INTERNATIONAL ASTRONAUTICAL CONGRESS

BRICS Nations Aim For the Moon and Mars

by Marsha Freeman

The momentum for stretching mankind's scientific inquiry into the farther reaches of space now lies with Eurasia, as was clearly shown at the International Astronautical Congress, held in Toronto Sept. 29-Oct. 3. (See our previous coverage of the Congress in *EIR*, Nov. 2 and Nov. 7, 2014.)

Two of the groundbreaking events in space exploration over the past year were the December 2013 landing of China's Chang'e-3 spacecraft and Yutu rover on the surface of the Moon, and the Indian Mars Orbiter Mission's successful insertion into orbit around the Red Planet, on Sept. 24. With these milestones, China joined the U.S. and Soviet Union as the only nations to have landed robotic spacecraft on the lunar surface; and India became the first nation in Asia to orbit Mars.

India and China have taken different space exploration paths. India has not yet had a manned space mission, which China accomplished in 2003. And China has not yet sent a spacecraft to Mars. Although it is misguided to think that these two nations are in an (often-asserted) "Asian space race," it is the case that each country's recent success has helped to spur the other to push forward. And within the new economic paradigm created by the BRICS nations (Brazil, Russia, India, China, and South Africa), space exploration is a necessity and a reality.

For both China and India, these outstanding accomplishments do not stand alone, but are indicative of a broader scientific and educational agenda, and a long-term commitment to develop their populations through science, education, and great economic projects.

India's Mars Mission

India's Mars Orbiter Mission (MOM), enthusiastically supported by Prime Minister Narendra Modi, sent back its first image of Mars on Sept. 24. On Oct, 15, the Indian Space Research Organization (ISRO) released photographs taken by MOM showing the movement of Mars' diminutive moon, Phobos, across the face of the planet.

But just as MOM was settling into its orbit, comet Siding Spring grazed the planet at a distance of less than 88,000 miles, on Oct. 19. To take advantage of this rare close encounter, scientists at ISRO studied what scientific measurements could be taken by MOM, and results from the encounter are forthcoming. Two NASA orbiters, Europe's Mars Express, and the U.S. rovers Opportunity and Curiosity, were also mobilized for this event.

On the sidelines of the Toronto conference, the heads of NASA and ISRO signed two documents formalizing space cooperation projects. First, a Mars Working Group was established, which will meet once a year to assess the potential for future joint missions to Mars. On Oct. 14, discussing the first scientific results from NASA's MAVEN mission, Principal Investigator Bruce Jakosky reported that a member of the Indian Mars team would visit his group in November, where

ISRO

Technicians ready the Indian Mars Orbiter Mission spacecraft for testing, before its Nov. 5, 2013 launch.

an agreement on sharing Mars data collected by both spacecraft "will be hammered out."

A second agreement formalizes work on a sophisticated NASA-ISRO Synthetic Aperture Radar (NISAR) spacecraft. The mission includes one radar system from each nation, at different frequencies. In combination, the radars will have a resolution of just a centimeter.

The mission will measure the deformation of the Earth's surface due to earthquakes, volcanic unrest, subsidence, uplifts, and landslides. It will be able to track the dynamics of the cryosphere, such as glaciers, sea ice, permafrost, and ice sheets; track changes in vegetation and wetlands; and support global disaster responses. The NISAR mission plans a 2020 launch.

India's Space and Science Agenda

Indian scientists are now planning the next steps in both lunar and Mars exploration, following the stunning success of their first missions. The 2008 Chandrayaan-1 Indian lunar orbiter will be followed by a second, more ambitious mission, now in the planning stage. "The aim is, three years from now, an Indian lander and Indian rover will land on the Moon," ISRO chairman K.S. Radhakrishnan told the press on Nov. 11. India is also planning a second Mars orbital mission, he said, which would be ready at the earliest for the 2018 launch opportunity. Unlike MOM, which was primarily a technology demonstration mission, the second craft will focus on science.

