International Cooperation in Space: Now More than Ever

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• Why should we collaborate in space?
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Why should we collaborate in space?

**Common Goals and Objectives**
- Search for life and its origin
- Explore & Extend human presence
- Develop exploration technologies and capabilities
- Perform science to support human exploration
- Stimulate economic expansion
- Perform space, Earth and applied sciences

**Orbits**
- **Geosynchronous Orbit**: Aproximately 36,000 km/22,000 mi
- **Mid-Earth Orbit**: Aproximately 2,000 - 36,000 km/1,240-22,000 mi
- **Low Earth Orbit**: Aproximately 2,000 km/1,240 mi
- **International Space Station**: Distance: 400 km/248 mi, Travel Time: 2 Days
- **Moon**: Distance: 382,500 km/237,674 mi, Travel Time: 3 Days
- **Mars**: Distance: 54,500,000 km/33,900,000 mi, Travel Time: 6 Months
NASA & International cooperation

- The National Aeronautics and Space Act created NASA in 1958 and states that every effort will be made to cooperate with the international community. This policy continues to be part of national space policy to this day.
- NASA’s technologies bring multiple societal benefits to it and its partners
  - Visit this game to see how space traces back to you: http://www.nasa.gov/externalflash/nasacity/index2.htm
- NASA has had over 3,000 agreements with over 100 nations, of which 500 remain active
- Eight of NASA’s partners account for 50% of the agreements
  - France, Germany, ESA, Japan, United Kingdom, Italy, Canada and Russia
- Two-thirds of the cooperative efforts are with science missions
- Half of the partners are European
Total International Agreements = 464
Total Countries: 125
Michael Lopez-Alegria

Michael was born in Spain but moved to the United States at a young age. During the seven months aboard the International Space Station in 2007, his crew operated, maintained, built and utilized the station and its science facilities.

Pedro Duque

Pedro was assigned to the first International Space Station advanced training class in 2001. He underwent preparation that qualified him for one of the first European long-term flights on board ISS.
International Space Station Overview

- NASA International Partnership
  - ASI/ESA/JAXA/CSA since 1980s
  - Roskosmos since 1993
- Builds on long history of international cooperation
  - Shuttle
  - Science missions
- Largest spacecraft ever built
  - 420,500 kg at completion
  - Over 40 assembly flights
- International crew
- International launch fleet
- International servicing vehicles
  - Commercial in development
- Globally distributed operations
Astrophysics

Heliophysics

Earth Science

Planetary Science

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SAMPLES FROM CURRENT MISSIONS
NASA Mars Reconnaissance Orbiter (MRO)

Launched in August 2005, MRO began seeking the history of water on Mars with its science instruments. MRO also serves as a relay between the rovers on Mars and the NASA antennas on Earth.

ESA Mars Express

Launched in June 2003, the Mars Express images the entire Martian surface, produces a map of the mineral composition, and determines the composition of the atmosphere.

Both vehicles serve as internationally interoperable data relays.
• Launched in October 1997, Cassini was launched with ESA’s Huygens probe. The probe was equipped with instruments to study Titan, Saturn’s largest moon. Cassini completed its initial mission and is now onto its second extended mission to study Saturn’s summer solstice.

• Seventeen countries have been involved with the design, fabrication and preparation of Cassini.
Launched in December 1995, SOHO is a collaboration between ESA and NASA to study the internal structure of the Sun, its extensive outer atmosphere, the origin of the solar wind, and the stream of highly ionized gas that blows continuously outward through the solar system.
• Launched in November 2004, Swift studies gamma-ray burst science in gamma-ray, X-ray, optical and ultraviolet wavebands.

• Prime Institution
  – Goddard Space Flight Center

• Lead University Partner
  – Penn State University

• International Hardware Partners
  – University of Leicester
  – Mullard Space Science Laboratory
  – Osservatorio Astronomico di Brera
  – ASI Science Data Center
Satellite laser ranging uses lasers to measure ranges from ground stations to satellite borne retro-reflectors to the millimeter level.

