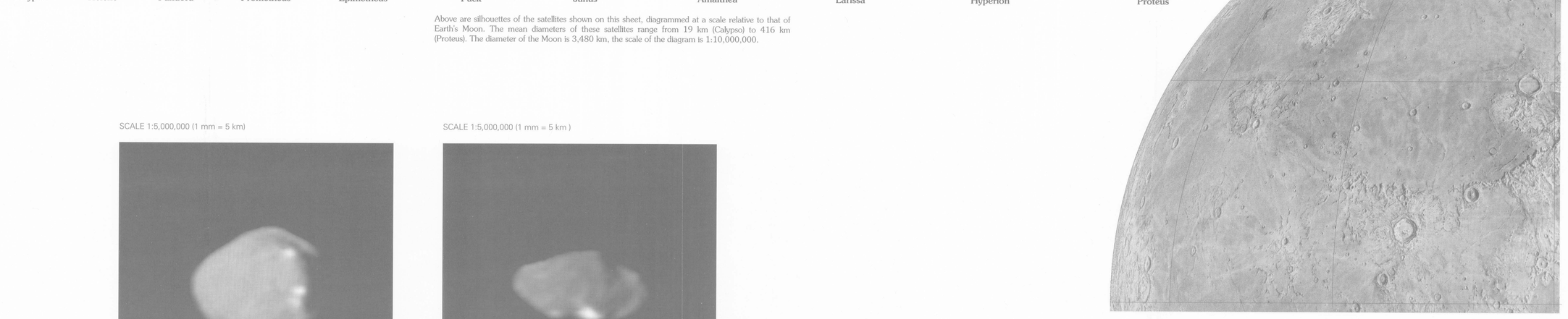
U. S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared for the
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

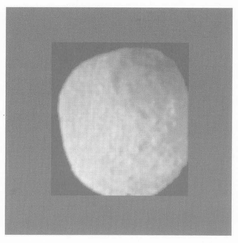
ATLAS OF THE SOLAR SYSTEM
TOPOGRAPHIC SERIES
OUTER PLANETS, IRREGULARLY SHAPED SATELLITES, 1995
I–2410



Above are silhouettes of the satellites shown on this sheet, diagrammed at a scale relative to that of Earth's Moon. The mean diameters of these satellites range from 19 km (Calypso) to 416 km (Proteus). The diameter of the Moon is 3,480 km, the scale of the diagram is 1:10,000,000.

Lunar Nearside

SCALE 1:10,000,000 (1 mm = 10 km)



PROTEUS
(NEPTUNE)
FDS 1138920
Resolution km/pxl 1.33
Spacecraft Latitude 4.11
Spacecraft Longitude 333.92
Northing Azimuth 137.77
Subsol Latitude –23.20
Subsol Longitude 287.96
Phase 52.48

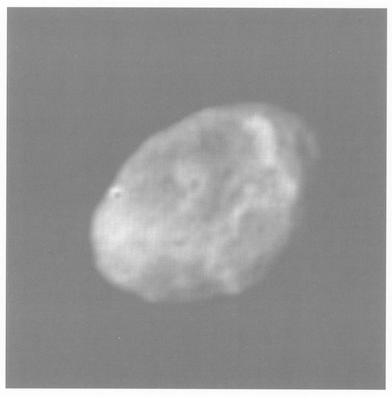
SCALE 1:5,000,000 (1 mm = 5 km)

AMALTHEA
(JUPITER)
FDS 1638131
Resolution km/pxl 3.86
Spacecraft Latitude –3.95
Spacecraft Longitude 194.90
Northing Azimuth 2.08
Subsol Latitude 0.87
Subsol Longitude 223.10
Phase 28.60

SCALE 1:5,000,000 (1 mm = 5 km)

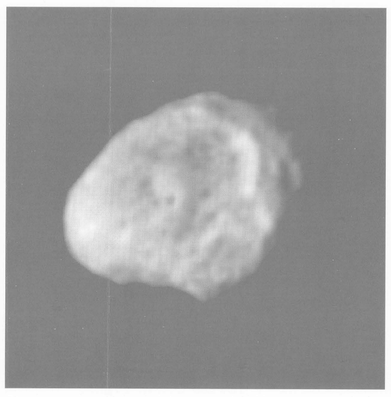
AMALTHEA
(JUPITER)
FDS 1637732
Resolution 6.42 km/pxl
Spacecraft Latitude –1.56
Spacecraft Longitude 91.90
Northing Azimuth 5.13
Subsol Latitude 0.87
Subsol Longitude 223.10
Phase 28.60

