

SPRING
2011

The free international astronomy webzine

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**Moons
beyond
the Moon
2**

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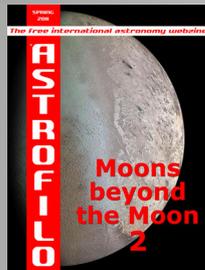
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ON THE COVER

Colour mosaic of Triton, obtained in 1989 by Voyager 2 during the flyby of Neptune. With a radius of 1350 km, about 22% less than our Moon, Triton is the largest of of the neptunian satellites. [NASA/JPL/USGS]

SPECIAL ISSUE

Moons beyond the Moon

(2 of 2)

Foreword

In this second part of the Spring issue, dedicated to the "other moons" of our planetary system, you will find the best images available of the satellites of Mars, Uranus, Neptune and the dwarf planets Pluto, Eris and Haumea. As in part 1, we have not included images of some of the smaller satellites; we think that the few examples shown of these are sufficient. Of course, our intention is not to present a complete catalogue of the over 170 natural satellites in our planetary system (though 110 pages in all isn't bad for a free magazine!) but rather to draw the reader's attention to the subject, leaving the temptation to complete the photographic album by searching the web for the numerous images present, taken by the various probes and telescopes.

Michele Ferrara

2

Moons beyond the Moon

(2 of 2)

Although the satellites of Mars find themselves 50% farther from the Sun than our own Moon, the satellites of Uranus and Neptune are respectively 19 and 30 times farther from the Sun. These are frozen, gloomy worlds. From Earth the Sun is about 30 arcminutes across and shines with an apparent magnitude of -26.7 (that of the full Moon is -12.7). At the distance of Uranus, the Sun appears as a very small disk 1.5 arcminutes across with an absolute magnitude of -20.3. From Neptune it is only 1 arcminute across, with a magnitude of -19.3. Considering that the logarithmic magnitude scale reflects how our eyes perceive brightness, then if we were on one of the satel-

lites of these two gas giants, we would judge the Sun to be about half way between the Sun and Moon in brightness, as these are seen from Earth.

Standing out in the Sun on one of these satellites would be rather like standing in a room with a single naked light bulb for illumination. The light would be rather poor and the shadows very sharp (given the small size of the light source).

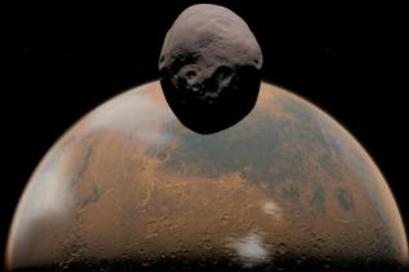
The radiant heat energy received from the Sun is about 350 times and 900 times less than at Earth, for Uranus and Neptune respectively. It is no surprise then, that the surfaces of these satellites are typically composed of ices (water, carbon dioxide, ammonia, etc) and rock in various ratios. What is per-

haps more of a surprise is that several satellites show signs of melting of these ices, and as a result some of regions of the surfaces are relatively young (e.g. the Uranian satellite Miranda).

In environments that receive so little energy from the Sun, the heat source for this melting is thought to be the heat generated by friction, as solid masses move past each other within the satellite, in response to tidal forces. Although tidal heating is probably the most important process for these satellites, solar radiation is not negligible even at the distance of Neptune, and is thought to be the cause of the famous nitrogen geysers on Triton (the darkest spots on this image).

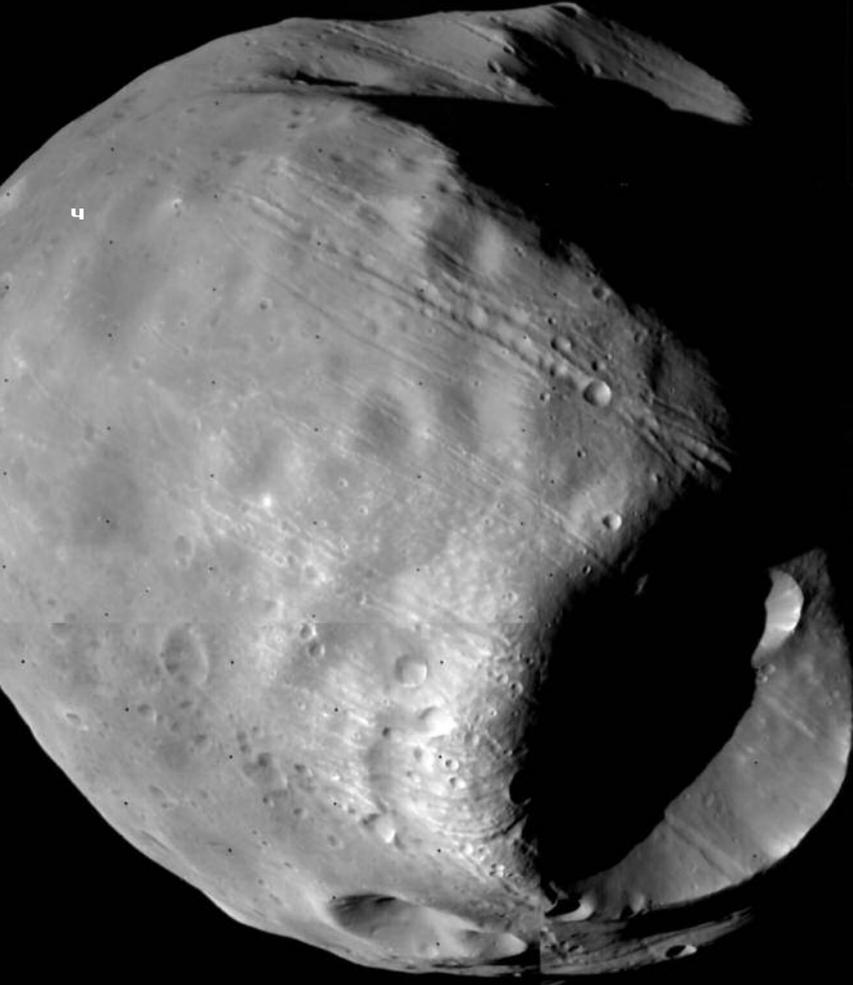
Marcel Clemens

3



Martian System

The names of the moons of Mars and the English translations of the names were specifically proposed by their discoverer, Asaph Hall, and as such, they have been accepted and retained under the current IAU nomenclature.



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Mars I (Phobos)

Phobos, the fear. Named after one of the horses that drew Mars' chariot; also called an "attendant" or "son" of Mars, according to chapter 15, line 119 of Homer's "Iliad".

Discovery: August 17, 1877 - Washington - A. Hall.



S



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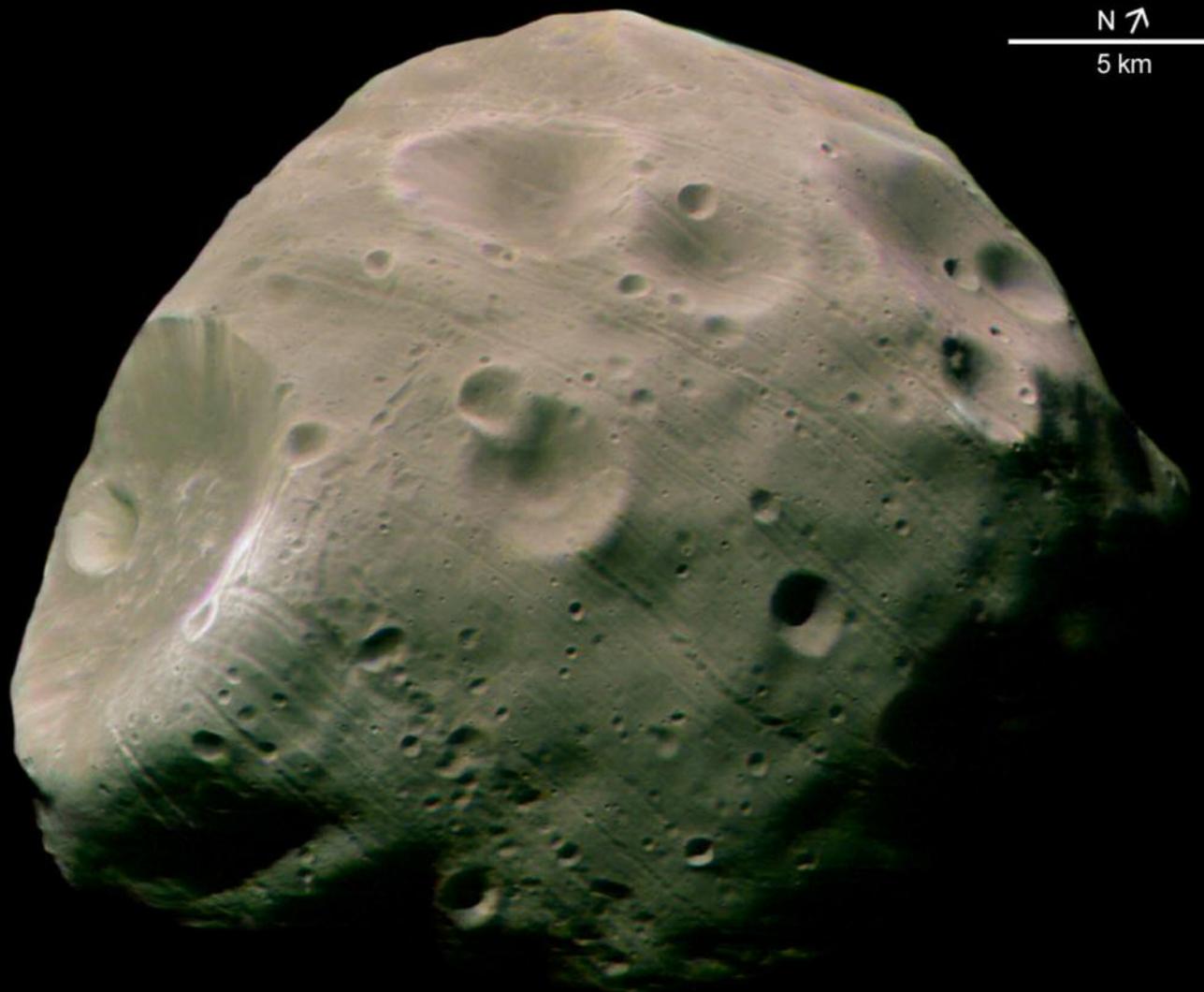
S - South pole

