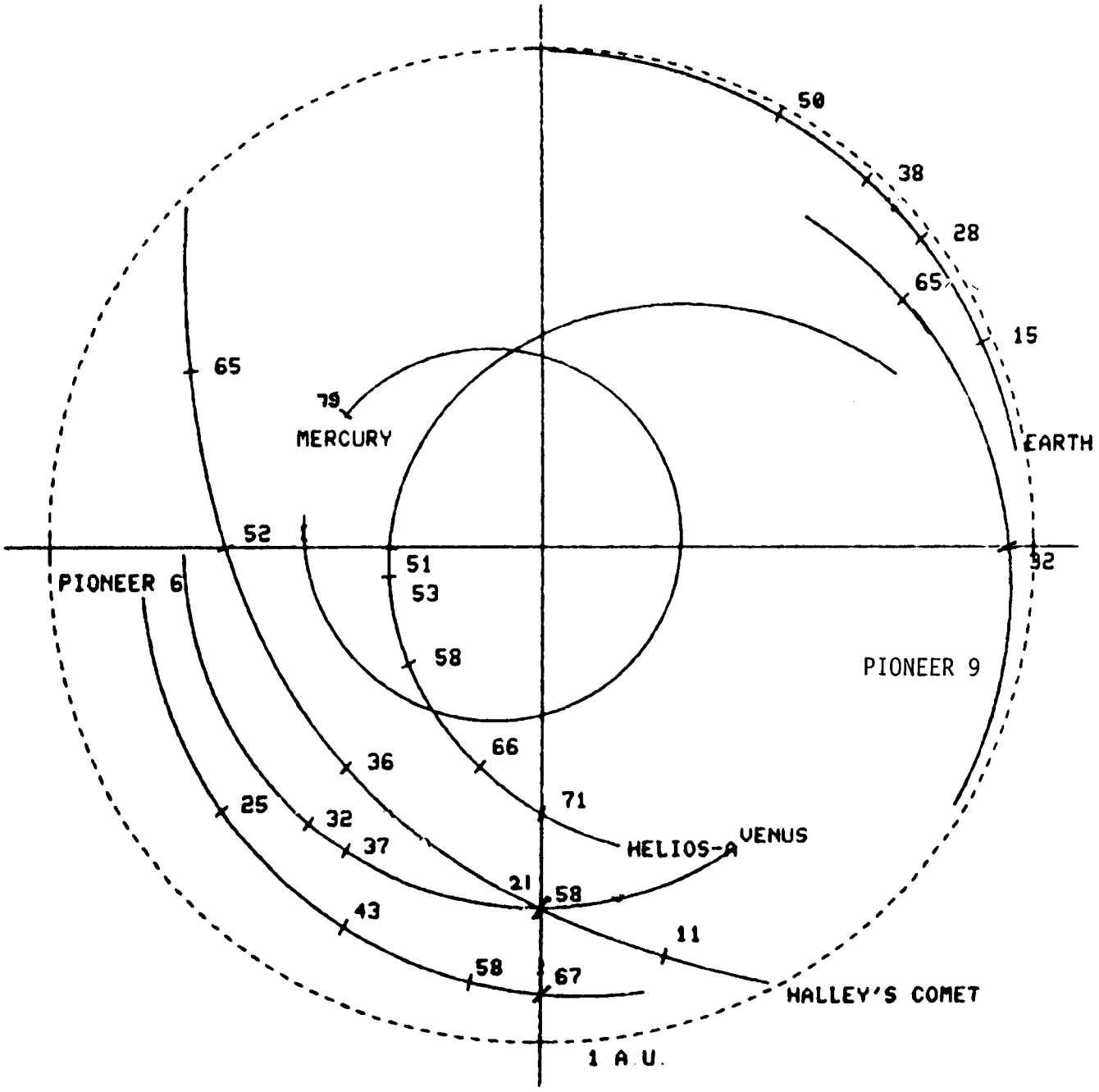
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME • 1981/ 1/ 0 00 STOP TIME • 1990/ 1/ 0 00

