

Neighbourhood Watch: Solar System Exploration during 2009

Emily Lakdawalla

The Planetary Society

E-mail: emily.lakdawalla@planetary.org

Key Words

Solar System Missions
Public Involvement
Engagement

Spaceships in every corner of the Solar System, from every corner of the world

There have never been so many planetary missions active at once as there are today. In 2009, spacecraft will explore the Moon, Mars, Venus, Mercury and Saturn; many others are on their way to explore comets, asteroids, the cold worlds of the Kuiper belt and beyond. The year will also see the launches of three more spacecraft towards Mars and two towards the Moon. The 23 spacecraft that will be active in 2009 are named and their activities summarised in the following tables.

Clearly, more and more nations are seeking to participate in the exploration of the Solar System, and particularly of our nearest neighbour, the Moon. Japan, China, India, the United States, Germany, the United Kingdom and Russia are all now planning or operating missions on the Moon, a confluence of effort that inspired the Society to declare the "International Lunar Decade"², beginning with the launch of Japan's *Kaguya* orbiter³ in 2007. Last year *Kaguya* was joined at the Moon by China's *Chang'e 1*⁴ and

Summary

As the International Year of Astronomy 2009 opens, there are nearly 20 spacecraft exploring our astronomical backyard, and five more are planned for launch in the coming year. Once the province of a few superpowers, Solar System exploration is now being conducted by countries across the world. The Planetary Society¹ strongly believes that the world's public should not only be told about the lessons learned from these missions, but also be invited to ride along for the adventure.

India's *Chandrayaan-1*⁵, and 2009 will see the launches of NASA's *Lunar Reconnaissance Orbiter*⁶ and *Lunar Crater Observation and Sensing Satellite (LCROSS)*⁷. The Planetary Society hopes that the Decade will serve as a framework for cooperation among the international organisations and nations conducting lunar missions, and also that it will provide a mechanism for scientists and engineers from developing nations and other countries not directly involved in space missions to participate in science programmes or smaller engineering developments.

Many of the next steps in the exploration of our neighbourhood in the Solar System are so challenging that they seem daunting without the commitment and cooperation of many (if not all) of Earth's space-faring nations. Establishing a permanent presence on the Moon; advancing the scientific study of the mini "solar systems" and moons of Jupiter, Saturn and beyond; returning scientifically useful samples of rocks from the surface of Mars; extending the presence of humans beyond Earth orbit to the Moon, asteroids and Mars — all of these will require billions of dollars and the kind of effort that only seems to be sustainable when departments of state, not just space agencies, commit to working together toward common goals.

So, to advance international cooperation further, The Planetary Society is supporting the development of the Global Exploration Strategy⁸. Fourteen space agencies (including ESA, NASA, and the agencies of Italy, the UK, France, China, Canada, Australia, Germany, India, Japan, South Korea, the Ukraine and Russia) have signed on to the first Global Exploration Strategy document, published by ESA in 2007. It presents a broad global consensus and concise rationale for human exploration of the Solar System, beginning with our nearest neighbour, the Moon. We hope that by the end of the International Lunar Decade, humans will have returned to the Moon and be looking outward, to the asteroids or Mars.

Opportunities for the public to participate in planetary exploration

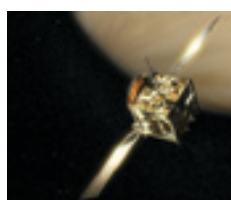
Developing expensive and technologically challenging planetary missions requires broad support by the taxpayers of space-faring nations, and space agencies are increasingly learning that it is not enough to tell the public about their successes; they must invite the public to, in effect, "ride along" with the voyages of discovery. One

Inner Solar System



MESSENGER (NASA)

En route to Mercury orbit insertion in 2011, *MESSENGER* will fly by Mercury for the third time on September 29. Credit: NASA/Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington.



Venus Express (ESA)

Venus Express is currently funded through at least April 2009. ESA has not yet determined its future after that, but the spacecraft is in good health and could continue returning data on Venus's atmosphere. Credit: ESA (Image by AOES Medialab).

The Moon



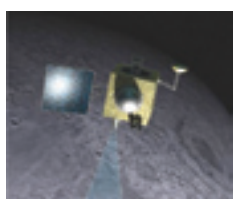
Kaguya (JAXA)

Kaguya finished its primary mission in October 2008, but will continue mapping the gravity field of the Moon and capturing high resolution stereo images until May 2009. Later in the summer, it will impact the Moon. Credit: JAXA.