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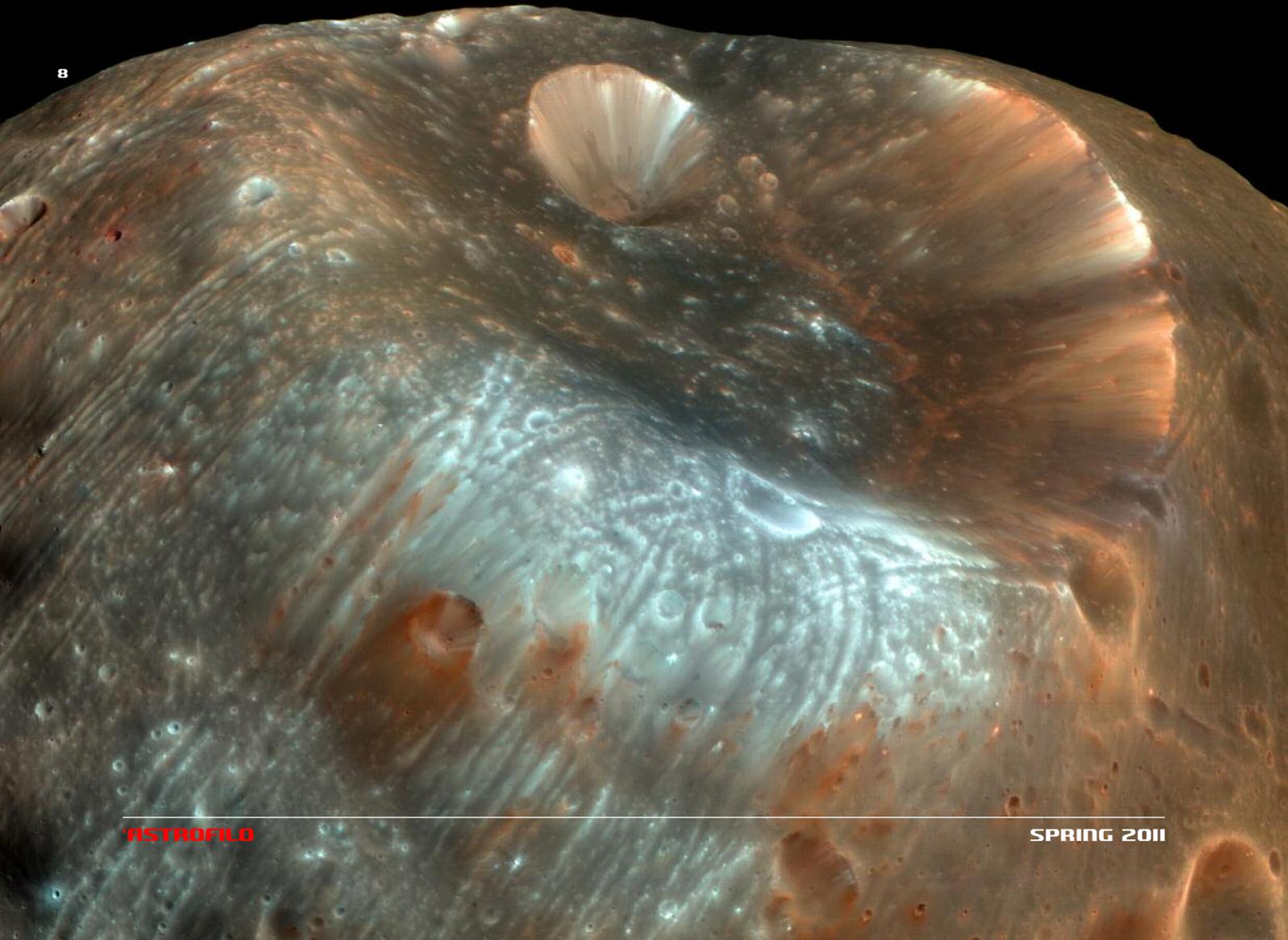
N - North pole





Phobos eclipse
March 7, 2004

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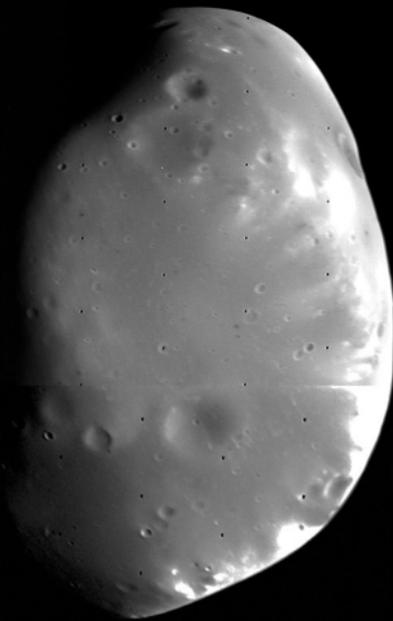


2 km

Mars II (Deimos)

Deimos, the terror. Named after one of the horses that drew Mars' chariot; also called an "attendant" or "son" of Mars, according to chapter 15, line 119 of Homer's "Iliad".

Discovery: August 11, 1877 - Washington - A. Hall.



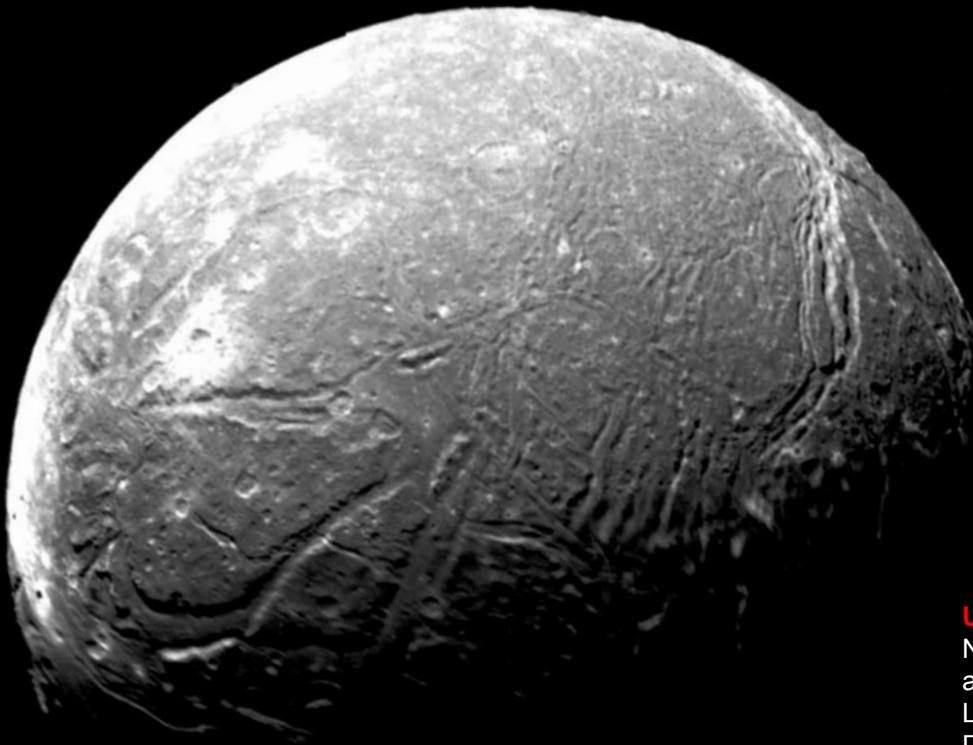
Deimos eclipse
March 4, 2004

Numeral	Name	Mean radius (km)	Semi-major axis (km)	Sidereal period (d) (r = retrograde)	Discovery date	Discovered by	Notes
MI	Phobos	11.1 ± 0.15	9,380	0.319	1877	Hall	Inner moon
MII	Deimos	6.2 ± 0.18	23,460	1.262	1877	Hall	Outer moon



Uranian System

Satellites in the uranian system are named after characters from Shakespeare's plays and after Pope's "Rape of the Lock".

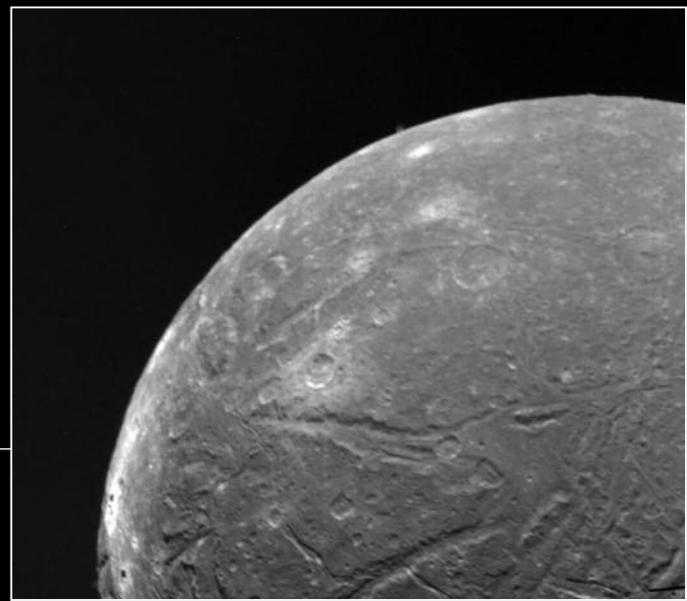
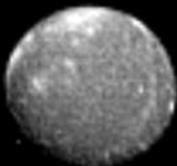


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Uranus I (Ariel)

Named by John Herschel after a sylph in Pope's "Rape of the Lock".

Discovery: October 24, 1851 - Liverpool - W. Lassell.



umbriel



Uranus II (Umbriel)

Umbriel was named by John Herschel after a malevolent spirit in Pope's "Rape of the Lock."

Discovery: October 24, 1851 - Liverpool - W. Lassell.



titania

Uranus III (Titania)

Named by Herschel's son John in the early 19th century after the queen of the fairies in Shakespeare's "A Midsummer Night's Dream".

Discovery: January 11, 1787 - Slough - W. Herschel.



o b e r o n



Uranus IV (Oberon)

Named by Herschel's son John in the early 19th century after the king of the fairies in Shakespeare's "A Midsummer Night's Dream".

Discovery: January 11, 1787 - Slough - W. Herschel.