SCALE 1:5,000,000 (1 mm = 5 km)



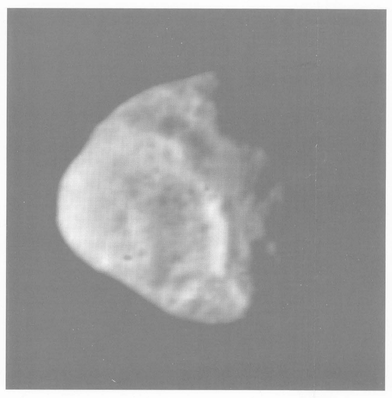
HYPERION
(SATURN)
FDS 4395906
Resolution 6.30 km/pxl
Spacecraft Latitude –17.73
Spacecraft Longitude 341.15
Northing Azimuth 12.49
Subsol Latitude –19.62
Subsol Longitude 19.46
Phase 36.27

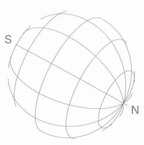
SCALE 1:5,000,000 (1 mm = 5 km)



HYPERION
(SATURN)
FDS 4396355
Resolution 5.25 km/pxl
Spacecraft Latitude –7.42
Spacecraft Longitude 339.04
Northing Azimuth 21.30
Subsol Latitude –19.63
Subsol Longitude 23.87
Phase 45.11

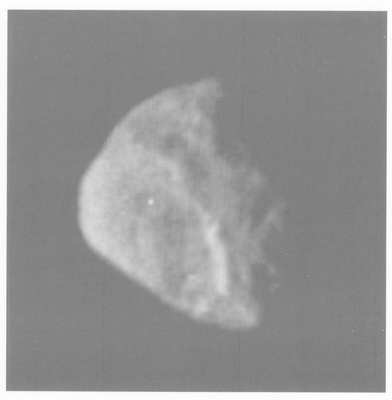
SCALE 1:5,000,000 (1 mm = 5 km)





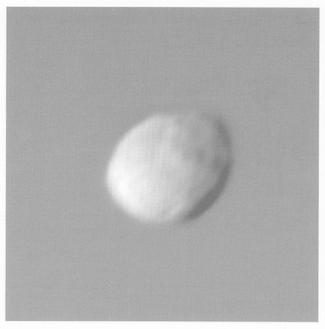
HYPERION
(SATURN)
FDS 4397243
Resolution 4.3 km/pxl
Spacecraft Latitude 21.28
Spacecraft Longitude 329.43
Northing Azimuth 28.05
Subsol Latitude –19.64
Subsol Longitude 31.93
Phase 73.55

SCALE 1:5,000,000 (1 mm=5 km)



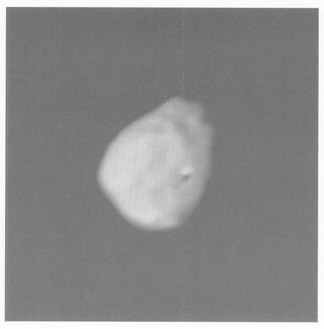
HYPERION
(SATURN)
FDS 4397455
Resolution 4.34 km/pxl
Spacecraft Latitude 29.20
Spacecraft Longitude 325.48
Northing Azimuth 26.28
Subsol Latitude –19.64
Subsol Longitude 33.94
Phase 82.08

SCALE 1:5,000,000 (1 mm = 5 km)



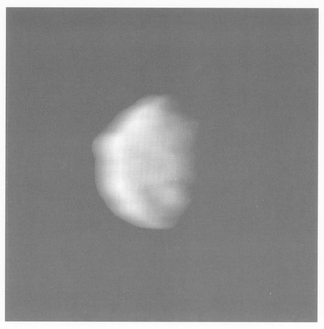
JANUS
(SATURN)
FDS 3493036
Resolution 5.54 km/pxl
Spacecraft Latitude –5.80
Spacecraft Longitude 193.00
Northing Azimuth 334.44
Subsol Latitude 4.20
Subsol Longitude 218.16
Phase 27.04