But a major challenge that India now has on the agenda is manned orbital missions. At the Toronto conference, Koppillil Radhakrishnan, the chairman of ISRO, announced that India will soon carry out an unmanned test of a crew capsule, in order to demonstrate the safe return of a spacecraft through the Earth's atmosphere, and its recovery. Since 2013, ISRO has also been developing space suits and life support systems for astronauts. On Nov. 4, Radhakrishnan told reporters that the unmanned crew vehicle would be launched in December, on the experimental GSLV-Mark III rocket. The 3.6-ton capsule will be taken to a height of 100-120 kilometers and ejected from there to land in the Bay of Bengal, in order to test the heat shield.

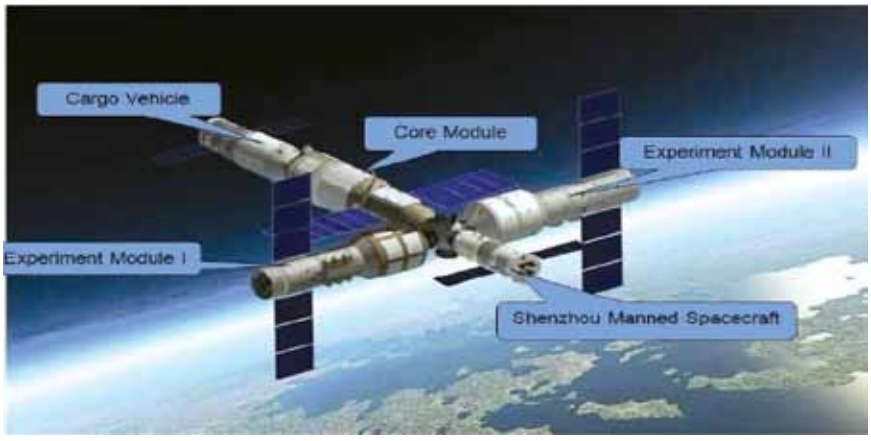
From early in its space program, India has seen international cooperation as beneficial and necessary. At present, it has cooperation agreements with 33 nations, many in the field of space applications. A natural focus has been its Asian neighbors.

Prime Minister Modi proposed in a speech earlier this year, that there should be a "SAARC satellite," under the auspices of the eight-member South Asian Association Regional Cooperation group. Among the member states, India is the only one with a number of satellites providing data on a wide range of applications. It now wants to extend coverage to all the 1.7 billion people in the SAARC region. This proposal was discussed at the 18th SAARC Summit in Nepal the last week in November, and supported as a way to "greatly benefit SAARC's social-economic growth," by Sri Lankan President Mahinda Rajapaska.

A breakthrough has been made in international space cooperation by India, with very wide-ranging potential. On Sept. 21, ISRO chairman Radhakrishnan told the press that, for the first time, China and India came to an agreement to work together, "creating a strong space presence in Asia." "This is not just a gesture," he stressed, "but a concrete step forward to cooperation." As for the focus of the cooperation, "right now, broadly speaking, it will be natural disasters and remote sensing, which are natural choices. But by March-April 2015, the joint working team would have prepared a roadmap, chalking out various options and opportunities for concentrated efforts in space exploration." Combining the strengths of the Indian and Chinese space programs would accelerate the entire international space exploration endeavor.

China's 'Open Door' Space Policy

Bowing to political pressure from the United States, Canada did not issue visas to either the Chinese or Russian space agency heads, or large numbers of their delegations, to attend the Toronto congress. The irony of barring China's top space officials, is that in the conference papers that were presented, China invited the international community to participate in its most ambitious space missions. But without the top leadership of China's National Space Administration present, it is likely there were missed opportunities to take the Chinese up on their offer.



National University of Defense Technology

China has given an open invitation to all space-faring nations to join its future modular space station. The two components that are labeled "Experiment Modules I and II" are available spots for docking other countries' laboratories to the station.

The next major step in China's manned space program will be the construction of a multi-module laboratory complex in Earth orbit, starting in 2018. On Sept. 10, at a press conference during the annual meeting of the Association of Space Explorers in Beijing, China's most senior astronaut, Yang Liwei, invited other nations to participate. "We've reserved a platform to cooperate with other countries in missions, by having designed interfaces for our space modules so that they can dock with modules of other countries," he said. This offer was amplified at the conference in Toronto.