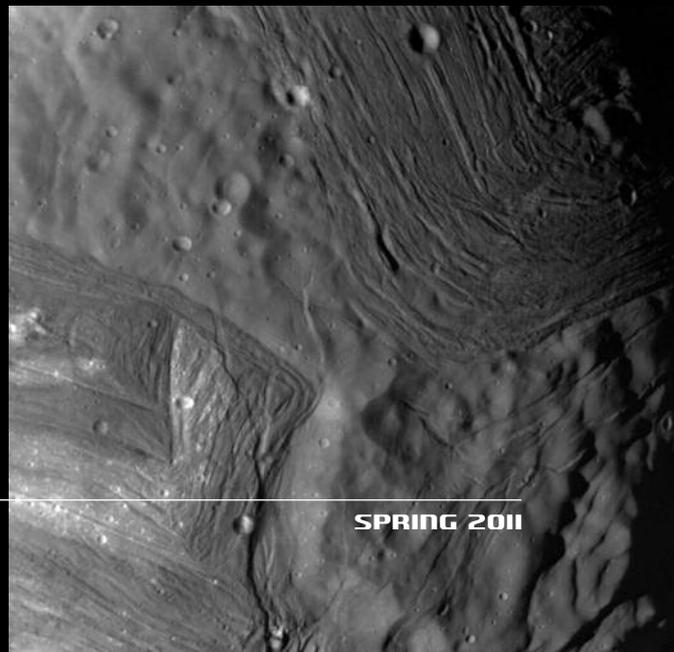
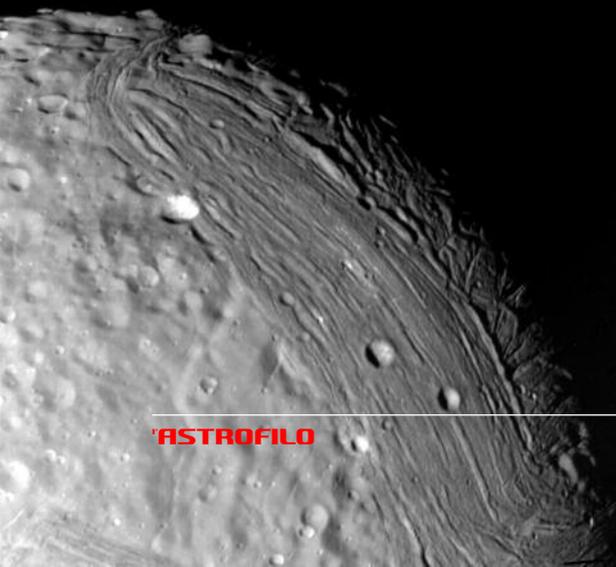
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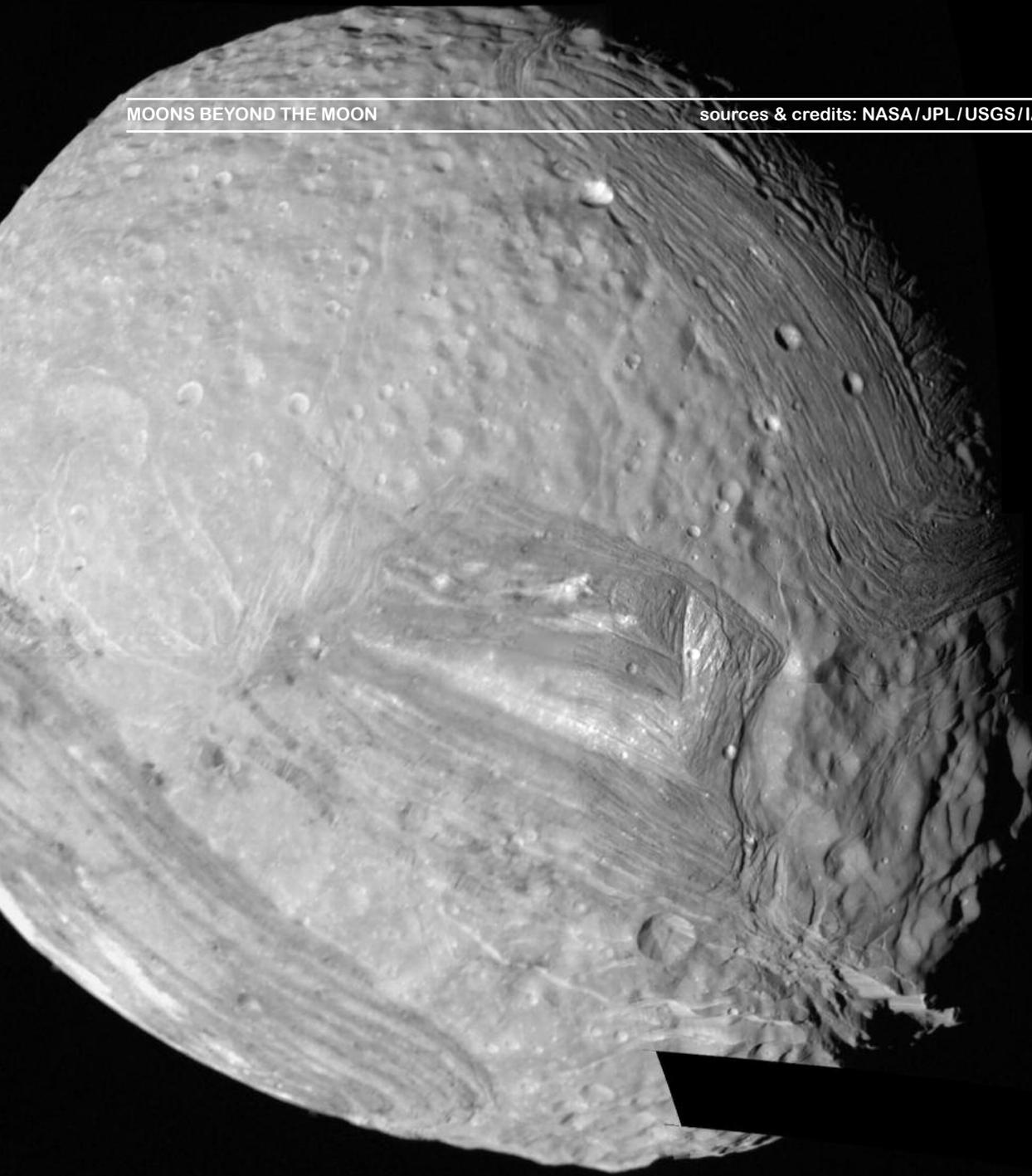
Uranus V (Miranda)

Named by Kuiper after the heroine of Shakespeare's "The Tempest".

Discovery: February 16, 1948
Fort Davis - G.P. Kuiper.

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Uranus VI (Cordelia)

Daughter of Lear in Shakespeare's "King Lear".

Discovery: January 20, 1986 - Voyager 2 - Voyager Science Team.

Uranus VII (Ophelia)

Daughter of Polonius, fiancée of Hamlet in Shakespeare's "Hamlet, Prince of Denmark".

Discovery: January 20, 1986 -

Voyager 2 - Voyager Science Team.

Uranus VIII (Bianca)

Daughter of Baptista, sister of Kate, in Shakespeare's "Taming of the Shrew".

Discovery: January 23, 1986 - Smith - Voyager 2.

Uranus IX (Cressida)

Character in Shakespeare's

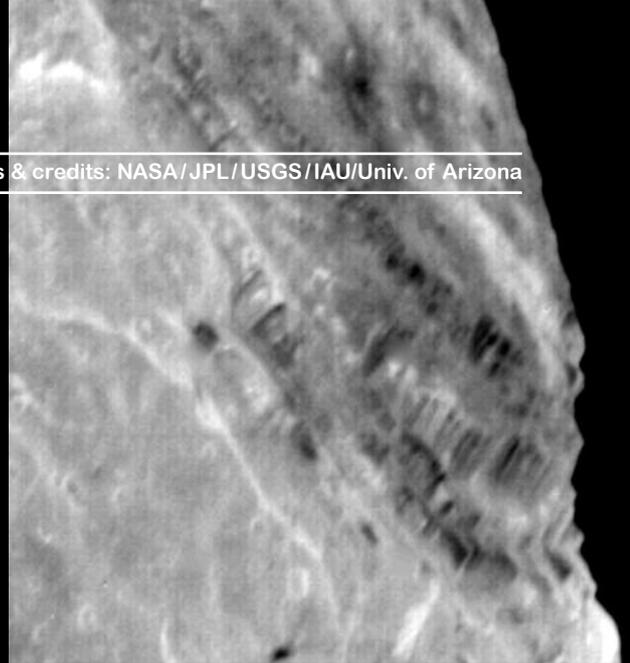
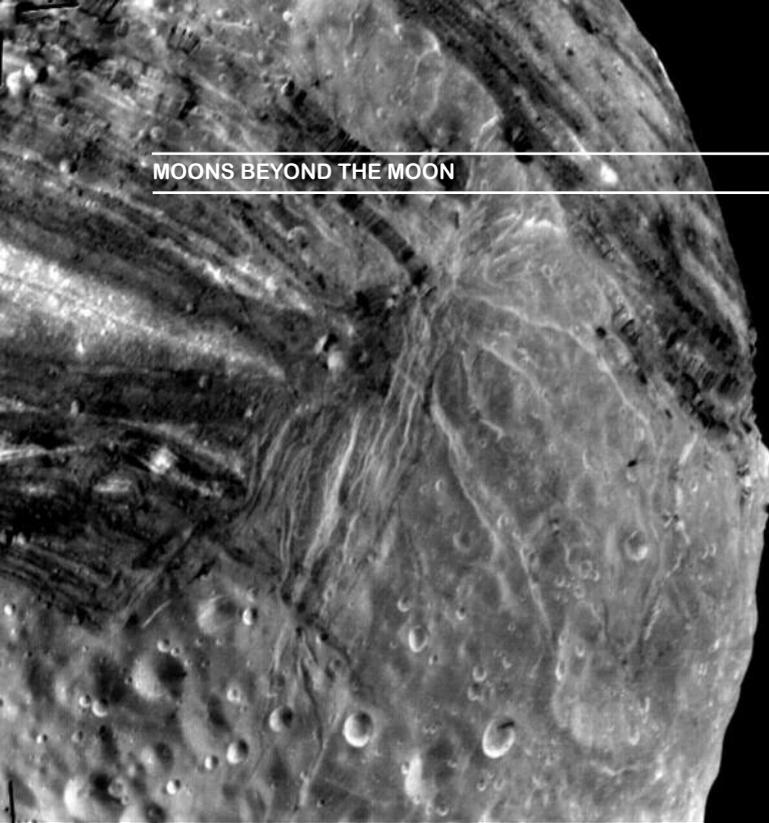
"Troilus and Cressida".

Discovery: January 9, 1986 - Voyager 2 - Voyager Science Team.

Uranus X (Desdemona)

Wife of Othello in Shakespeare's "Othello, the Moor of Venice".

Discovery: January 13, 1986 - Voyager 2 - Voyager Science Team.



Uranus XI (Juliet)

Heroine of Shakespeare's "Romeo and Juliet".
Discovery: January 3, 1986 - Voyager 2 - Voyager Science Team.

Uranus XII (Portia)

Wife of Brutus in Shakespeare's "Julius Caesar".
Discovery: January 3, 1986 - Voyager 2 - Voyager Science Team.

Uranus XIII (Rosalind)

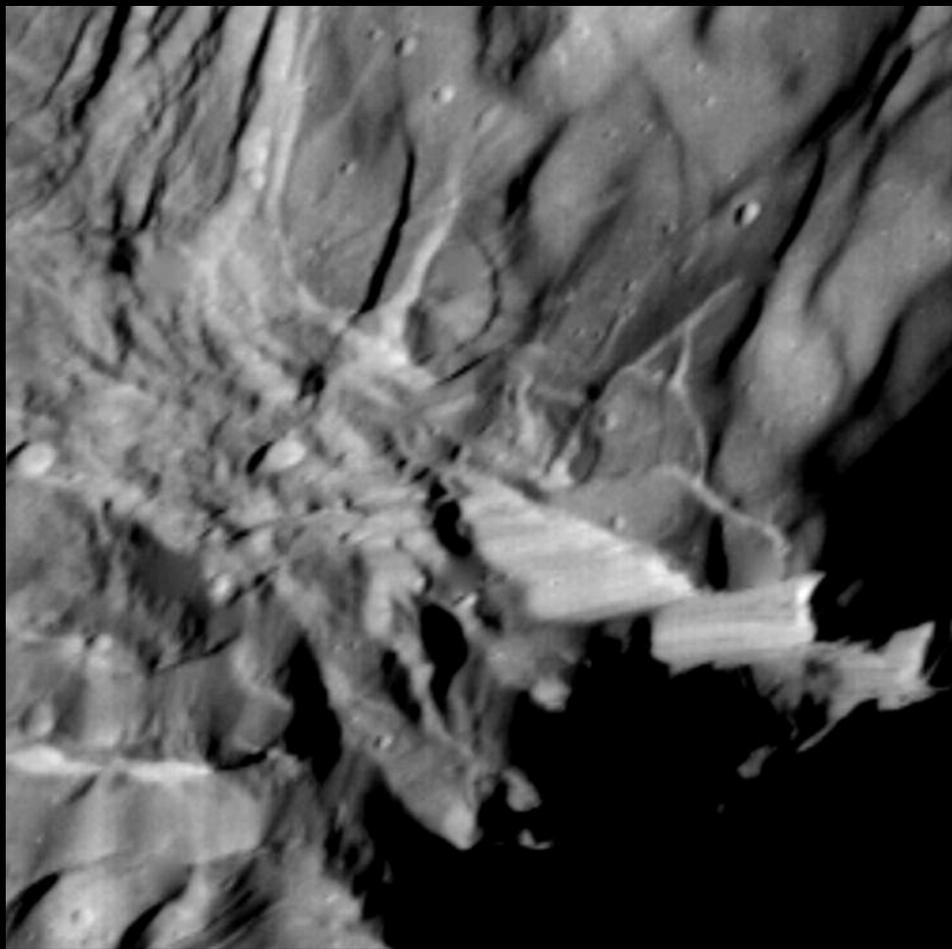
Daughter of the banished duke in Shakespeare's "As You Like It".
Discovery: January 13, 1986 - Voyager 2 - Voyager Science Team.