SCALE 1:5,000,000 (1 mm = 5 km)



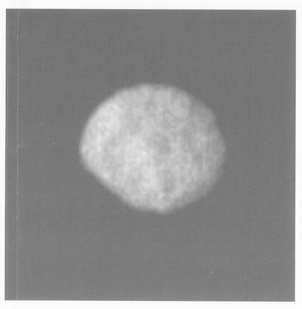
JANUS
(SATURN)
FDS 3493611
Resolution 4.76 km/pxl
Spacecraft Latitude –11.19
Spacecraft Longitude 294.69
Northing Azimuth 309.90
Subsol Latitude 4.21
Subsol Longitude 314.61
Phase 25.10

SCALE 1:5,000,000 (1 mm = 5 km)



JANUS
(SATURN)
FDS 3494217
Resolution 3.33 km/pxl
Spacecraft Latitude –22.38
Spacecraft Longitude 347.53
Northing Azimuth 347.00
Subsol Latitude 4.21
Subsol Longitude 59.97
Phase 75.51

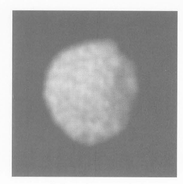
SCALE 1:5,000,000 (1 mm = 5 km)



LARISSA
(NEPTUNE)
FDS 1138148*
Resolution km/pxl –22.73
Spacecraft Latitude –3.95
Spacecraft Longitude 92.28
Northing Azimuth 16.43
Subsol Latitude –22.70
Subsol Longitude 106.33
Phase 12.95

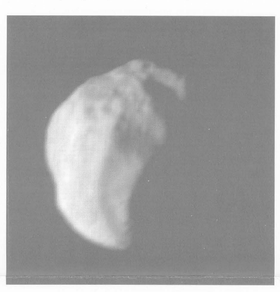
* Data for this image was not available, therefore data for FDS 1138153 (image not available) was substituted for FDS 1138148.

SCALE 1:5,000,000 (1 mm = 5 km)



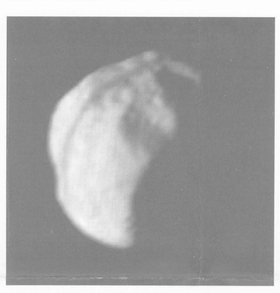
PUCK
(URANUS)
FDS 2683716
Resolution km/pxl NA
Spacecraft Latitude NA
Spacecraft Longitude NA
Northing Azimuth NA
Subsol Latitude NA
Subsol Longitude NA
Phase NA

SCALE 1:2,500,000 (1 mm = 2.5 km)



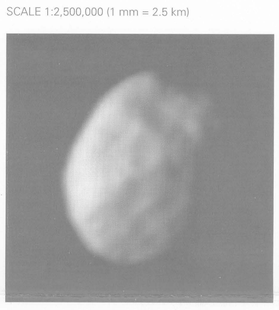
EPIMETHEUS
(SATURN)
FDS 3494229
Resolution 1.65 km/pxl
Spacecraft Latitude –44.63
Spacecraft Longitude 290.00
Northing Azimuth 294.32
Subsol Latitude 3.89
Subsol Longitude 317.44
Phase 54.38

SCALE 1:2,500,000 (1 mm = 2.5 km)



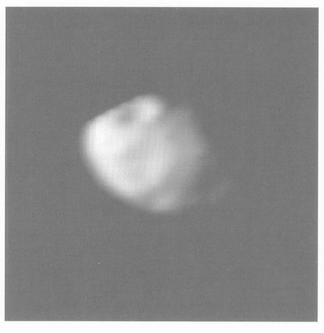
EPIMETHEUS
(SATURN)
FDS 3494245
Resolution 1.60 km/pxl
Spacecraft Latitude –46.09
Spacecraft Longitude 292.13
Northing Azimuth 296.09
Subsol Latitude 3.89
Subsol Longitude 322.05
Phase 56.58

SCALE 1:2,500,000 (1 mm = 2.5 km)