A conference paper by Zhou Lini, from the Center for National Security and Strategic Studies at the National University of Defense Technology, reported that China's station will be composed of three 22-ton modules, which can accommodate three astronauts for six-month stays. The Chinese core module and two experiment modules will comprise the basic station. There will be five docking ports, which will enable the 66-ton station to be expanded to up to 180 tons, comparable to Russia's 1990s Mir station. (For the sake of comparison, the two-dozen-nation International Space Station weighs nearly 420 tons.)

According to Zhou, at the highest level of cooperation, other countries could build their own scientific laboratory modules, to be docked to the station. They could either launch the module to the Chinese station themselves, or have China launch and deliver it for them. China's space station "can be reached by rockets launched from Cape Canaveral as well as French Guiana on the Equator, enabling participation in the construction of the [Chinese] Space Station by the United States and Europe," the paper invitingly states. It is also an option to have foreign astronauts trained in China, and transported to the station either on foreign spacecraft or on China's Shenzhou craft. (The European Space Agency currently has astronauts learning Chinese.)

Utilizing the facilities of the station also provides opportunities for international cooperation. Payloads for experiments could be jointly developed, and could include experiments in life science, materials science, and microgravity physics. China has set up the International Cooperation and Exchange Center of China Manned Space Engineering to promote and facilitate such cooperation.

Developing interoperable hardware for international rescue of crew members in an emergency, another area for cooperation that China proposes, has been talked about for decades, but has never come to fruition. Such a capability would be evidence of "a new form of international humanitarian spirit," the author of the paper proposes.

To the Moon and Mars

At a press conference on Sept. 24 at China's Foreign Ministry, spokesman Hua Chunying replied to a question about the Indian Mars launch. "We congratulate India on its successful launch of the mission Mangalyaan into Mars orbit," she said. "This achievement is the pride of India, as well as Asia, and also represents a major step in humanity's peaceful exploration and utilization of outer space." But it is also the case that "the

China National Space Administration

China has accelerated its Chang'e lunar development program, toward its goal of mining helium-3 on the Moon, for fusion fuel. During the Chang'e-5T1 mission this Fall, the spacecraft took this photograph of the far side of the Moon (never seen from Earth), with the Earth in the distance.

Indian Mars mission has put pressure on China," a Chinese representative told this writer at the Toronto Congress. Unfortunately, China's first attempt to study Mars was a small orbiter carried on Russia's Phobos-Grunt mission, which failed to leave Earth orbit. China has been mapping out its own Mars exploration program.

In June, China's chief lunar scientist, Ouyang Ziyuan, told the International Planetarium Society conference in Beijing that China plans to land a rover on Mars in 2020, and to return soil samples to Earth a decade later. Much of the capability for this deep-space exploration already has been developed and used by China's lunar missions, added Ye Peijian, chief scientist for the Chang'e lunar missions from the China Academy of Space Technology. Li Ming et al. in a paper in Toronto, explained that Chang'e-2 was sent into deep space after completing its lunar mission, and is now more than 80 million kilometers from Earth. Such an accomplishment "opens the door to asteroid exploration," they stated, as well as Mars.

Chinese space officials put a prototype Mars rover on display at Airshow China 2014, on Nov. 10. They said that although there has not been an official government announcement of a Mars mission, a rover is being designed. It is similar to the lunar Yutu ("Jade Rabbit") rover, but "larger, tougher, and a better climber." It will be able to negotiate larger rocks, and its wheels will be better able to withstand rough terrain. The rover will be tested in the rugged terrain of Tibet and tasked to handle large rocks in the Gobi Desert.

China's lunar exploration program has been accelerated due to the success of the first three missions. Rather than repeat last December's Chang'e-3 mission and land a spacecraft and rover on the Moon, lunar planners decided to cancel that back-up mission, and instead take the next step. The Oct. 23 launch of China's fourth mission to the Moon, informally designated Chang'e-5T1, was designed to help lay the basis for the very challenging 2017 Chang'e-5 mission, to land a craft on the Moon, scoop up soil, and return the sample capsule to Earth.