Uranus XIV (Belinda)

Character in Pope's "Rape of the Lock".
Discovery: January 13, 1986 - Voyager 2 - Voyager Science Team.

Uranus XV (Puck)

Mischievous spirit in Shakespeare's "A Midsummer Night's Dream".
Discovery: December 30, 1985 - Voyager 2 - Voyager Science Team.



Uranus XVI (Caliban)

Named after the grotesque, brutish slave in Shakespeare's "The Tempest".

Discovery: September 6, 1997

Palomar - B. Gladman, P. Nicholson, J.A. Burns and J. Kavelaars.

Uranus XVII (Sycorax)

Named after Caliban's mother in Shakespeare's "The Tempest".

Discovery: September 6, 1997

Palomar - P. Nicholson, B. Gladman, J. Burns and J. Kavelaars.

Uranus XVIII (Prospero)

Named after the rightful Duke of Milan in "The Tempest".

Discovery: July 18, 1999 -

Mauna Kea - M. Holman, J. Kavelaars, B. Gladman, J.-M. Petit, and H. Scholl.

Uranus XIX (Setebos)

Setebos was a new-world (South American) deity's name that Shakespeare popularized as Sycorax's god in "The Tempest".

Discovery: July 18, 1999 -

Mauna Kea - J. Kavelaars, B. Gladman, M. Holman, J.-M. Petit, and H. Scholl.

Uranus XX (Stephano)

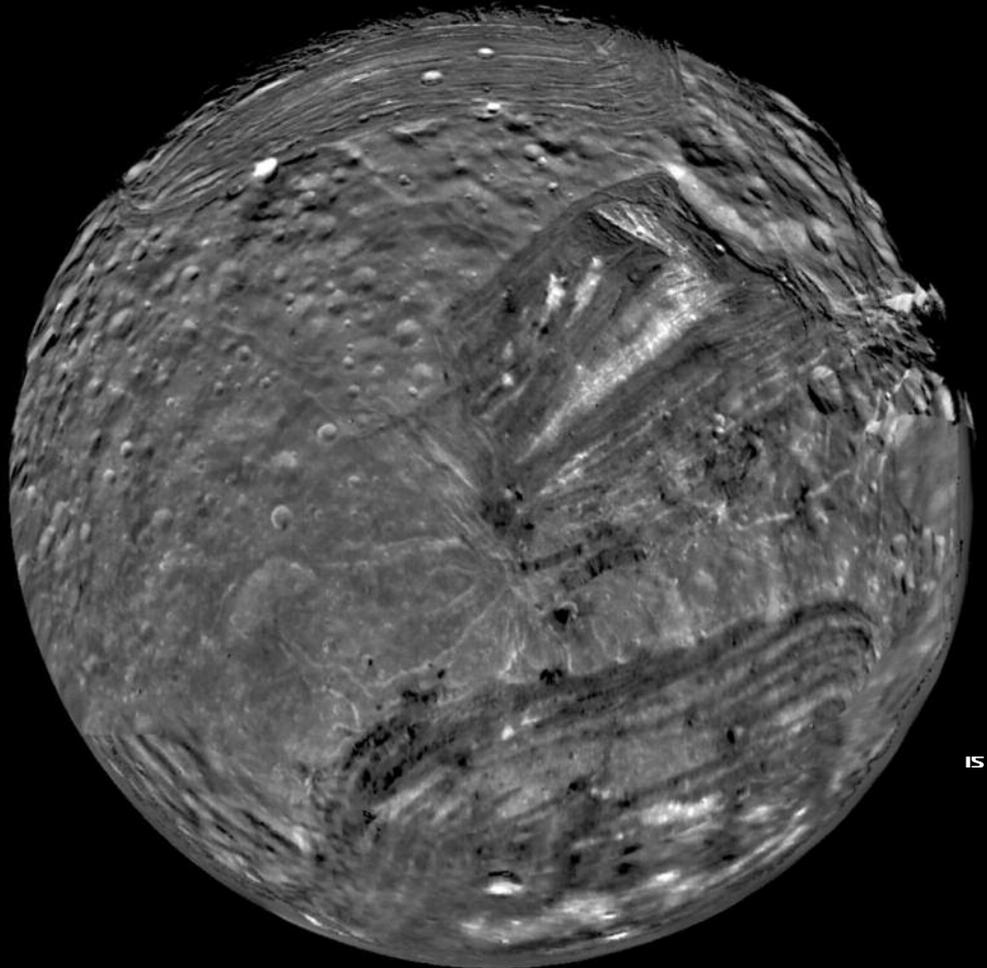
Named after a drunken butler in "The Tempest".

Discovery: July 18, 1999 -

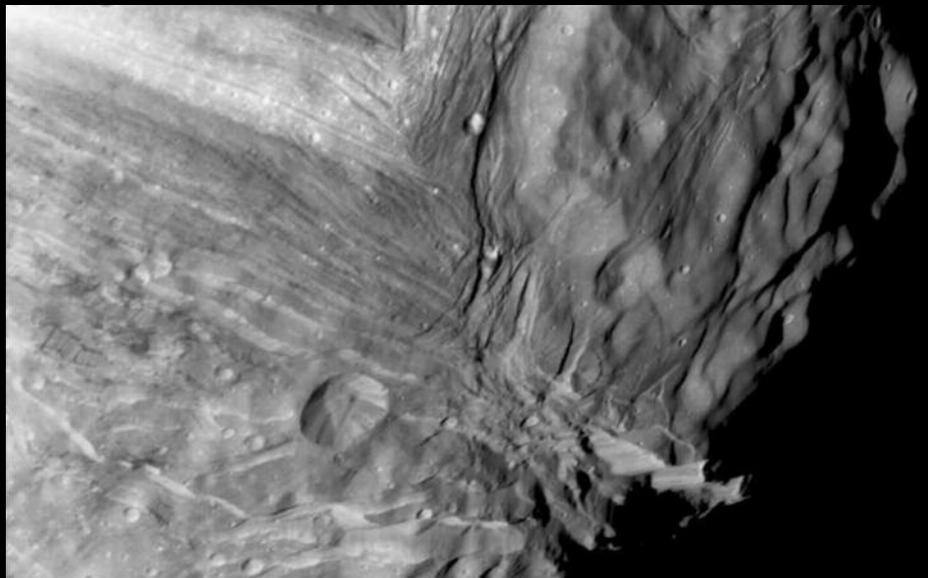
Mauna Kea - B. Gladman, M. Holman, J. Kavelaars, J.-M. Petit, and H. Scholl.

Uranus XXI (Trinculo)

A jester in Shakespeare's "The Tempest".

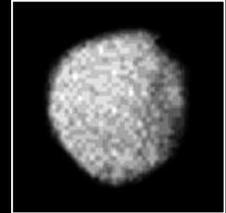


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Discovery: January 18, 1986 - Voyager 2 - E. Karkoschka.

Uranus XXVI (Mab)

The fairies' midwife in "Romeo and Juliet".

Discovery: August 25, 2003 - Hubble Space Telescope - M.R. Showalter and J.J. Lissauer.

Uranus XXVII (Cupid)

A character in "Timon of Athens".

Discovery: August 25, 2003 - Hubble Space Telescope - M.R. Showalter and J.J. Lissauer.

Discovery: August 13, 2001 - Cerro Tololo - M. Holman, J.J. Kavelaars and D. Milisavljevic.

Uranus XXII (Francisco)

A lord in "The Tempest".

Discovery: August 13, 2001 - Cerro Tololo - J. Kavelaars, M. Holman, D. Milisavljevic, and T. Grav.

Uranus XXIII (Margaret)

A gentlewoman attending to Hero from "Much Ado About Nothing".

Discovery: August 29, 2003 - Mauna Kea - S.S. Sheppard, D.C. Jewitt.

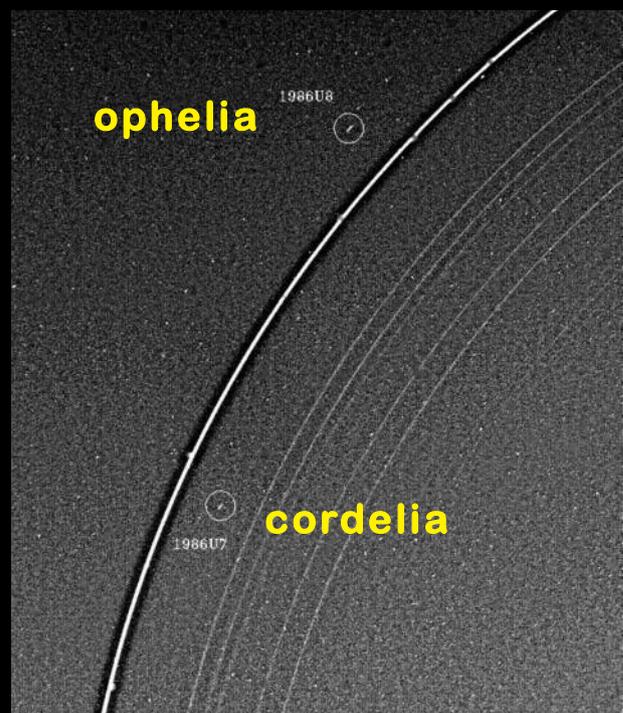
Uranus XXIV (Ferdinand)

Son of the King of Naples in "The Tempest".

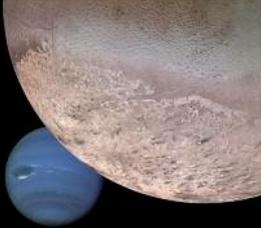
Discovery: August 13, 2001 - Cerro Tololo - D. Milisavljevic, M. Holman, J. Kavelaars, and T. Grav.

Uranus XXV (Perdita)

Daughter of Leontes and Hermione in "The Winter's Tale".

