State of the Solar System 2014

Solar System exploration is making spectacular progress. As of early 2014, we have emerged for the first time from the enormous bubble of magnetism and ionized gas that the Sun emits and entered interstellar space. We have had close encounters with all of the planets out to Neptune and we're on our way to Pluto. We are exploring Mars with two rovers and several orbiters. We are using a fleet of spacecraft for coordinated study of the Sun and its effects on the Solar System. We are in orbit around Mercury, flying to a dwarf planet in the asteroid belt, and continuing an extensive tour of Saturn and its moons. And our exploration out there helps to unite us here on Earth, as many missions are cooperative endeavors with the space agencies of other nations.

Sun

Currently flying: IRIS, SDO, STEREO, Hinode, RHESSI, Cluster, ACE, SOHO, and Wind. These spacecraft study the Sun, its interactions with Earth, and the environment of the inner Solar System.

2013 highlights: IRIS was launched into Earth orbit to study how the solar atmosphere is energized. The current solar maximum (peak of the 11-year sunspot cycle) has been unusually weak as the cyclical reversing of the Sun's magnetic poles has continued.

Outlook for 2014:
Reversal of the Sun's magnetic field will likely be completed, marking the midpoint of Solar Cycle 24. After the cycle's peak, we will look for large coronal holes on the Sun, from which high-speed streams will become a driver of space weather.

Mercury

Currently flying: MESSENGER

2013 highlights: Mapped elemental composition of Mercury's surface, found the planet shrank much more than previously estimated and that space weathering darkens Mercury's surface four times faster than that of the Moon. Also observed comets Encke and ISON, measured effects of radio-wave interaction with the solar corona's magnetic field, and mapped interstellar ions in the inner heliosphere.

Outlook for 2014: Observations will be made at lower altitudes, enabling imaging and other measurements with unprecedented spatial resolution.

Venus

Currently flying: Venus Express, a European Space Agency (ESA) orbiter.

Outlook for 2014: The mission will end in June, after more than 10 years in orbit. Before the spacecraft runs out of fuel, it will maneuver into the planet's tenuous upper atmosphere for further scientific measurements and engineering tests of aerobraking. The mission will end as the spacecraft descends into denser atmospheric layers and burns up.

Earth's Moon

Currently flying: LADEE, Lunar Reconnaissance Orbiter (LRO), ARTEMIS

2013 highlights: LADEE was launched into lunar orbit to study the Moon's exosphere (its extremely tenuous gas and dust atmosphere) and demonstrate a novel high-rate laser communications system. LRO continues to map the lunar surface. China landed its first rover on the Moon.

Outlook for 2014: After taking science data at unprecedented low altitudes (a few kilometers), LADEE will deliberately impact the lunar surface in April. LRO will continue investigating the lunar surface. ARTEMIS will continue studying the Moon's interaction with the solar wind among other investigations.

Mars

Currently operating on the surface: Curiosity and Opportunity rovers

Currently orbiting: Mars Odyssey, Mars Reconnaissance Orbiter, Mars Express (ESA with NASA participation)

2013 highlights: MAVEN was launched on Nov. 18. Curiosity and Opportunity each discovered evidence of an ancient habitable environment, and Curiosity found that the exposed surface of Gale Crater's floor is recent enough to have preserved potential signs of life. Opportunity passed the 10-year mark on Mars' surface. MRO found possible brine flows in the enormous canyon, Valles Marineris.

Outlook for 2014: Both NASA's MAVEN and India's Mars Orbiter Mission will enter Mars orbit on Sept. 21. MAVEN will explore the atmosphere's interactions with the Sun and solar wind. Curiosity will reach the lower slopes of Mt. Sharp to investigate the planet's history preserved in its rock layers. Opportunity will winter on Endeavour Crater's rim while examining minerals formed in water. MRO and Mars Express will continue to map Mars from orbit and monitor changes on the surface. Odyssey's orbit will drift until November 2015 to an orientation enabling the spacecraft to make the first systematic observations of conditions just after sunrise and sunset. The 2016 InSight lander, which will study the planet's deep interior, is in development. Mars 2020 will select its payload and begin development.

Asteroids

Currently flying: Dawn, NEOWISE, NEOSSat

2013 highlights: As the Dawn spacecraft continued its voyage to dwarf planet Ceres, the Dawn science team finished processing the data the spacecraft had transmitted during its orbit of Vesta, completing the geologic mapping of that asteroid. NASA's NEOWISE was reactivated and Canada's NEOSSat was launched by India's space agency. Both are Earth-orbiters.

Outlook for 2014: Dawn will close in on Ceres as the team makes final preparations for next year's arrival. NEOWISE and NEOSSat will continue to search for asteroids and comets that could threaten Earth. Japan plans to launch Hayabusa 2, its second mission to bring samples of an asteroid back to Earth.

Comets

Currently flying: Rosetta is en route. It's a European Space Agency (ESA) mission for which NASA provides instruments and support.

2013 highlights: Marked nearly a decade of space travel, during which it swung by Earth three times and Mars once for gravity assists, and flew by asteroids Steins and Lutetia in the asteroid belt between Mars and Jupiter.

Outlook for 2014: Following a successful awakening in January from more than two years of deep-space hibernation, it is scheduled to rendezvous with comet 67P/Churyumov-Gerasimenko in May and escort the comet to the inner solar system.

Jupiter

Currently flying: Juno is en route.

2013 highlights: The spacecraft flew by Earth in October for a gravity assist to boost its speed and set course for a 2016 arrival at Jupiter. Instrument testing and calibrations were completed.

Outlook for 2014: Will continue its journey to Jupiter.

Saturn

Currently flying: Cassini

2013 highlights: Probed a Titan sea's depth for the first time and detected possible evaporates surrounding the north polar lakes. Revealed that Saturn's gravity controls Enceladus' jets, obtained the best views yet of a giant hurricane at Saturn's north pole and discovered that the planet's natural vibrations create wavelike patterns in its rings. Panoramic mosaic of Saturn backlit by the Sun captured Saturn's moons, rings, Mars, Venus and Earth together for the first time, as people from over 40 countries waved back at the spacecraft.

Outlook for 2014: Cassini will fly by Titan 11 times, observing seasonal changes, seeking lake reflections and probing the depth of the moon's largest sea, Kraken Mare. High-inclination orbits will enable excellent views of Saturn's poles and rings, passage through new regions of the magnetosphere, and continuation of aurora observations.

Pluto

Currently flying: New Horizons is en route.

2013 highlights: Nine-day rehearsal of the activities New Horizons will conduct during its closest approach of Pluto. The LORRI imager separately detected Pluto and its largest moon, Charon.

Outlook for 2014: The spacecraft will start its first optical navigation campaign in July and will cross Neptune's orbit on August 25, the 25th anniversary of Voyager's encounter with that planet.

Outer Heliosphere and Beyond

(region far beyond all the planets, where the Sun's magnetic field and solar wind give way to the interstellar medium)

Currently flying: Voyager 1, Voyager 2, IBEX

2013 highlights: New evidence that in 2012, Voyager 1 crossed from the heliosphere into interstellar space. At year's end, the spacecraft was about 12 billion miles (19 billion km) from the Sun. Voyager 2 reported on conditions some 10 billion miles (16 billion km) from the Sun. IBEX, which orbits Earth and detects particles that have traveled from the edge of the heliosphere, imaged the heliotail for the first time. That's the part of the solar bubble that trails the solar system as we travel through the interstellar medium.

Outlook for 2014: These spacecraft will continue to help us understand conditions in the uncharted outskirts of the Solar System.