Chang'e-5T1 successfully tested the ability of a vehicle to return to Earth from the Moon, at a high-speed 25,000 miles per hour, testing a "skip reentry" technique, dipping the craft into the atmosphere to slow it down through friction, before the final descent to Earth. It landed successfully on Nov. 1.

One of the hallmarks of China's lunar exploration program is the long-term goal of mining the rare isotope helium-3, to fuel the fusion energy power plants of the future on Earth. Recently, both Russia and India have also expressed the importance of such an effort.

On Oct. 8, Russian cosmonaut Alexander Volkov, speaking at an All Russia Science Festival in Chelyabinsk, said, "There is water on the Moon, and there is helium-3, which is better than any other energy source existing on the Earth. . . . One day, we will run out of oil and coal, and mankind will need energy. Then, we will start supplying it from the neighboring planet." And on Oct. 14, Indian technologist Apathukatha Pillai told reporters that helium-3 fusion is of great interest to India and other countries. "I predict by the next two decades, we could see missions being carried out to tap the resources in the Moon," he said.

But not everyone is as farsighted. At the Toronto Congress, *EIR*'s William Jones raised this stated Chinese lunar mission objective, during a session on the exploration of the Moon. "Every scientist I have spoken to says that it is not possible to use helium-3 in fusion," respected space professional John Rummel responded. "In fact, it may even be poison for fusion reactors!"

This ignorant reply was countered by Bernard

Foing, the European Space Agency's chief scientist on lunar missions. "The Chinese have a long-term view in their lunar exploration," he explained. "They think in terms of the next 100 years. Obviously, if you can collect thousands of tons of helium-3 on the Moon, and transport it to Earth, this would be a tremendous boon to mankind. They must develop their lander capable of bringing human beings back to the Moon, begin planning a lunar base, develop the equipment for mining the resources, and put in place a system to transport the material back to Earth. It is a long-term project, but this is the way they are thinking about their program." And China is already working on each necessary phase of this long-term project.

Khrunichev State Research and Production Space Center

Russia is rebuilding and modernizing its space industry, including the new Vostochny Cosmodrome. The Angara rocket, seen here being assembled, will be the first new post-Soviet launch vehicle.

New Russian Capabilities

The Russian space agency is focused on the future, with a new ten-year plan due out before the end of this year. Although much of the top leadership of the national space agency Roscosmos was not allowed to attend the Toronto conference, the papers that were presented there reflected a dramatic increase in funding for space programs, and described new manned space and planetary initiatives that are underway.

The Ukraine-related sanctions placed upon Russia over the past half year, while not (yet) affecting cooperation on the International Space Station (ISS), have had an impact in related fields. These motivated the Russian leadership to, first, make a commitment to develop the domestic capability to produce space hardware that it has until now imported, and, second, to broaden cooperation with other nations, notably China, and formulate its future plans jointly with non-U.S. partners.

On Oct. 31, Russian Deputy Prime Minister Dmitri Rogozin, questioned about cooperation with China, replied: "We have rather energetic relations with the People's Republic of China, and Western countries should be thanked a lot for that. I am not even joking." The sanctions policy "broke some psychological barriers, which probably existed in someone's head regarding cooperation with China," he explained.

In November, a delegation of Roscosmos and rocket and space industry representatives went to the International Aviation & Aerospace Exhibition in Zhuai, China, where specific projects were to be discussed with representatives of China's space industry. On Nov. 11, plans were unveiled to deploy several monitoring stations in China for Russia's GLONASS navigation satellites, and several Chinese sites are being evaluated. The United States has refused to allow GLONASS stations on American soil.