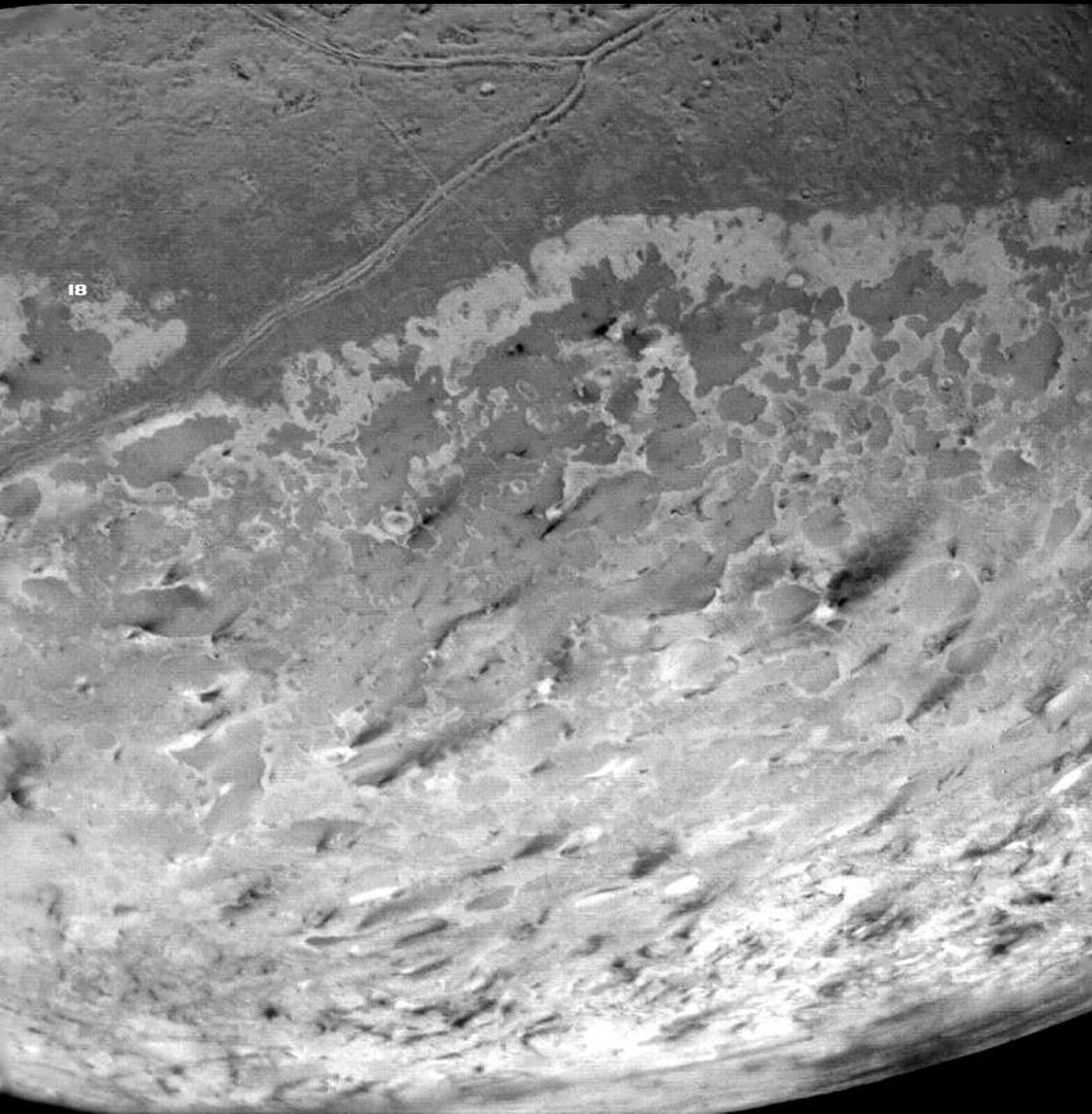


Numeral	Name	Mean radius (km)	Semi-major axis (km)	Sidereal period (d) (r = retrograde)	Discovery date	Discovered by	Notes
U I	Ariel	578.9 ± 0.6	190,900	2.520	1851	Lassell	Main group moon
U II	Umbriel	584.7 ± 2.8	266,000	4.144	1851	Lassell	Main group moon
U III	Titania	788.9 ± 1.8	436,300	8.706	1787	Herschel	Main group moon
U IV	Oberon	761.4 ± 2.6	583,500	13.46	1787	Herschel	Main group moon
U V	Miranda	235.8 ± 0.7	129,900	1.413	1948	Kuiper	Main group moon
U VI	Cordelia	20.1 ± 3	49,800	0.335	1986	Terrile (Voyager 2)	Inner moon (shepherd)
U VII	Ophelia	21.4 ± 4	53,800	0.376	1986	Terrile (Voyager 2)	Inner moon (shepherd)
U VIII	Bianca	25.7 ± 2	59,200	0.435	1986	Smith (Voyager 2)	Inner moon
U IX	Cressida	39.8 ± 2	61,800	0.464	1986	Synnott (Voyager 2)	Inner moon
U X	Desdemona	32.0 ± 4	62,700	0.474	1986	Synnott (Voyager 2)	Inner moon
U XI	Juliet	46.8 ± 4	64,400	0.493	1986	Synnott (Voyager 2)	Inner moon
U XII	Portia	67.6 ± 4	66,100	0.513	1986	Synnott (Voyager 2)	Inner moon
U XIII	Rosalind	36 ± 6	69,900	0.558	1986	Synnott (Voyager 2)	Inner moon
U XIV	Belinda	40.3 ± 8	75,300	0.624	1986	Synnott (Voyager 2)	Inner moon
U XV	Puck	81 ± 2	86,000	0.762	1985	Synnott (Voyager 2)	Inner moon
U XVI	Caliban	49	7,231,000	579.73 (r)	1997	Gladman, Nicholson, Burns, Kavelaars	Retrograde irregular
U XVII	Sycorax	95	12,179,000	1,288.3 (r)	1997	Gladman, Nicholson, Burns, Kavelaars	Retrograde irregular
U XVIII	Prospero	15	16,256,000	1,978.29 (r)	1999	Gladman, Holman, Kavelaars, Petit, Scholl	Retrograde irregular
U XIX	Setebos	15	17,418,000	2,225.21 (r)	1999	Gladman, Holman, Kavelaars, Petit, Scholl	Retrograde irregular
U XX	Stephano	10	8,004,000	677.36 (r)	1999	Gladman, Holman, Kavelaars, Petit, Scholl	Retrograde irregular
U XXI	Trinculo	5	8,504,000	749.24 (r)	2001	Holman, Kavelaars, Milisavljevic	Retrograde irregular
U XXII	Francisco	6	4,276,000	266.56 (r)	2001	Holman, Kavelaars, Milisavljevic, Gladman	Retrograde irregular
U XXIII	Margaret	5.5	14,345,000	1,687.01	2003	Sheppard, Jewitt	Prograde irregular
U XXIV	Ferdinand	6	20,901,000	2,887.21 (r)	2001	Holman, Kavelaars, Milisavljevic, Grav	Retrograde irregular
U XXV	Perdita	10	76,417	0.638	1986	Karkoschka (Voyager 2)	Inner moon
U XXVI	Mab	5	97,736	0.923	2003	Showalter, Lissauer	Inner moon
U XXVII	Cupid	5	74,392	0.613	2003	Showalter, Lissauer	Inner moon

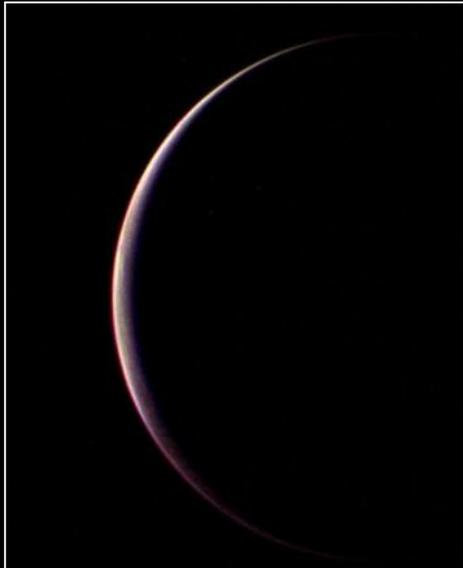
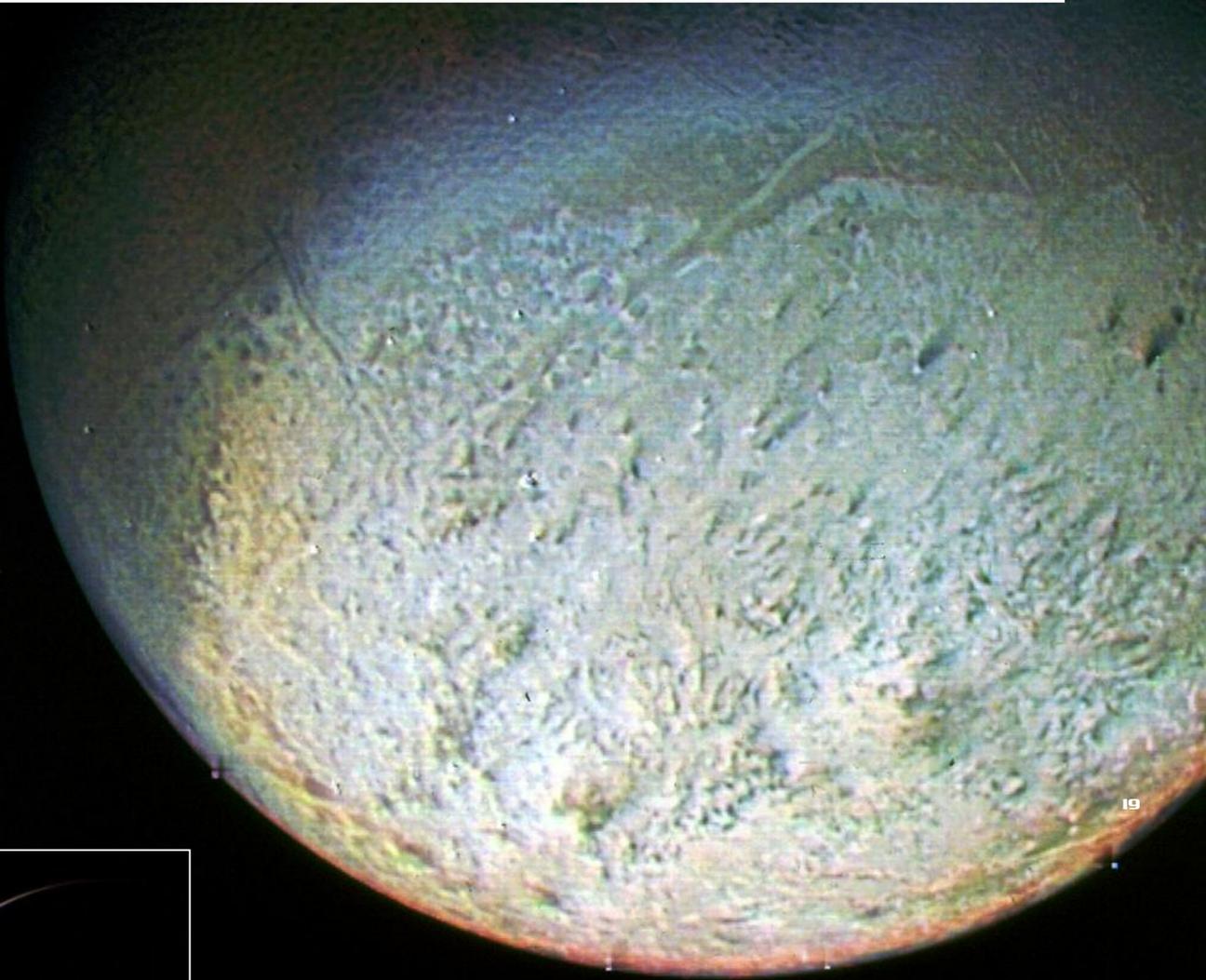


Neptunian System

Satellites in the neptunian system are named after characters from Greek or Roman mythology associated with Neptune or Poseidon or the oceans. Irregular satellites are named after the Nereids, the daughters of Nereus and Doris, and the attendants of Neptune.