EPIMETHEUS
(SATURN)
FDS 4399554
Resolution 3.32 km/pxl
Spacecraft Latitude 33.49
Spacecraft Longitude 184.99
Northing Azimuth 33.38
Subsol Latitude 8.07
Subsol Longitude 224.93
Phase 44.72

SCALE 1:2,500,000 (1 mm = 2.5 km)

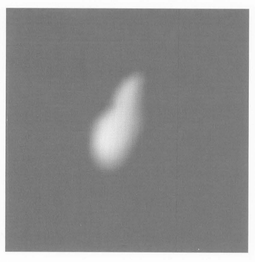


PANDORA
(SATURN)
FDS 4399815
Resolution 3.71 km/pxl
Spacecraft Latitude 25.58
Spacecraft Longitude 68.41
Northing Azimuth 8.43
Subsol Latitude 8.06
Subsol Longitude 167.20
Phase 67.45

SCALE 1:2,500,000 (1 mm = 2.5 km)

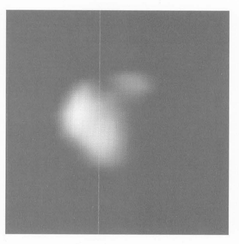
PROMETHEUS
(SATURN)
FDS 4399829
Resolution 3.34 km/pxl
Spacecraft Latitude 28.12
Spacecraft Longitude 268.65
Northing Azimuth 47.43
Subsol Latitude 8.06
Subsol Longitude 292.52
Phase 30.16

SCALE 1:1,000,000 (1 mm = 1 km)



CALYPSO
(SATURN)
FDS 4399741
Resolution km/pxl 2.28
Spacecraft Latitude 43.23
Spacecraft Longitude 252.00
Northing Azimuth 97.95
Subsol Latitude 6.90
Subsol Longitude 248.90
Phase 36.44

SCALE 1:1,000,000 (1 mm = 1 km)



HELENE
(SATURN)
FDS 4399547
Resolution km/pxl 3.61
Spacecraft Latitude 31.08
Spacecraft Longitude 79.31
Northing Azimuth 357.99
Subsol Latitude 8.21
Subsol Longitude 171.37
Phase 87.53

Table 1. *Physical properties of imaged satellites*

[Abbreviations: Desig., designation; Mag., visible magnitude at opposition; Equ., subplanetary equatorial radius; Orb. equ., along orbit equatorial radius; Den., density; km, kilometer; J, Jupiter; S, Saturn; U, Uranus; N, Neptune; s, same as orbit period; ?, meaningful value cannot be determined from available data]

Body	Name	Desig.	Year of Discovery	Mag.	Radius				Den.	Mass[1] (×10⁻¹⁰)	Albedo	Semimajor axis of orbit (×10⁻³ km)	Eccentricity of orbit	Inclination of orbit to planet's equator	Orbit peroid (days)	Rotation period (days)	Image km/pixel
					Mean	Equ.	Orb. equ.	Polar									
J V	AMALTHEA		1892	14.1	86.2±3	131.0	73.0	67.0	?	38	0.05	181.3	0.003	0.4°	0.498	s	3.83
S VII	HYPERION		1848	14.19	141.5±20	180±20	140±20	112.5±20	?	300	0.3	1,481.1	0.1042	0.43°	21.277	chaotic	4.3
S X	JANUS	1980S1	1966/80	14.5	88.8±4	97.0	95.0	77.0	?	?	0.8	151.472	0.007±0.002	0.14°±0.05°	0.6945	s	3.06
S XI	EPIMETHEUS	1980S3	1966/80	15.7	59.5±3	69.0	55.0	55.0	?	?	0.8	151.422	0.009±0.002	0.34°±0.05°	0.6942	s	3.32
S XII	HELENE	1980S6	1980	18.4	16.0	17.5±2.5			?	?	0.7	377.40	0.005	0°	2.7369	?	3.61
S XIV	CALYPSO	1980S25	1980	18.7	9.5±4	15.0	8.0	8.0	?	?	0.6	294.66	0	0°	1.8878	?	2.28
S XVI	PROMETHEUS	1980S27	1980	15.8	50.1±3	74.0	50.0	34.0	?	?	0.6	139.35	0.004	0.0°±0.1°	0.613	?	3.34
S XVII	PANDORA	1980S26	1980	16.5	41.9±2	55.0	44.0	31.0	?	?	0.9	141.70	0.0042±0.006	0.0°±0.1°	0.6285	?	3.71
U XV	PUCK	1985U1	1985	20.2	77.0±5				?	?	0.07	86.01	<0.001	0.31°	0.761832	?	?
N VI	LARISSA	1989N2	1989	22.0	96.0±7	104		89	?	?	0.06	73.55	0.0014	0.20°	0.554654	?	4.16
N VII	PROTEUS	1989N1	1989	20.3	208±8	218	208	201	?	?	0.06	117.65	<0.001	0.55°	1.122316	?	1.33