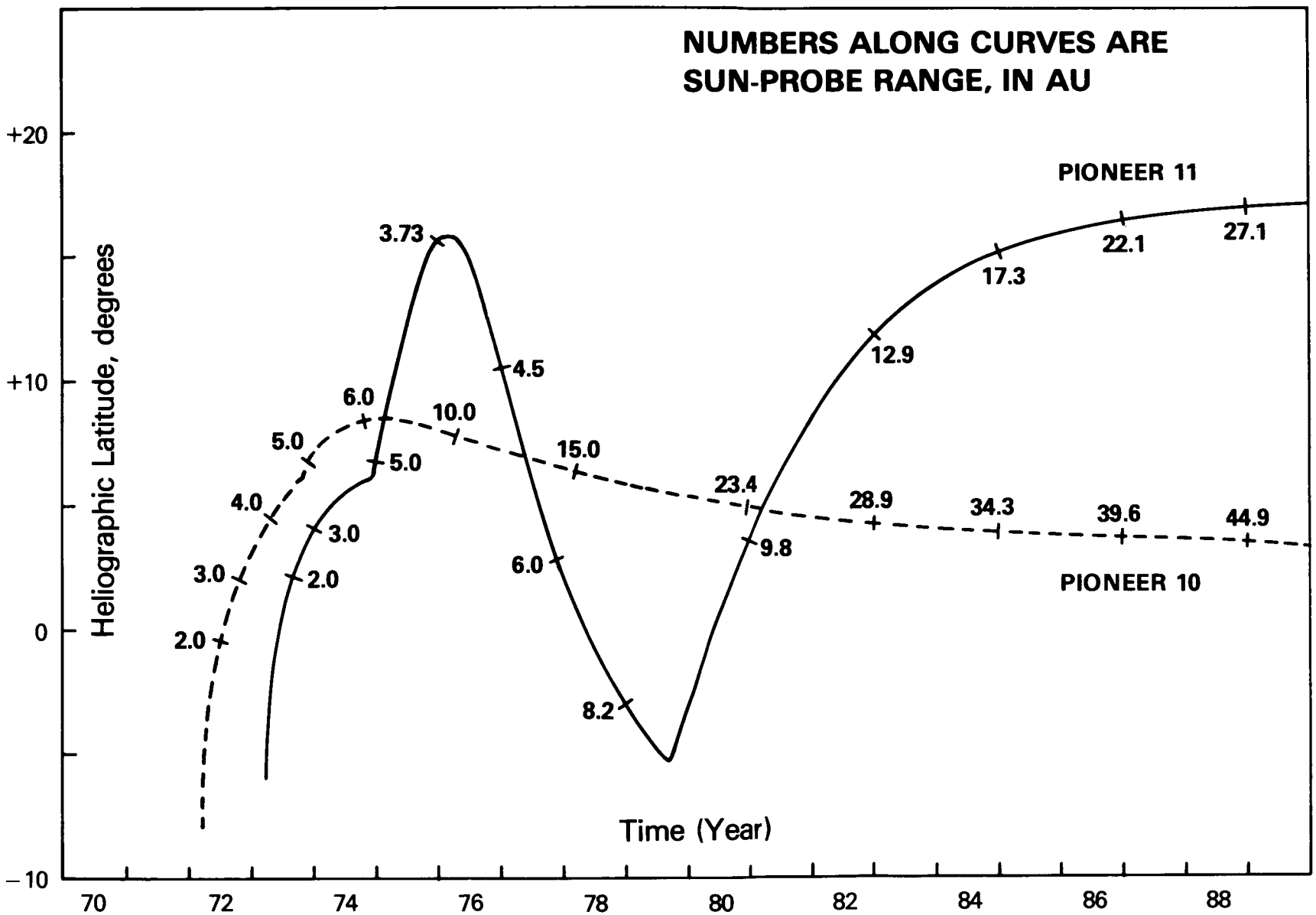


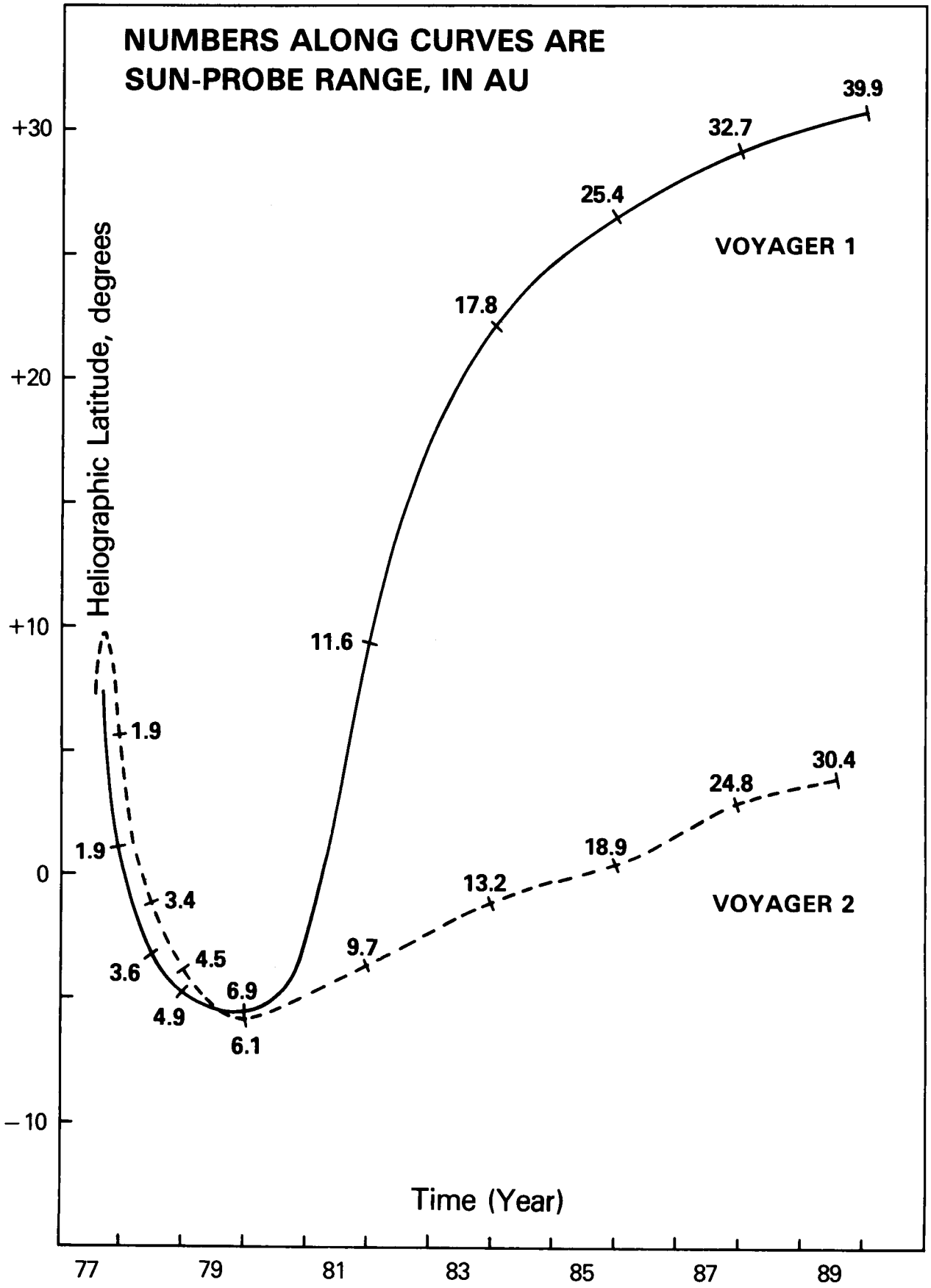
HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE

START TIME = 1986/ 2/ 0.00 STOP TIME = 1986/ 79/ 0 00



HELIOCENTRIC ORBITS PROJECTED ONTO ECLIPTIC PLANE


NUMBERS ALONG CURVES ARE
SUN-PROBE RANGE, IN AU
PIONEER 11
PIONEER 10
Heliographic Latitude, degrees
Time (Year)
+20
+10
0
−10
70
72
74
76
78
80
82
84
86
88
3.73
4.5
6.0
8.2
5.0
3.0
2.0
6.0
10.0
15.0
23.4
28.9
34.3
39.6
44.9
5.0
4.0
3.0
2.0
9.8
12.9
17.3
22.1
27.1


NUMBERS ALONG CURVES ARE
SUN-PROBE RANGE, IN AU
Heliographic Latitude, degrees
+30
+20
+10
0
−10
Time (Year)
77
79
81
83
85
87
89
VOYAGER 1
VOYAGER 2
39.9
32.7
25.4
17.8
11.6
1.9
1.9
3.4
3.6
4.5
4.9
6.9
6.1
9.7
13.2
18.9
24.8
30.4