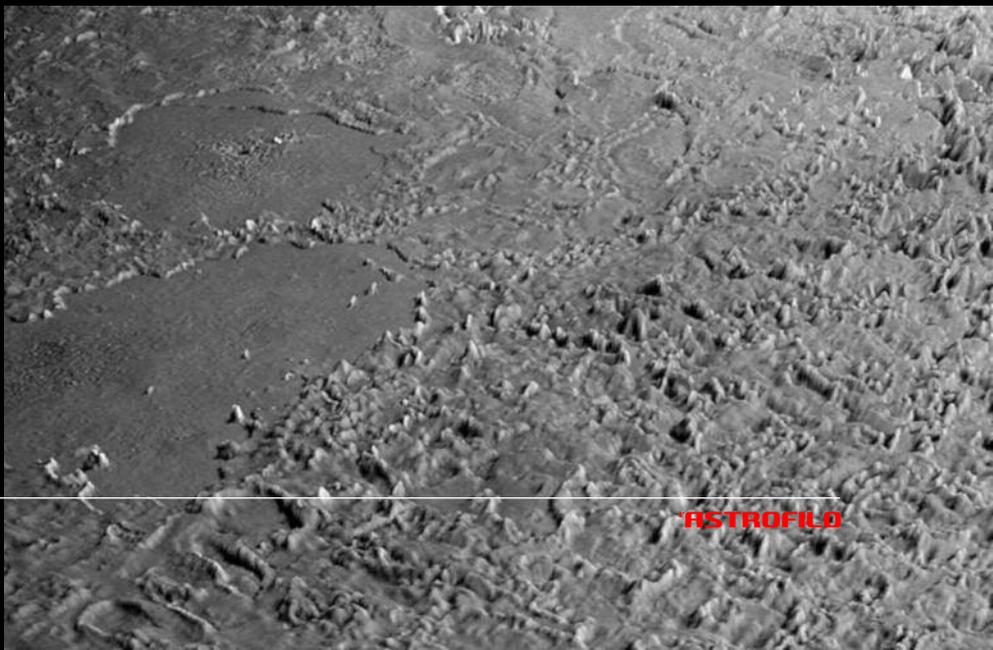


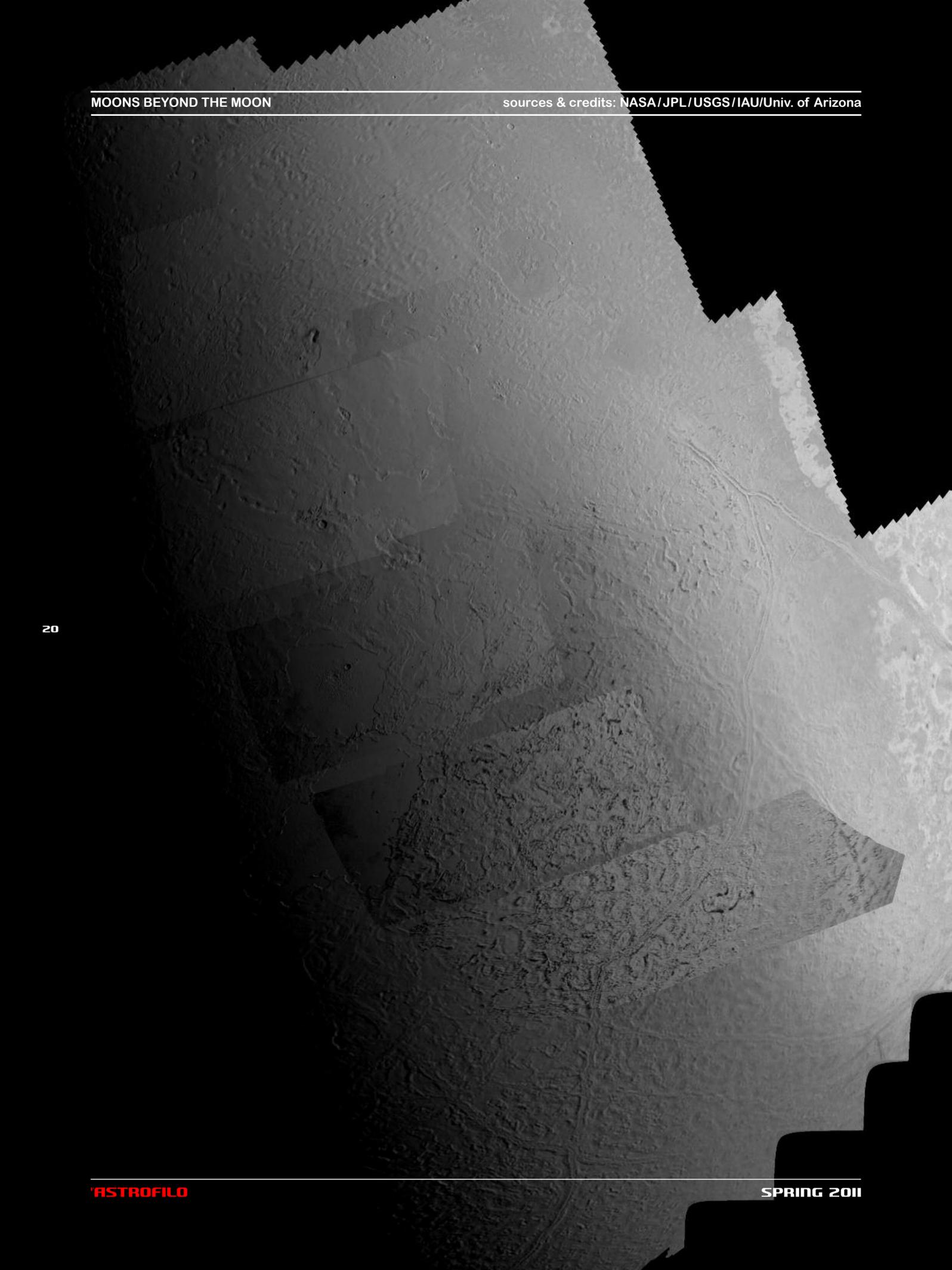
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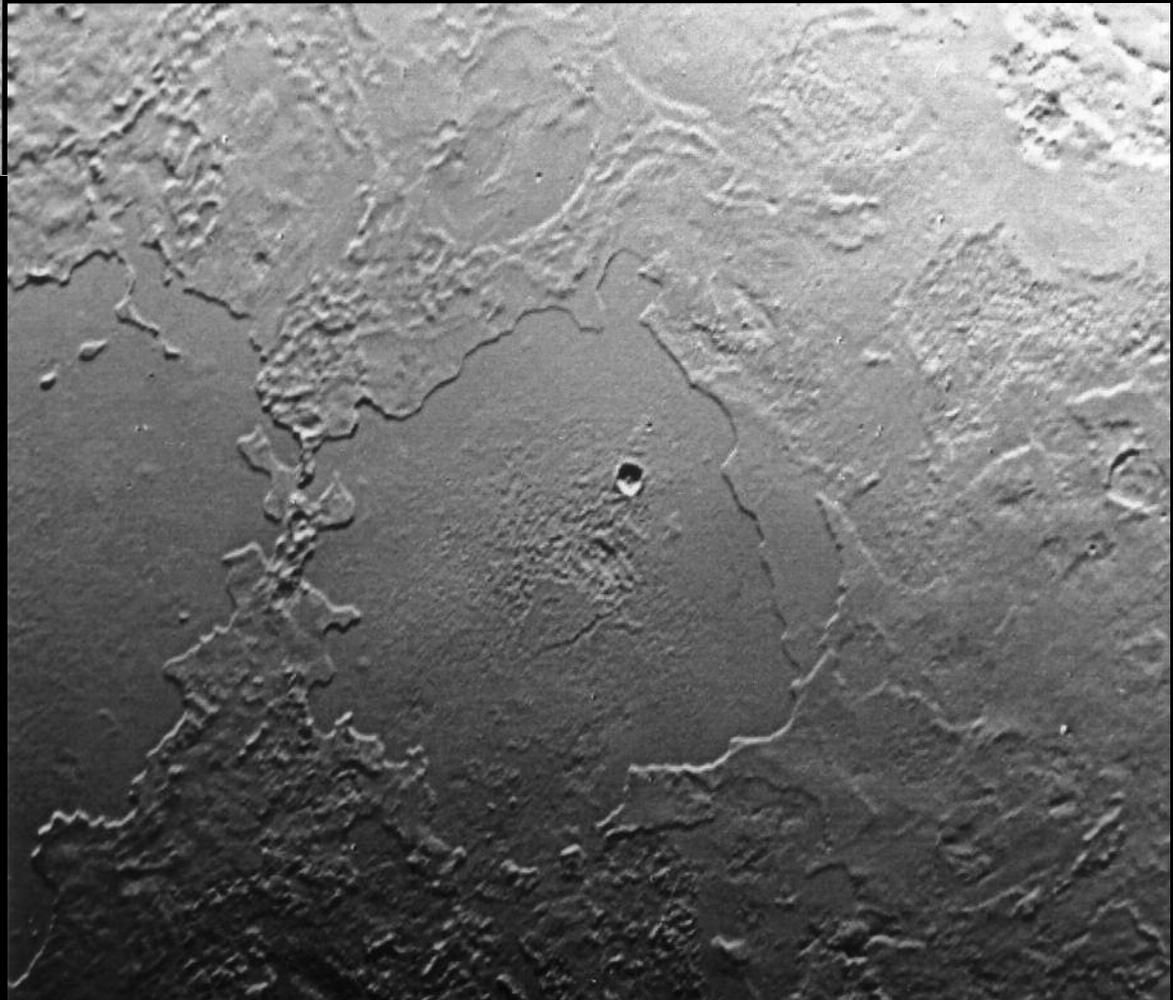
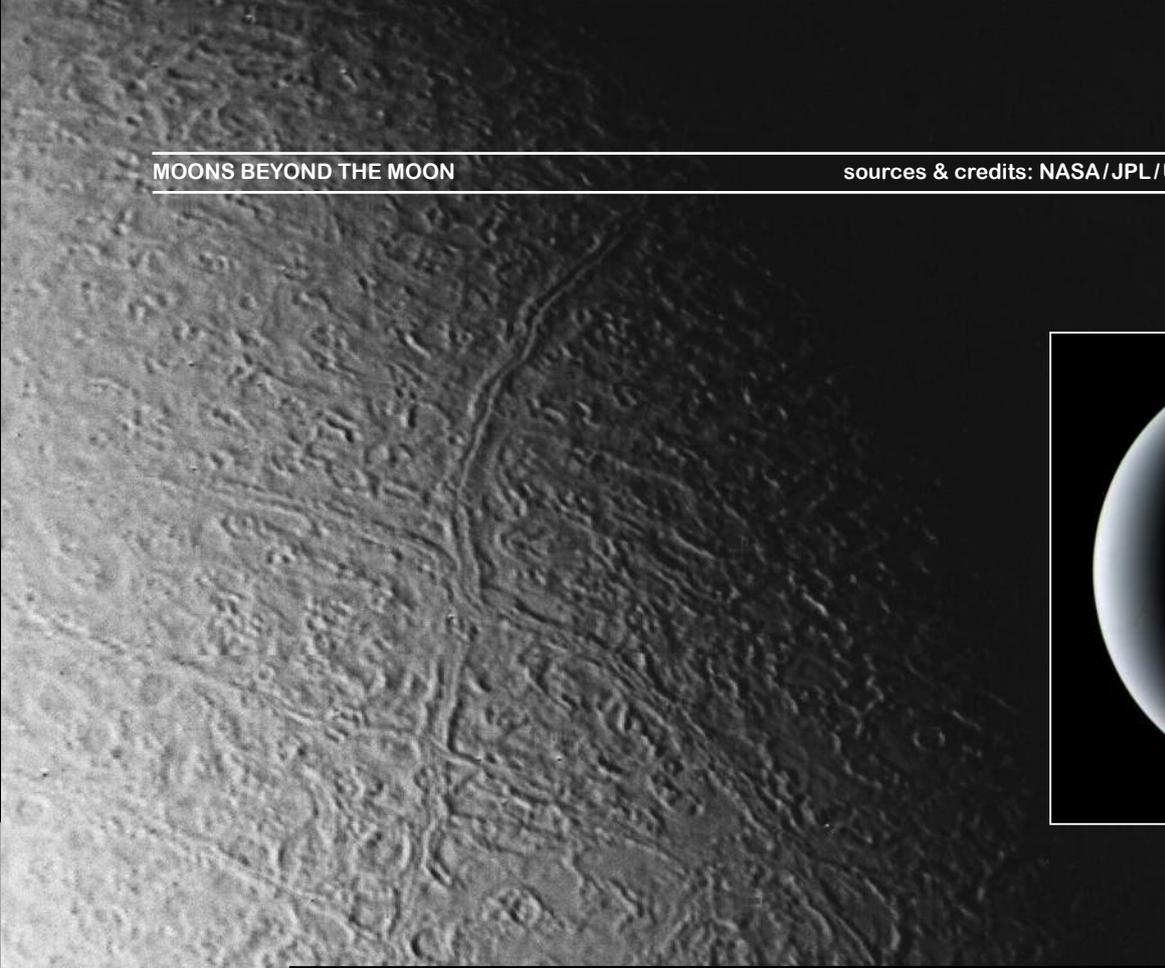