Chang'e 1 (China)

Shortly after the lunar orbit insertion of *Chang'e 1*, Chinese officials announced that the fuel margin should permit them to double the length of its science mission to two years. Credit: CNSA.



Chandrayaan-1 (India)

Launched in October 2008, *Chandrayaan-1*'s lunar mapping mission will continue through 2009. Credit: ISRO.



Lunar Reconnaissance Orbiter (NASA)

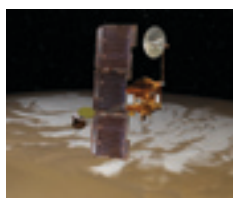
Lunar Reconnaissance Orbiter is expected to launch in spring 2009 and will spend the rest of the year mapping the Moon; its cameras will be the first since Apollo's to be able to spot human-made artefacts on the Moon. Credit: NASA.



LCROSS (NASA)

Launching with the *Lunar Reconnaissance Orbiter*, *LCROSS* will impact the lunar about two months later, possibly in May. The event will be watched by Earth-based astronomers, including a worldwide amateur community. Credit: NASA.

Mars



2001 Mars Odyssey (NASA)

Although long past the end of its primary mission, 2001 *Mars Odyssey* shows no signs of faltering and will likely still be mapping Mars and serving as a communications relay for the Mars Exploration Rovers. Credit: NASA/JPL.



Mars Express (ESA)

In orbit since 2003, *Mars Express*'s mission will likely be extended again to continue its mapping of the surface and subsurface of Mars, as well as the surface of Mars's moon Phobos. Credit: ESA.



Mars Reconnaissance Orbiter (NASA)

Mars Reconnaissance Orbiter's primary mission ended in November 2008, and is now in its Extended Science Phase. Once the Mars Science Laboratory arrives it will serve as the primary Mars telecommunication satellite. Credit: JPL/NASA.



Mars Exploration Rovers (NASA)

Although both *Spirit* and *Opportunity* are showing signs of their advanced age, there is no reason to expect that they will not survive well into 2009, when spring and summer in Mars's southern hemisphere should bring them warmer temperatures and more solar power than they enjoyed in 2008. Credit: NASA/JPL/Cornell University/Maas Digital.



Phobos-Grunt (Russia)

Phobos-Grunt is currently scheduled to launch toward Mars in October 2009 to collect samples from Mars's moon Phobos and return them to Earth. Credit: Paolo Ulivi.



Yinghuo-1 (China)

China's first mission beyond Earth orbit will hitch a ride to Mars with the *Phobos-Grunt* spacecraft, launching in October 2009. Credit: CNSA.

Table 1. Planetary exploration missions active in 2009 (Cont.).

Saturn



Cassini-Huygens (NASA/ESA/ASI)

Throughout 2009 the *Cassini* orbiter will be in its first extended mission, continuing studies of Saturn, its rings and its moons; highlights will be three exceptionally close flybys of the geyser moon Enceladus, and witnessing the arrival of Saturn's equinox in August. Credit: NASA/JPL.

Deep Space / Cruise



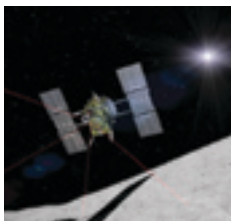
Dawn (NASA)

In February 2009, *Dawn* will fly by Mars, which will supply a gravity assist to boost the ion-powered spacecraft onward to its planned 2011 arrival at the asteroid Vesta. Credit: McREL.



Deep Impact (NASA)

As part of the EPOXI extended mission, the *Deep Impact* spacecraft has completed its observations of extrasolar planets. It is now travelling towards a 2010 rendezvous with Jupiter-family comet 103P/Hartley 2. Credit: NASA/JPL/UMD. Credit: NASA/JPL/UMD.



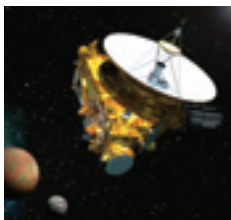
Hayabusa (JAXA)

Although seriously injured during its dramatic touchdown on asteroid Itokawa in 2005, *Hayabusa* in its attempt to return its sample capsule (which may or may not contain a sample) to Earth in 2010. Credit: LiVE Company Ltd.



International Cometary Explorer (ICE) (NASA)

After an eight-year hiatus, NASA re-established contact with *ICE* in 2008, which flew through the tail of comet Giacobini-Zinner in 1985. Still in good condition with most of its instruments functioning, *ICE* is on course for a return visit to Earth in 2014, when it may be sent onward to explore another comet. Credit: NASA.