[1]Value given is relative to Earth's mass, which is 5.98×10^{24} kg.

NOTES ON SATELLITE IMAGES

The Voyager 1 and 2 spacecraft discovered 21 new satellites of Jupiter, Saturn, Uranus, and Neptune in addition to obtaining images of many previously known satellites. Although the major ("classic") satellites of these planetary systems were imaged extensively, only a few images were obtained that show surface details of the minor satellites. Seven previously known small satellites and four other bodies discovered by the Voyager spacecraft (table 1) were adequately resolved; the remaining 29 satellites were unresolved or nearly so. Because their nonspherical shape is apparent in the images, these objects are referred to as "irregularly shaped." This dataset is poorly documented, and it is in danger of being lost as the many images of the primary planets, their rings, and the major satellites overwhelm it within the planetary data bases.

This sheet presents the most significant images of these small satellites at a coherent set of scales, accompanied by geometric and photometric information extracted from the Supplemental Experiment Data Record (SEDR). Related images that were not used (table 2) and data on the unresolved satellites not shown on this sheet (table 3) are given as an aid to future research.

Images are shown as approximate orthographic presentations, at scales of 1:10,000,000 (Proteus), 1:5,000,000 (Amalthea, Hyperion, Janus, Larissa, and Puck), 1:2,500,000 (Epimetheus, Pandora, and Prometheus), and 1:1,000,000 (Calypso and Helene). Each image is accompanied by a line drawing that shows a latitude/longitude grid for that object with the appropriate projection geometry. The size of the grids has been standardized to complement a uniform display of SEDR data and does not represent a comparative scaling of these images. The grids are projected on spherical surfaces and are intended to show only the orientation of each satellite. The pole and rotation rate for Hyperion are in dispute; a pole at lat 1.3° S., long 262° and a 13.1–day rotation period were used for the images (Davies and others, 1989). SEDR data for Puck could not be located; subspacecraft values of lat 61° S., long 78°, phase angle 33°, and a resolution of 4.5 km per pixel were assumed for that image (Peter C. Thomas, written commun., 1992).

The data shown on this sheet have been derived from material generously provided by Peter C. Thomas of the Center for Radiophysics and Space Research of Cornell University.

Image processing was performed by Jo-Ann Bowell and Ella M. Lee, using methods described by Edwards (1987). Further processing was done by Ralph Aeschliman on the Macintosh computer using Adobe Photoshop and Illustrator software. Derivation and compilation of the projections were done by Christopher Isbell and Ralph Aeschliman. Jay L. Inge was responsible for the primary concept, design, and text.

REFERENCES CITED

Davies, M.E., and nine others, 1989, Report of the IAU/IAG/Cospar Working Group on Cartographic Coordinates and Rotational Elements of the Planets and Satellites: 1988: Celestial Mechanics and Dynamical Astronomy, v. 46, p. 187–204.

Edwards, Kathleen, 1987, Geometric processing of digital images of the planets: Photogrammetric Engineering and Remote Sensing, v. 53, no. 9, p. 1219–1222.