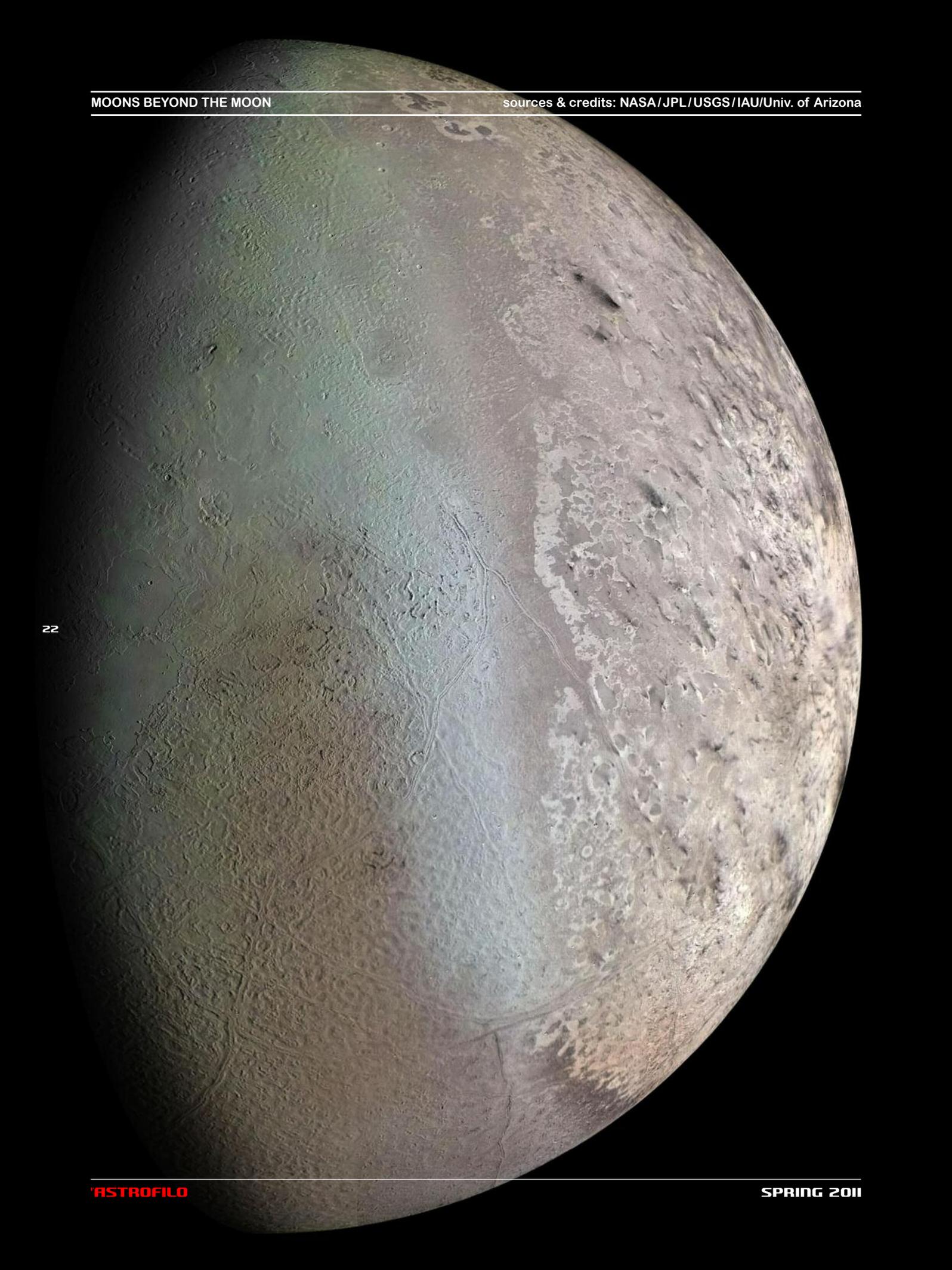
Neptune I (Triton)

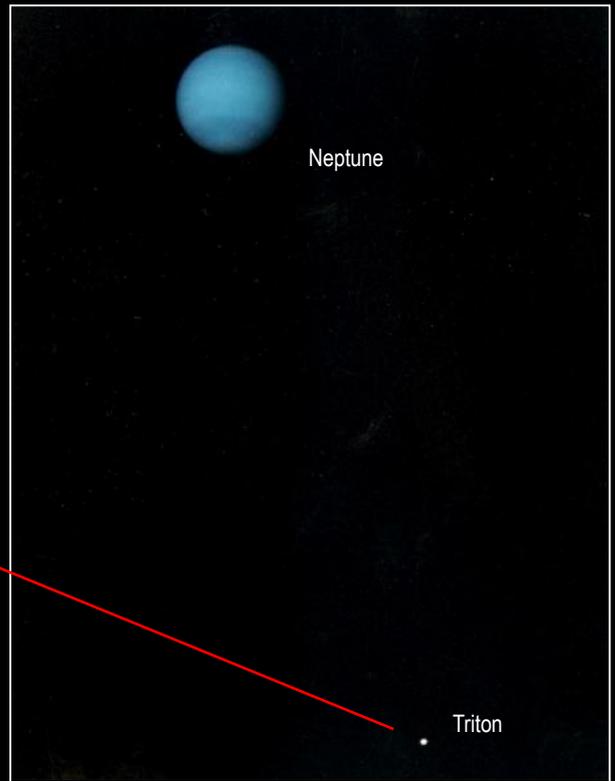
Triton is named after the sea-god son of Poseidon (Neptune) and Amphitrite. The first suggestion of the name Triton has been attributed to the French astronomer Camille Flammarion. Discovery: October 10, 1846 - Liverpool - W. Lassell.







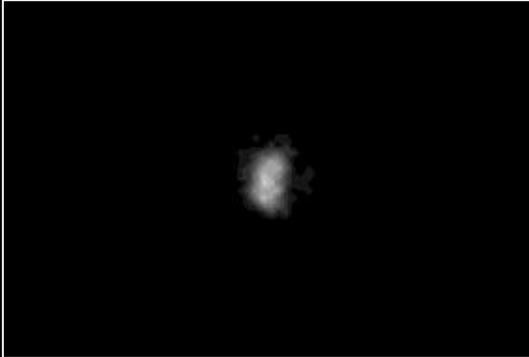




Neptune II (Nereid)

The Nereids were the fifty daughters of Nereus and Doris and were attendants of Neptune.

Discovery: May 1, 1949 - Fort Davis - G.P. Kuiper.



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Neptune III (Naiad)

The name of a group of Greek water nymphs who were guardians of lakes, fountains, springs, and rivers.

Discovery: August 1989 - Voyager 2 - Voyager Science Team.

Neptune IV (Thalassa)

Greek sea goddess. Mother of Aphrodite in some legends; others say she bore the Telchines.

Discovery: August 1989 - Voyager 2 - Voyager Science Team.

Neptune V (Despina)

Daughter of Poseidon (Neptune) and Demeter.

Discovery: July 1989 - Voyager 2 - Voyager Science Team.

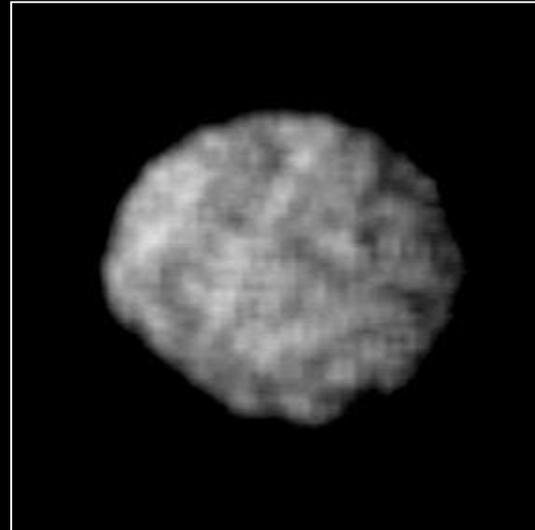
Neptune VI (Galatea)

One of the Nereids, attendants of Poseidon.

Discovery: July 1989 - Voyager 2 - Voyager Science Team.

Neptune VII (Larissa)

A lover of Poseidon. After the discovery by Voyager, it was established that an occul-



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tation of a star by this satellite had been fortuitously observed in 1981 by H. Reitsema, W. Hubbard, L. Lebofsky, and D. J. Tholen.

Discovery: July 1989 - Voyager 2 - Voyager Science Team.

Neptune VIII (Proteus)

Greek sea god, son of Oceanus and Tethys.

Discovery: June 1989 - Voyager 2 - Voyager Science Team.

Neptune IX (Halimede)

One of the Nereids, the fifty daughters of Nereus and Doris.

Discovery: August 14, 2002 - Cerro Tololo M. Holman, J. Kavelaars, T. Grav, W. Fraser, and D. Milisavljevic.

Neptune X (Psamathe)

One of the Nereids, lover of Aeacus and mother of Phocus.

Discovery: August 29, 2003 - Mauna Kea - S.S. Sheppard, D.C. Jewitt, J. Kleyna et al.

Neptune XI (Sao)

One of the Nereids, the fifty daughters of Nereus and Doris.

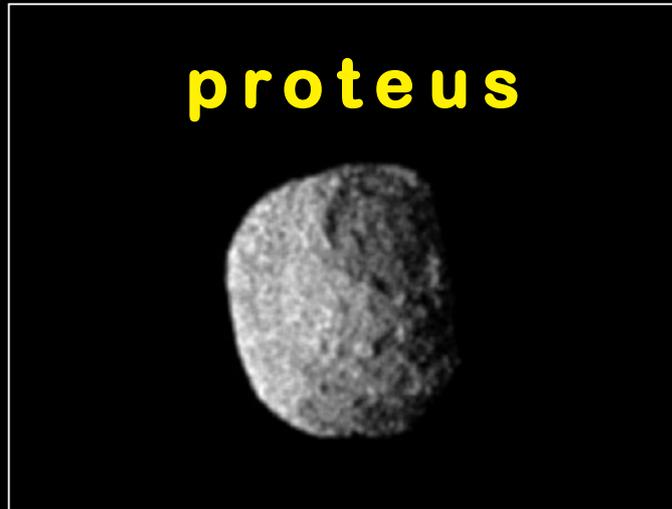
Discovery: August 14, 2002

Cerro Tololo - T. Grav, M. Holman, J. Kavelaars, W. Fraser, and D. Milisavljevic.