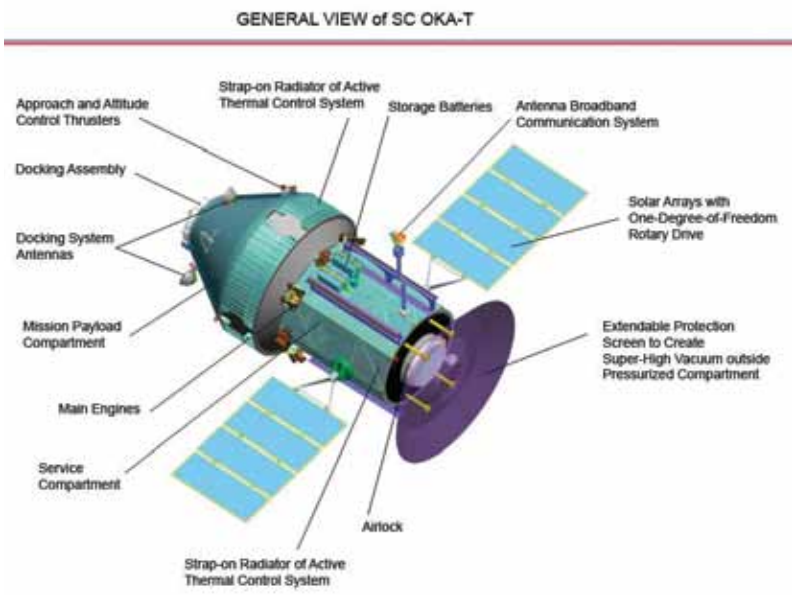
One immediate focus of the 2016-25 long-range plan is the completion of the Vostochny launch complex in the Russian Far East, for which $5 billion has been allocated. Vostochny opens new possibilities by allowing Russia to launch its new heavy-lift Angara series of rockets, and eventually its manned missions, from a new, state-of-the-art facility on Russian soil. (The Baikonur Cosmodrome in Kazakhstan has been the base for all Russian manned space flights since Soviet times.)

Russia is also upgrading its venerable Soyuz

manned spacecraft, developing a next-generation manned vehicle to replace it, and completing the long-delayed modules to be added to the ISS.

At the Toronto conference, an exciting addition to the ISS complex was discussed by Dr. Igor Sorokin, from the S.P. Korolev Rocket and Space Corporation Energia. It is a free-flying research and manufacturing module, designated OKA-T, which is now under development. The robotic spacecraft will fly near the ISS, co-orbiting with the station. It will provide a microgravity environment for experiments, free from the vibrations caused by the movement of the crew in the station.

OKA-T will be attached to the station periodically for servicing and repair by crew members, and for the exchange of completed experiments for new ones. It is scheduled for launch in 2018. These flexible space platforms can be designed for one scientific discipline's experiments, such as materials processing, with specialized equipment required for that, or can accommodate a broad range of experiments at the same time.



S.P. Korolev Rocket and Space Corporation, Energia

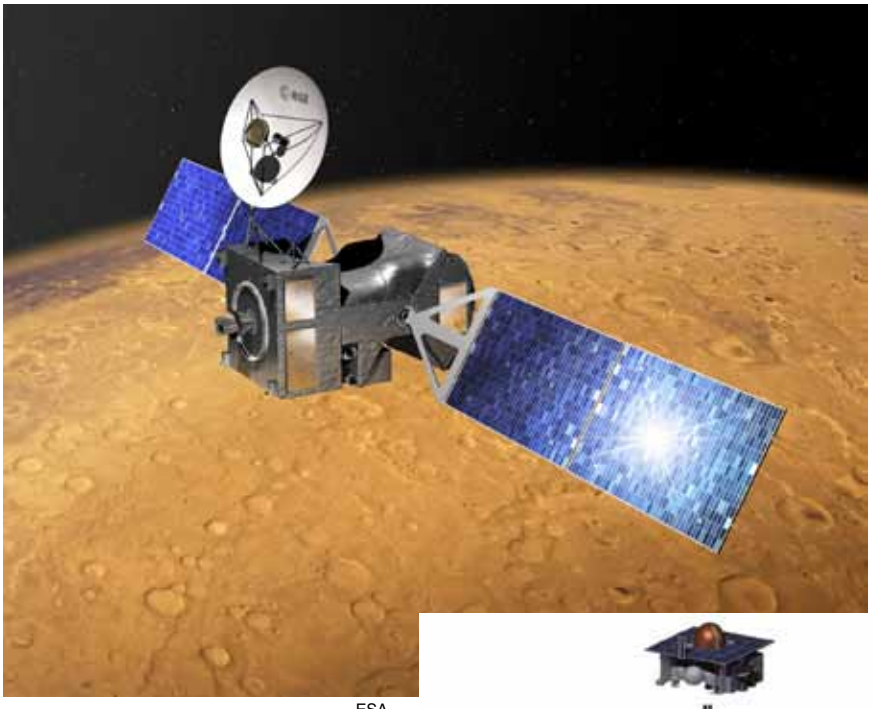
A new, free-flying space laboratory, the OKA-T, will be launched to the International Space Station in 2018. Separated a short distance from the ISS, it will be able to accommodate microgravity experiments, free from the vibration of crew movements on the station.