The primary mission of the ILRS is to support, through satellite and lunar laser tracking data and related products, geodetic and geophysical research activities.

Laser Ranging to GNSS will assist in developing Improved models and reference frames necessary to support

- Earthquake prediction
- Global sea surface height and ice sheet thickness

Laser ranging ground stations are distributed all over the world, including the US and Mediterranean countries.

San Fernando, Spain
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FUTURE MISSIONS
• MSL is scheduled to launch November 25, 2011. Curiosity, MSL’s rover, will join the other two rovers (Spirit and Opportunity) on Mars. Curiosity will determine whether Mars ever was, or is still is able to support microbial life.

• Spain’s Ministry of Science and Innovation, National Aerospace Technical Institute (INTA) and the Center for Industrial Technology Development (CDTI) provided the Remote Environmental Monitoring Station, which will monitor daily and seasonal changes using the sensors on the mast.

• The Deep Space Network will provide communications support to MSL.
MAVEN is set to launch around November 2013. MAVEN will explore Mars’ upper atmosphere, ionosphere and interaction with the sun and solar wind. The data will be used to determine the loss of CO$_2$, NO$_2$, and H$_2$O in the atmosphere.

- The Institut de Recherche en Astrophysique et Planétologie (IRAP) in Toulouse, France will provide a sensor for the Solar Wind Electron Analyzer.
- The Deep Space Network will provide communications support to MAVEN.
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INTERNATIONAL PROJECTS USING SCIENCE DATA
• Project areas include
  – Scientific research
  – Earth science applications
  – Education initiatives

• Examples of ongoing cooperation
  – Aerosol Robotic Network (AERONET)
  – Global Learning and Observations to Benefit the Environment
  – SERVIR (Central America, East Africa, Himalaya region)
  – Space Geodetic Network
  – International Space Weather Initiative
  – Digital Learning Network
  – NASA Lunar Science Institute
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SPACE COMMUNICATIONS AND NAVIGATION
Space Communication and Navigation (SCaN) manages NASA’s space communications from the Earth to the satellites and back.

SCaN’s customers are diverse and located all over the world
- NASA and other US government entities
- Private industry
- ESA, JAXA, Roscosmos, other space agencies

There are three networks of antennas that SCaN manages
- Deep Space Network – based at the Jet Propulsion Laboratory in California
- Near Earth Network – based at the Goddard Space Flight Center in Maryland
- Space Network – based at the Goddard Space Flight Center in Maryland

Each of these networks has partners across the globe
Madrid Deep Space Communications Complex
Los ‘españoles del Apollo’ vuelven a Fresnedillas 40 años después

Los trabajadores de la estación recuerdan la llegada del hombre a la Luna

Alicia Riuera

Fresnedillas

“En aquel momento éramos 103 españoles trabajando en la estación de Fresnedillas, y otros tan tos estadounidenses”, recuerda Manuel Bautista. Aquel momento era julio de 1969, la fecha cul minante del programa Apollo que llevó al ser humano a la su perficie lunar, y Bautista era el director de las estaciones de seguimiento que la NASA instaló en España para comunicarse con aquellos naves espaciales legendarias durante varias horas cada día. La de Fresnedillas Valdepeñas estaba en el viaje de vuelta a la Luna y ayer se juntaron en el pueblo varias decenas de técnicos e ingenieros que entonces trabajaron allí para recorrer y festear.

La celebración fue una iniciativa del Ayuntamiento de Fresnedillas y entre los invitados había numerosos españoles, pero también estadounidenses llegados para la ocasión. Aparentemente, todo para los ya ausentes, vísperos y mucha ale gría llenaron la sala de la Casa de la Cultura de Fresnedillas, tras la parte oficial de los actos, presid idos por Esperanza Aguirre.

“Cuando Armstrong puso el pie en la Luna no pensábamos en que ibamos a estar aquí celebrándolo 40 años después”, apunta Luis Ruiz de Gopegui, entonces direc tor de la estación. A Bautista le llama la atención que precisa mente 40 años después no se ha ya vuelto a poner el pie allí. “Pero no el, se acabará volviendo”, dice.