New Horizons (NASA)

New Horizons will spend most of 2009 hibernating while it travels 533.7 million kilometres (3.57 astronomical units) on its way to Pluto. It will not reach Pluto until 2015. Credit: Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute (JHUAPL/SwRI).



Rosetta (ESA)

ESA's flagship mission to a comet will fly by Earth for the third time on November 13, en route to its planned arrival at comet Churyumov-Gerasimenko in May 2014. Credit: ESA/C. Carreau.



Stardust (NASA)

Throughout 2009, *Stardust* will be cruising toward a February 2011 encounter with Tempel 1. Credit: NASA/JPL.



Voyager 1 and 2 (NASA)

The two long-lived spacecraft will hopefully still be returning data from the interstellar medium beyond the Solar System. Credit: NASA/JPL.

very simple method of helping people to feel a sense of ownership over space missions is to facilitate "Messages from Earth" opportunities⁹. These allow the public to send their names and, sometimes, good wishes along with planetary missions. The oldest example is still in orbit around Saturn: *Cassini* carries a DVD¹⁰ with 616 400 handwritten signatures from people living in 81 countries, scanned to digital format. The advent of the internet has made collecting names easier, so two DVDs, each containing four million names, were sent with the Mars Exploration Rovers¹¹. With *Phoenix*, a DVD was included containing "Visions of Mars"¹², a collection

of Mars-inspired literature, art and personal greetings from leading space visionaries of our time. The *Lunar Reconnaissance Orbiter* will be the next spacecraft to carry names beyond Earth.

But members of the public can do more to actually contribute to the scientific results of space missions. One such opportunity is The Planetary Society's Stardust@home project¹³. After completing a short online training session, members of the public can help examine more than 700 000 microscopic scans of the *Stardust* spacecraft's interstellar dust collection plates, searching

for a few dozen micron-sized grains of dust. To date, only a quarter of the collection plates have been scanned, so plenty more work remains for 2009.

There will also be two opportunities for amateur astronomers to contribute to lunar science. On separate dates in the summer of 2009, there will be two missions intentionally crashing into the Moon: the two spacecraft of *LCROSS* in the early summer and Japan's huge *Kaguya* orbiter in the late summer. The *LCROSS* impact will be into a permanently shadowed region of one of the lunar poles; observations of the plume raised by

The year starts with Mars in early northern autumn; Saturn in late northern winter; Uranus in early northern spring; and Neptune in early northern winter.

	Astronomical Events	Spacecraft Events
January	4: Earth at perihelion 11: Full Moon 24: Jupiter at conjunction 26: Annular solar eclipse	14: <i>Stardust</i> : Earth flyby (en route to Tempel 1 rendezvous in 2011)
February	9: Full Moon 9: Penumbral lunar eclipse 13: Neptune at conjunction 20: Venus at maximum brightness	2: <i>Cassini</i> : Distant Rhea flyby 7: <i>Cassini</i> : Titan flyby 18: <i>Dawn</i> : Mars flyby (en route to Vesta rendezvous in 2011)
March	8: Saturn at opposition 11: Full Moon 13: Uranus at conjunction 20: Earth at equinox 28: Venus at conjunction	6: <i>Kepler</i> planet-hunting spacecraft: Launch 27: <i>Cassini</i> : Titan flyby
April	9: Full Moon 29: Venus at maximum brightness	<i>Venus Express</i> : End of extended mission 4: <i>Cassini</i> : Titan flyby, first of 10 straight with 16-day orbit matching Titan's 20: <i>Cassini</i> : Titan flyby 24: <i>Lunar Reconnaissance Orbiter</i> : Launch
May	9: Full Moon 22: Mars at solstice (northern winter)	5: <i>Cassini</i> : Titan flyby 21: <i>Cassini</i> : Titan flyby
June	6: Full Moon 20: Earth at solstice	6: <i>Cassini</i> : Titan flyby 22: <i>Cassini</i> : Titan flyby
July	4: Earth at aphelion 7: Full Moon 7: Penumbral lunar eclipse 22: Total solar eclipse in Asia	8: <i>Cassini</i> : Titan flyby 11: <i>Cassini</i> : Distant Dione flyby 24: <i>Cassini</i> : Titan flyby 26: <i>Cassini</i> : Distant Tethys flyby
August	6: Full Moon 6: Penumbral lunar eclipse 11: Saturn at equinox (northern spring) 15: Jupiter at opposition 18: Neptune at opposition	9: <i>Cassini</i> : Titan flyby 11: <i>Cassini</i> : Observes Saturn at equinox! 25: <i>Cassini</i> : Titan flyby, last of 10 straight
September	4: Full Moon 5: Earth crosses Saturn's ring plane 17: Uranus at opposition 18: Saturn at conjunction 22: Earth at equinox	15: <i>Mars Science Laboratory</i> : Launch period opens 20: <i>Cassini</i> : Distant Dione flyby 29: <i>MESSENGER</i> Mercury flyby #3
October	4: Full Moon 27: Mars equinox (northern spring)	<i>Phobos-Grunt</i> and <i>Yinghuo-1</i> : Launch 12: <i>Cassini</i> : Titan flyby 13-14: <i>Cassini</i> : Distant Rhea, Mimas, and Tethys flybys
November	2: Full Moon	2: <i>Cassini</i> : Targeted Enceladus flyby (1 of 2 this month) 13: <i>Rosetta</i> : Earth flyby #3 (en route to comet rendezvous May 2014) 21: <i>Cassini</i> : Targeted Enceladus flyby and distant Rhea flyby
December	2: Full Moon 21: Earth at solstice 31: Full Moon (blue moon!) 31: Partial lunar eclipse	12: <i>Cassini</i> : Titan flyby 26: <i>Cassini</i> : Distant Tethys flyby 28: <i>Cassini</i> : Titan flyby