Such free-flying unmanned experiment modules were originally envisioned by NASA, for similar materials processing and other research, but were never funded.

The Moon Is the Focus

Russia is planning a series of new lunar exploration missions, with the goal of carrying out manned missions to the Moon after 2030. Several presentations in Toronto described how, in order to gain time, and augment its own technical capabilities, Roscosmos is in discussions with the European Space Agency to carry out joint lunar missions, of increasing complexity. This cooperation would build upon two joint Russia-ESA ExoMars missions, which are already under development, and will be launched during this decade. Papers on the future lunar missions were presented in Toronto by joint Russian-European technical teams.

The first planned Russian lunar mission in this new series, the Luna-Glob Lander, or Luna-25, will demonstrate a soft landing at the lunar south pole, long-duration operations on the surface, and survivability during the two-week lunar night. It is an ambitious mission, which will conduct investigations of the Moon's very-low-density exosphere, deploy high-speed penetrators for subsurface study, and also carry an instrument to



ESA

Two joint European/Russian robotic missions will be launched to Mars over the next five years. The ExoMars Trace Gas Orbiter, seen in this artist's drawing (above), will investigate methane and other atmospheric trace gases, and will carry along a descending and landing demonstrator module.

NPO Lavochkin

The Russian Space Science Institute hopes to re-do the Phobos/Grunt mission, to the tiny moon of Mars.

study galactic cosmic rays. After some delay, Luna-Glob has been scheduled for 2018.

Luna-26, the Luna-Resurs Orbiter, will follow, to conduct scientific investigations from orbit and to act as a communications relay for the lander that will arrive on the next mission. Luna-27. The Luna-Resurs Lander, now planned for launch in 2019, will validate more advanced exploration capabilities at the south pole. All of these missions are prerequisites to a future manned mission.

ESA has been considering what it can contribute to Russia's lunar exploration program, "taking into account current and foreseen budgetary constraints in Europe." The idea is for ESA to contribute already-developed advanced technologies to the Russian missions, which ESA can then use in its other missions. This would also protect skilled jobs in industry and research institutions in Europe.

Europe's Pilot system is a very sophisticated autonomous landing system, which could be used in Russia's lunar missions. The PROSPECT systems provide analysis of potential resources at any location on the Moon, by drilling into the subsurface, and analyzing samples on site. SPECTRUM would enable network-like communications among multiple craft at the Moon, and access to communications by engineers in mission control with landers that have no direct line-of-sight with the Earth.

Looking further into the future, ESA is considering developing a joint Lunar Polar Sample Return mission with Russia, in the 2020s. "Developing capabilities together with Russia is an example of cooperation that can be extended to a more global scenario," a paper presented at the Congress concludes.

Although Russia has greatly expanded its international outreach, it remains committed to developing its own leading-edge technologies, and ambitious national missions. And despite a lack of success in the past, it is not giving up on Mars.

A "reboot" of Russia's Mars missions is "a matter of honor," said Lev Zeleny, director of the Academy of Science's Space Research Institute, on Oct. 13. The 2011 Russian Phobos-Grunt mission, in which the spacecraft failed to leave Earth orbit, will have a second try, he said. This is unlikely to happen before 2024, but that will enable it to benefit from the two cooperative ExoMars missions Russia is carrying out with Europe in 2016 and 2020.

The alignment of nations cooperating to meet the challenges of exploring space is dramatically shifting. With China, India, and Russia now taking the lead, the other BRICS countries, and all of the nations that will join the World Land-Bridge, will be able to participate in this great project of exploration.