Larry Haag, con 30 años en tu nceces, era el jefe de computado res. “Teníamos una ordenación...” que había”, dice. “Cuando llegaron a la Luna yo estaba trabajando, muy emocionado, y pensé: ‘¡Lo hemos logrado!’

Aaron Dutton trabajó cuatro años en Fresnedillas y ayer recor noció que “España es muy diferente ahora”, que el ordenador se ocupaba de ordenadores y de operaciones de seguimiento y estaba convencido, dice, de que se iba a lograr el alunizaje. Su colega Lenny Parker sabía que estaban haciendo historia en aquel momento. Todos tenían entonces en torno a los 30 o los 40 años.

Los españoles de Fresnedillas y las demás estaciones fueron fichados por su cualifica ción técnica o de ingeniería, recuerda Bautista, pero lo más difícil era encontrar a gente que, además, hablara inglés. Ayer recordó los hitos que cumplieron, incluidas las comunicaciones cruciales del alunizaje. Pero tam bién comentó que hubo muchísima suerte, cada paso era crítico”, dice Manuel Bautista.

Otra roca traída de la Luna fue examinada en el CSIC en 1971

Fraguas, Madrid

Una roca lunar donada a España por el primer hombre que pisó la Luna, el astronauta estadounidense Neil Armstrong, fue recibida, seccionada y examinada por el catedrático de Petrología José María Fuster Casas en 1971.

Fuentes del Consejo Superior de Investigaciones Científicas (CSIC) aseguran haber visto expuesta esta piedra procedente del satélite terrestre en una visita a este laboratorio. Desde entonces, hace años, pero hoy nadie acierta a explicar dónde se encuentra ni si existe con la que se cree que Estados Unidos regaló a Francia y que también habría desaparecido.

“No tenemos la menor idea de su existencia”, dijo ayer Carmen G. Peñalver, responsable del área de Patrimonio, en cuyo inventario institucional no figura. Lo cierto es que a la roca examinada por el profesor Fuster se une la otra roca lunar que desapareció del Museo del Aire hace ahora cinco años. Hasta su desaparición en 2004, esta había permanecido en el despacho del director del museo de Alcalá de Henares, al que había sido cedida por Manuel Casajust, que la recibió de Armstrong en señal de gratitud hacia el general republicano español Emilio Juste. (Granada-Dublín, 1967), procurador de los di señorios de la escañafía y el ro paje espacial, fallecido en el año 1967 y muerto en el vuelo de descenso a la Luna, de donde Armstrong trajo 21 kilos de material rocoso lunar...”
• SCaN will be presenting the Visitor Center at the Madrid Deep Space Communications Complex a permanent loan of a Moon Rock from the Apollo 15 mission on 27. October.
• With a partnership between NASA and the Instituto Nacional de Tècnica Aeroespacial (INTA), the PARTNeR program allows high school students, university students and amateur astronomical associations from Spain, to explore the universe using a reconfigured 34 meter antenna and share that data through the Internet. Two programs that the students can participate are monitoring X-ray binaries and measuring Jupiter’s magnetosphere radio emission variability. This antenna, also known as DSS-61, played key roles in tracking the Mariner missions, Voyagers 1 and 2, Galileo, and other deep space missions before its reconfiguration in 2001.

• For more information, visit: http://partner.cab.inta-csic.es/
SCaN represents NASA at many different international forums. These forums help find interoperability opportunities among countries, saving money and time for future planning.

- Inter-Operability Plenary (IOP)
- Interagency Operations Advisory Group (IOAG)
- Consultative Committee for Space Data Systems (CCSDS)
- World Radio-communication Conference (WRC)
- International Telecommunication Union (ITU)
- International Committee on Global Navigation Satellite Systems (ICG)
- Space-Based Positioning, Navigation and Timing (SPNT)
• International cooperation has and will remain very important to NASA
• Well structured international cooperation can contribute significantly to national goals of each participant
• Spain has been and will be a valuable partner to NASA
• NASA is always looking for new partnership opportunities
International Cooperation

BACKUP

INTERNATIONAL PROJECTS USING SCIENCE DATA
AERONET is an optical, ground-based, aerosol-monitoring network and data archive, providing vital information about aerosols in the atmosphere.