**Neptune XII
(Laomedea)**

One of the Nereids, the fifty daughters of Nereus and Doris.

Discovery:
August 13, 2002 - Cerro Tololo - J. Kavelaars, M. Holman,



T. Grav, W. Fraser, and D. Milisavljevic.

**Neptune XIII
(Neso)**

One of the Nereids, the fifty daughters of Nereus and Doris.

Discovery:
August 14, 2002 - Cerro Tololo - M. Holman, J. Kavelaars, T. Grav, W. Fraser, and D. Milisavljevic.

Numeral	Name	Mean radius (km)	Semi-major axis (km)	Sidereal period (d) (r = retrograde)	Discovery date	Discovered by	Notes
NI	Triton	1353.4 ± 0.9	354,800	5.877 (r)	1846	Lassell	Main group moon (retrograde)
NII	Nereid	170 ± 25	5,513,400	360.14	1949	Kuiper	Prograde irregular
NIII	Naiad	33 ± 3	48,227	0.294	1989	Terrile (Voyager 2)	Inner moon
NIV	Thalassa	41 ± 3	50,075	0.311	1989	Terrile (Voyager 2)	Inner moon
NV	Despina	75 ± 3	52,526	0.335	1989	Synnott (Voyager 2)	Inner moon
NVI	Galatea	88 ± 4	61,953	0.429	1989	Synnott (Voyager 2)	Inner moon
NVII	Larissa	97 ± 3	73,548	0.555	1989	Reitsema, Hubbard, Lebofsky, Tholen (Voyager 2)	Inner moon
NVIII	Proteus	210 ± 7	117,647	1.122	1989	Synnott (Voyager 2)	Inner moon
NIX	Halimede	31	15,728,000	1,879.71 (r)	2002	Holman, Kavelaars, Grav, Fraser, Milisavljevic	Retrograde irregular
NX	Psamathe	20	46,695,000	9,115.91 (r)	2003	Jewitt, Kleyna, Sheppard, Holman, Kavelaars	Retrograde irregular
NXI	Sao	22	22,422,000	2,914.07	2002	Holman, Kavelaars, Grav, Fraser, Milisavljevic	Prograde irregular
NXII	Laomedea	21	23,571,000	3,167.85	2002	Holman, Kavelaars, Grav, Fraser, Milisavljevic	Prograde irregular
NXIII	Neso	30	48,387,000	9,373.99 (r)	2002	Holman, Kavelaars, Grav, Fraser, Milisavljevic	Retrograde irregular

Dwarf planets' moons

Pluto I (Charon)

Named after the mythological boatman who ferried souls across the river Styx to Pluto for judgement.

Discovery: April 13, 1978 - Flagstaff - J.W. Christy.



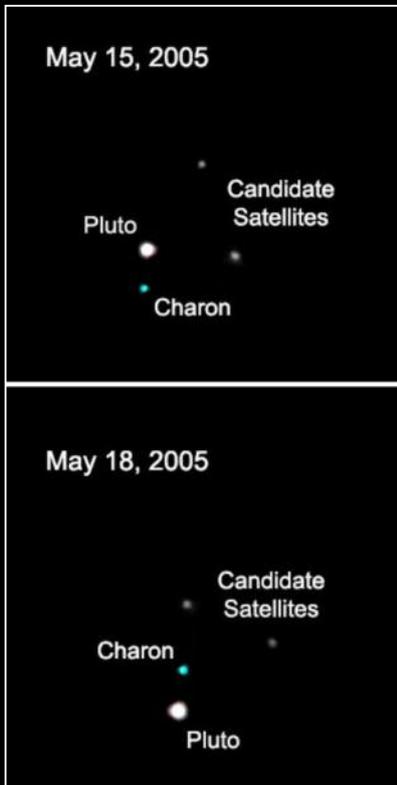
Pluto

Charon

Pluto II (Nix)

Goddess of darkness and night, mother of Charon. (Nix is the Egyptian spelling of the Greek name Nyx.)

Discovery: May 15, 2005 - Hubble Space Telescope - H.A. Weaver, S.A. Stern, M.J. Mutchler, A.J. Steffl, M.W. Buie, W.J. Merline, J.R. Spencer, E.F. Young, and L.A. Young.



May 15, 2005

Pluto

Candidate Satellites

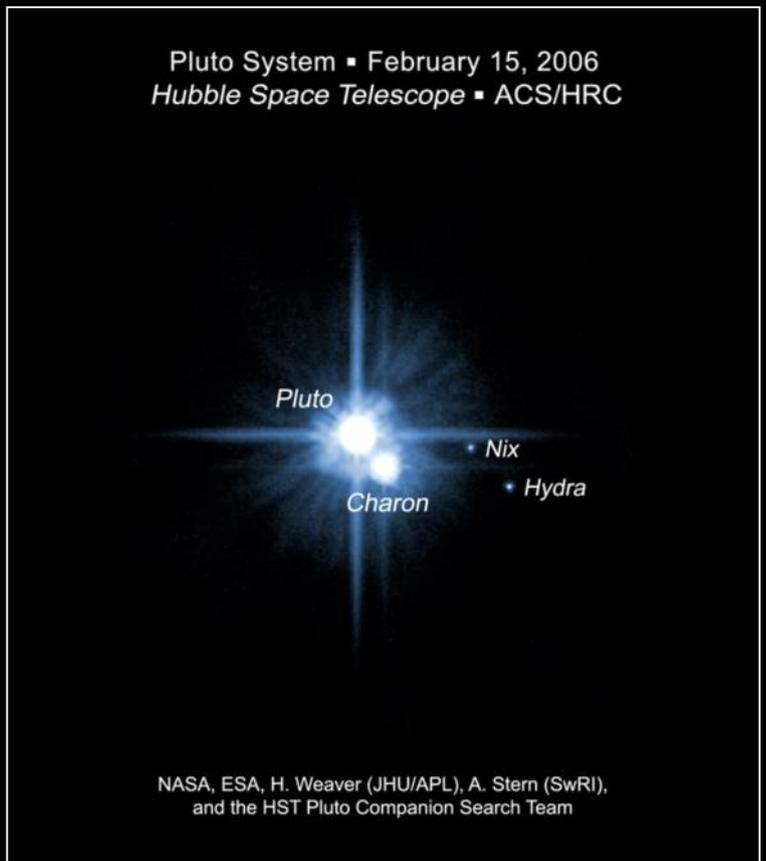
Charon

May 18, 2005

Charon

Candidate Satellites

Pluto



Pluto System ▪ February 15, 2006
Hubble Space Telescope ▪ ACS/HRC

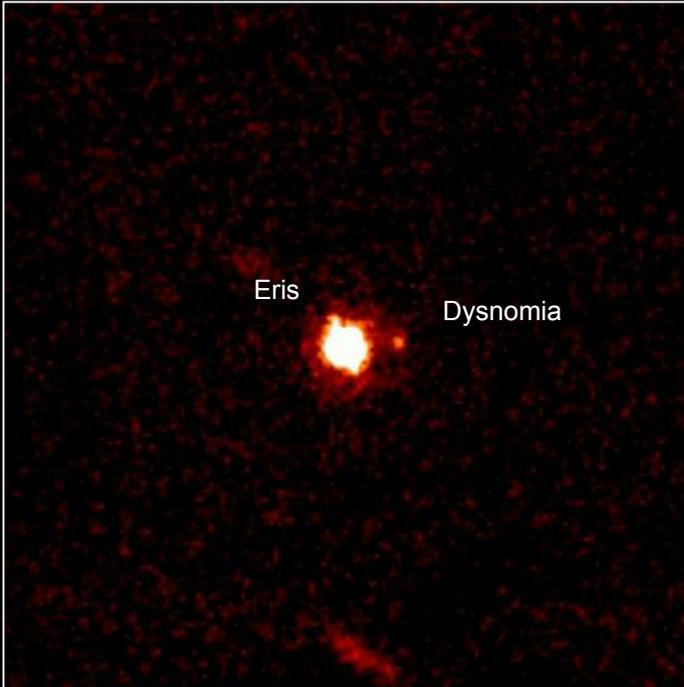
Pluto

Nix

Charon

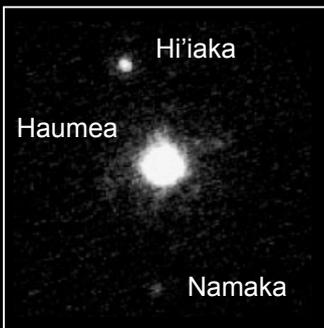
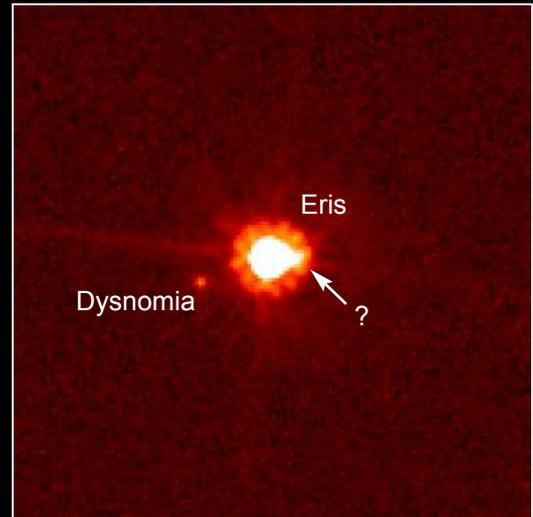
Hydra

NASA, ESA, H. Weaver (JHU/APL), A. Stern (SwRI),
and the HST Pluto Companion Search Team



Eris I (Dysnomia)

Eris' daughter, spirit of lawlessness.
 Discovery: September 10, 2005 - Keck Observatory, Mauna Kea - M.E. Brown and the adaptive-optics team.



Haumea I (Hi'iaka)

Daughter of Haumea, patron goddess of the island of Hawaii and of hula dancers.

Discovery: January 26, 2005 - Keck Observatory, Mauna Kea - M.E. Brown and the adaptive-optics team.

Haumea II (Namaka)

Daughter of Haumea, water spirit in Hawaiian mythology.

Discovery: November 7, 2005 - Keck Observatory, Mauna Kea - M.E. Brown and the adaptive-optics team.

Numeral	Name	Mean radius (km)	Semi-major axis (km)	Sidereal period (d) (r = retrograde)	Discovery date	Discovered by
PI	Charon	593 ± 13	17,536	6.387	1978	Christy
PII	Nix	23 ÷ 67.5	48,708	24.86	2005	Weaver, Stern Buie, et al.
PIII	Hydra	30.5 ÷ 83.5	64,749	38.20	2005	Weaver, Stern Buie, et al.
EI	Dysnomia	~150	37,370 ± 150	15.774	2005	Brown, Rabinowitz, Trujillo et al.
HI	Hi'iaka	~155	49,500 ± 400	49.12	2005	Brown et al.
HII	Namaka	~85	39,000 (r)	34.7	2005	Brown et al.