the impact could confirm the presence or absence of water in these regions. The Planetary Society will be helping to organise and promote a worldwide campaign by amateur astronomers to photograph the impact plume, and hopes to mobilise the same group to watch *Kaguya's* demise. The exact dates of both events will not be known until a couple of months before they occur.

The world's public can also now take science into their own hands, because many missions now provide relatively easy internet access to entire catalogues of raw image data being returned from spacecraft. Data from all active Mars orbiters can be accessed via map-based interfaces after proprietary periods have expired, while some missions (currently, the Mars Exploration Rovers

and *Cassini*) provide nearly instantaneous access to "raw" image data. Until recently, such data was only useable by trained experts at research institutions, but the proliferation of digital camera use by members of the general public, in combination with increasing high speed internet access, has resulted in the birth of a worldwide community of armchair scientists who download, process, examine, and then discuss the images being returned by active planetary missions. The joy of discovery of new landscapes on strange worlds, once limited to the few scientists fortunate enough to be on mission science, is now accessible to the world's public via the internet. The Planetary Society is helping this community to grow by converting some planetary datasets from the arcane formats used by researchers into more commonly used formats like JPEG and PNG, and providing guidance on how to find and process images from planetary missions.

We hope that the worldwide events of the International Year of Astronomy in 2009 will focus public attention not only on distant stars and galaxies, but also on our own Solar System. Space is not just what we see at the other end of a telescope; we live in space, too, and it is as important to study our own neighbourhood as it is to examine the Universe beyond.

Notes

- ¹ <http://planetary.org>
- ² http://www.planetary.org/programs/projects/lunar_decade/
- ³ http://www.selene.jaxa.jp/index_e.htm
- ⁴ http://planetary.org/explore/topics/chang_e_1/
- ⁵ <http://isro.org/Chandrayaan/index.htm>
- ⁶ <http://lunar.gsfc.nasa.gov/>
- ⁷ <http://lrcross.arc.nasa.gov/>
- ⁸ <http://www.scitech.ac.uk/Resources/PDF/gesframe-work.pdf>
- ⁹ <http://planetary.org/programs/projects/messages/>
- ¹⁰ <http://saturn.jpl.nasa.gov/kids/amazing-dvd.cfm>
- ¹¹ http://www.planetary.org/programs/projects/red_rover_goes_to_mars/dvd.html
- ¹² <http://www.planetary.org/programs/projects/messages/vom.html>
- ¹³ <http://stardustathome.ssl.berkeley.edu/>

Biography

Emily Lakdawalla is the Science and Technology Coordinator for The Planetary Society. She received a Bachelor's degree in geology from Amherst College and then taught science to fifth- and sixth-grade children in Chicago. She went on to Brown University to study planetary geology. Lakdawalla came to The Planetary Society in 2001, and she now writes for the website and weblog, records the "Q and A" segment on the weekly Planetary Radio show and occasionally contributes to the Society's bimonthly magazine, *The Planetary Report*.