Table 2. *Information from Supplemental Experiment Data Record for images not shown on this sheet*

[Abbreviations: FDS, Flight Data System count (spacecraft clock time); km, kilometers. Negative values for latitude refer to the southern hemisphere]

Satellite	FDS	Resolution (km/pixel)	Spacecraft latitude	Spacecraft longitude	Northing azimuth	Subsol latitude	Subsol longitude	Phase
AMALTHEA	1636911	11.38	0.27	286.63	57.78	0.87	286.03	0.85
AMALTHEA	1636912	11.38	0.27	286.99	58.10	0.87	286.43	0.82
AMALTHEA	1636913	11.38	0.26	287.35	57.80	0.87	286.84	0.79
AMALTHEA	1636914	11.39	0.26	287.70	58.11	0.87	287.24	0.77
AMALTHEA	1636915	11.39	0.26	288.06	57.86	0.87	287.64	0.74
AMALTHEA	1637730	6.45	–1.54	91.17	5.10	0.87	126.36	35.27
AMALTHEA	1637734	6.38	–1.58	92.63	5.13	0.87	127.97	35.41
AMALTHEA	1637736	6.35	–1.60	93.37	5.12	0.87	128.76	35.48
AMALTHEA	1637738	6.31	–1.61	94.11	5.10	0.87	129.56	35.54
AMALTHEA	1637740	6.28	–1.63	94.85	5.09	0.87	130.37	35.61
AMALTHEA	1637741	6.27	–1.64	95.22	4.96	0.87	130.77	35.64
AMALTHEA	1638147	3.83	–4.04	202.14	1.84	0.87	229.52	27.80
AMALTHEA	1638531	4.19	–4.12	278.75	1.99	0.87	319.45	40.98
AMALTHEA	2065542	5.12	–10.83	157.91	3.04	0.34	237.01	79.36
AMALTHEA	2065550	5.10	–10.90	161.39	2.97	0.34	240.22	79.11
CALYPSO	4399328	3.16	37.51	201.25	60.23	6.90	222.10	35.99
EPIMETHEUS	4399114	6.09	21.63	91.00	20.38	8.06	133.87	43.43
HYPERION	4392731	16.19	–39.71	332.44	323.95	–19.58	350.55	25.44
HYPERION	4394328	10.81	–33.90	339.87	343.48	–19.60	5.15	26.60
HYPERION	4396343	5.28	–7.93	339.17	21.31	–19.62	23.69	44.65
HYPERION	4396347	5.27	–7.76	339.13	21.34	–19.62	23.75	44.80
HYPERION	4396802	4.61	4.64	335.65	27.17	–19.63	27.64	56.57
HYPERION	4397211	4.31	19.32	330.28	28.55	–19.63	31.44	71.49
HYPERION	4397219	4.31	19.81	330.07	28.37	–19.63	31.56	72.00
HYPERION	4397223	4.30	20.05	329.96	28.35	–19.64	31.62	72.26
HYPERION	4397231	4.30	20.54	329.75	28.20	–19.64	31.74	72.77
JANUS	4399746	3.33	30.10	256.67	52.86	8.41	278.02	29.49
LARISSA	1138142							
LARISSA	1138153	4.16	–22.73	92.28	16.43	–22.70	106.33	12.95
PANDORA	4398311	7.92	20.96	190.00	45.17	8.05	209.56	22.87
PHOEBE	4430441	18.87	22.01	251.52	26.32	22.97	260.59	8.44
PHOEBE	4430449	18.87	21.98	255.78	26.66	22.97	264.72	8.32
PROMETHEUS	4397527	10.53	18.54	184.00	44.79	8.05	201.64	20.10
TELESTO	4399752	6.07	15.50	340.24	24.88	7.02	9.94	30.30

TABLE 3. *Physical properties of satellites not shown on this sheet*

[Abbreviations: Desig., designation; Mag., visible magnitude at opposition; Equ., subplanetary equatorial radius; Orb. equ., along orbit equatorial radius; Den., density; km, kilometer; J, Jupiter; S, Saturn; U, Uranus; N, Neptune; s, same as orbit period; ?, meaningful value cannot be determined from available data]