NASA has active sensors at over 350 sites in 86 countries and territories.

AERONET provides a long-term, continuous and readily accessible database of various aerosol properties for research and characterization, validation/calibration of satellite retrievals.
• NASA collaborates with national agencies, institutes, universities, and individual scientists to provide global societal benefits
  — With ISRO to measure monsoons and thunderstorms over India
  — With a Thai University (Chulalongkorn) and Vietnam to measure aerosol distribution and the impacts from weather in southeast Asia.
  — With the UAE to measure aerosols in the Middle East, one of the largest concentrations of atmospheric aerosols in the world.
• The AERONET office welcomes new partnerships and is eager to expand the network
• More information at: http://aeronet.gsfc.nasa.gov/
The Global Learning and Observations to Benefit the Environment

- NASA partners with National Oceanic and Atmospheric Administration (NOAA) and National Science Foundation (NSF) on GLOBE, an internet-based education program for students, teachers and scientists who work together to understand the environment.

- Students take measurements that can then be shared with others around the world, using the internet to record the data.

- Through classroom activities, fieldwork and international collaboration, students develop a better understanding of the Earth’s environment on a local, regional, and global basis.
Exploring Science through the GLOBE Science Network
• The network of schools involved in GLOBE continues to grow, providing unique learning opportunities and contributing useful science
  – GLOBE schools are in over 111 countries
  – Over 1.5 million students have participated in GLOBE
  – Over 54,000 teachers have been trained to work with GLOBE
  – Over 23,000 schools are GLOBE members
  – Over 21 million measurements have been taken as part of the GLOBE program

• More information about GLOBE is at: http://globe.gov
NASA partnered with the US Agency for International Development (USAID), the World Bank and the Central American Commission for Environment and Development (CCAD) in 2004 as a joint venture.

SERVIR integrates satellite observations, ground-based data and forecast models to monitor environmental changes and to improve response to natural disasters (floods, earthquakes, landslides and earthquakes).

Three facilities currently exist, with plans to expand to other regions:
- SERVIR Central America (Panama)
- SERVIR Africa (Kenya)
- SERVIR Himalaya (Nepal)
The central concept is to get critical information into the hands of decision makers for societal benefit, while also using SERVIR data for education and capacity building.

SERVIR provides information to decision makers related to:

- Disaster Analysis
- Environmental Monitoring
- Air Quality Assessment
- Climate Change and Biodiversity
- Short Term Weather Prediction
- Flood forecasting

SERVIR info is online at:
Cooperation with 16 countries on six continents to answer key questions:

- How do tectonics and climate interact to shape the Earth’s surface and create natural hazards?
- What are the interactions among ice masses, oceans and the solid Earth and their implications for sea level change?
- What are the dynamics of the Earth’s gravity and magnetic fields?
- Are we using water resources in a sustainable fashion?

These Space Geodetic Systems techniques allow us to understand the exact position of ground based systems, precise orbits of spacecraft and the location of Earth in the cosmic framework as key enablers of research activities:

- Satellite Laser Ranging
- Very-Long Baseline Interferometers
- Global Navigation Satellite System
- Other geodetic imaging techniques

For more information:
[http://science.nasa.gov/earth-science/focus-areas/surface-and-interior](http://science.nasa.gov/earth-science/focus-areas/surface-and-interior)
• ISWI was established from the activities during the International Heliophysical Year (IHY) between 2007 – 2009. ISWI was established to advance the space weather science by instrument deployment, analysis, physical modeling of the Sun-Earth system, and interpretation of space weather data.

• NASA, United Nations Office for Outer Space Affairs, JAXA, Bulgarian Academy of Sciences and Kyushu University are sponsors of ISWI.

• ISWI instruments can be found in over 60 countries on six continents.

• For more information visit: http://iswi-secretariat.org/