Body	Name	Desig.	Year of Discovery	Mag.	Radius				Den.	Mass[1] (×10⁻¹⁰)	Albedo	Semimajor axis of orbit (×10⁻³ km)	Eccentricity of orbit	Inclination of orbit to planet's equator	Orbit peroid (days)	Rotation period (days)	Image km/pixel
					Mean	Equ.	Orb. equ.	Polar									
J VI	HIMALIA		1904	14.84	85±10				?	50	0.03	11,480	0.15798	27.63°	250.5662	0.4	NA
J VII	ELARA		1904/5	16.77	40±10				?	4	0.03	11,737	0.20719	24.77°	259.6528	0.5	NA
J VIII	PASIPHAE		1908	17.03	18				?	1	?	23,500	0.378	145.0°	735R	?	NA
J IX	SINOPE		1914	18	14				?	0.4	?	23,700	0.275	153.0°	758R	?	NA
J X	LYSITHEA		1938	18.4	12				?	0.4	?	11,720	0.107	29.02°	259.22	?	NA
J XI	CARME		1938	17.9	15				?	0.5	?	22,600	0.20678	164.0°	692R	?	NA
J XII	ANANKE		1951	18.9	10				?	0.2	?	21,200	0.16870	147.0°	631R	?	NA
J XIII	LEDA		1974	20.2	5				?	0.03	?	11,094	0.14762	26.07°	238.72	?	NA
J XIV	THEBE		1979/80	15.7	50±10	55		45	?	4	0.05	222.0	0.015±0.006	0.8°±0.2°	0.6745	s	NA
J XV	ADRASTEA	1979J1	1979	19.1	10±10	13	10	8	?	0.1	0.05	128.5	0	0°	0.29826	?	20
J XVI	METIS		1979/80	17.5	20±10	20		20	?	0.5	0.05	128.2	0.004	0°	0.295478	?	20
S IX	PHOEBE		1898	16.45	110±10	115±10	110±10	105±10	?	7	0.06	12,952	0.16326	177.0°	550.48R	0.4	18.87
S XIII	TELESTO	1980S13	1980	18.5	11±4	15±2.5	12.5±5	7.5±2.5	?	?	0.5	294.66	0	0°	1.8878	?	6.07
S XV	ATLAS	1980S28	1980	18	16±4	18.5	17.2	13.5	?	?	0.9	137.67	0.0	0.3°	0.6019	?	13.4
S XVIII	PAN	1981S13	1981	23–25	10±3				?	?	?	133.6	0	?	?	?	NA
U VI	CORDELIA	1986U7	1986	24.1	13±2				?	?	0.07	49.77	<0.001	0.1°	0.335033	?	NA
U VII	OPHELIA	1986U8	1986	23.8	15±2				?	?	0.07	53.79	0.010	0.1°	0.376409	?	NA
U VIII	BIANCA	1986U9	1986	23.0	21±3				?	?	0.07	59.17	<0.001	0.2°	0.434577	?	NA
U IX	CRESSIDA	1986U3	1986	22.2	31±4				?	?	0.07	61.78	<0.001	0°	0.46357	?	NA
U X	DESDEMONA	1986U6	1986	22.5	27±3				?	?	0.07	62.68	<0.001	0.2°	0.473651	?	NA
U XI	JULIET	1986U2	1986	21.5	42±5				?	?	0.07	64.35	<0.001	0.1°	0.493066	?	NA
U XII	PORTIA	1986U1	1986	21.0	54±6				?	?	0.09	66.09	<0.001	0.1°	0.513196	?	NA
U XIII	ROSALIND	1986U4	1986	22.5	27±4				?	?	0.07	69.94	<0.001	0.3°	0.558459	?	NA
U XIV	BELINDA	1986U5	1986	22.1	33±4				?	?	0.07	75.26	<0.001	0.0°	0.623525	?	NA
N II	NEREID		1949	18.7	170±25				?	2000	0.4	5,513.4	0.7512	27.6°	360.13619	?	43.3
N III	NAIAD	1989N6	1989	24.7	29±6				?	?	0.06	48.23	<0.001	4.74°	0.294396	?	23.6
N IV	THALASSA	1989N5	1989	23.8	40±8				?	?	0.06	50.07	<0.001	0.21°	0.311485	?	17.4
N V	DESPINA	1989N3	1989	22.6	74±10				?	?	0.054	52.53	<0.001	0.07°	0.334655	?	16.9
N VI	GALATEA	1989N4	1989	22.3	79±12				?	?	0.06	61.94	<0.001	0.05°	0.428745	?	18.4

[1]Value given is relative to Earth's mass, which is 5.98×10^{24} kg.

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1995

Prepared on behalf of the Planetary Geology Program, Solar System Exploration Division, Office of Space Science, National Aeronautics and Space Administration, under contract W-15,814

Manuscript approved for publication March 22, 1993

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