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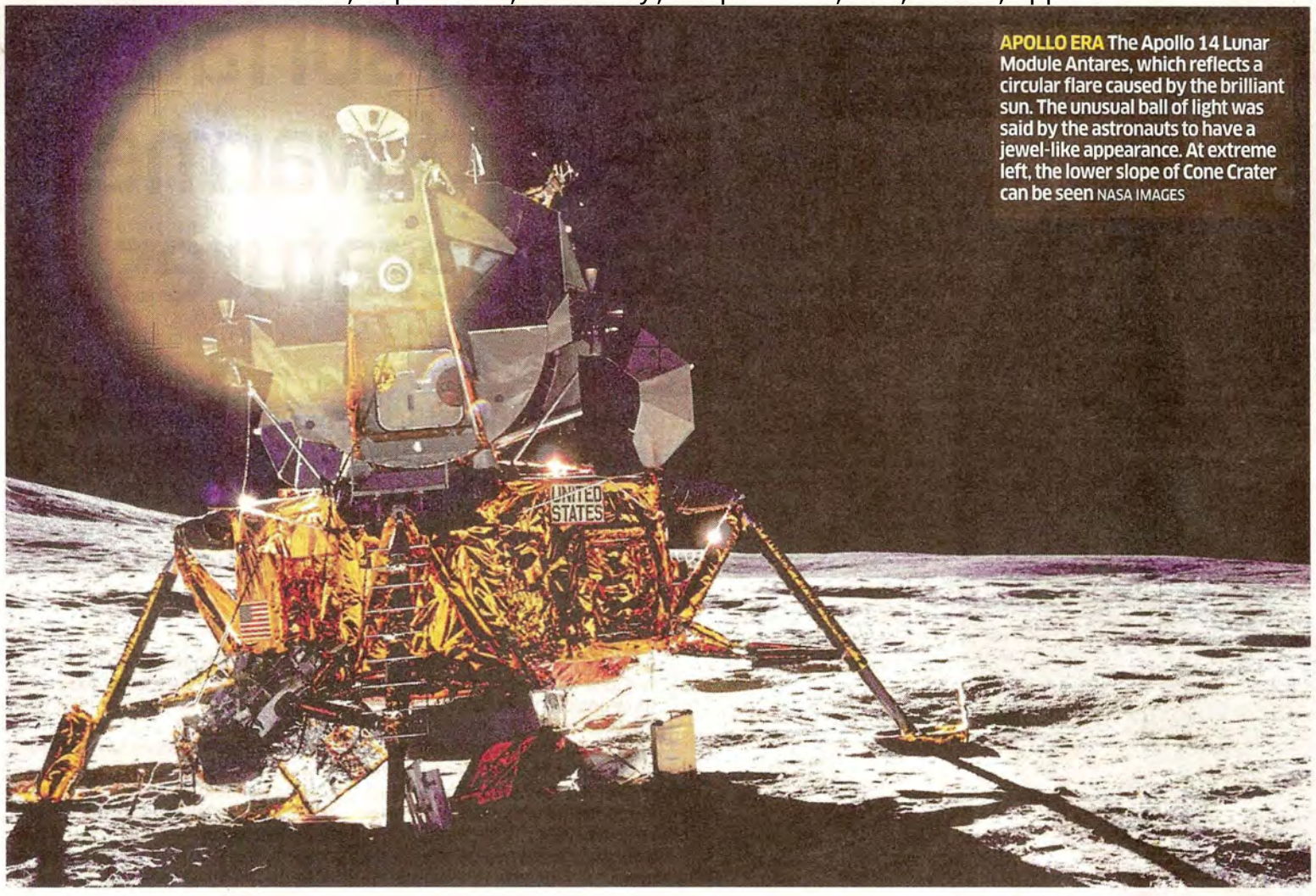

APOLLO ERA The Apollo 14 Lunar Module Antares, which reflects a circular flare caused by the brilliant sun. The unusual ball of light was said by the astronauts to have a jewel-like appearance. At extreme left, the lower slope of Cone Crater can be seen NASA IMAGES

To the moon and back

SPACE MISSIONS There are ambitious plans to restart manned moon missions as follow-ups of Apollo, perhaps starting as early as 2020. These would be more sophisticated. There are also plans to set up moon bases where astronauts can stay for several months, writes **C Sivaram**

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Even as the debate over whether Chandrayan was a success or not seems to have just died down in the country, elsewhere, a moon mission celebrated its 50th anniversary last week (September 14). Luna 2 was the first spacecraft to land on the moon (with the Russian flag).

Forty years ago, on July 20, Apollo XI landed on the moon, the lunar module (LM) carrying two astronauts down to the lunar surface, while the mothership, the command service module (CMS) with one of the astronauts continues to orbit the moon. Subsequently, ten more astronauts landed on the moon, the last being Apollo 17 in December 1972. Apollo 13 could just circumnavigate the moon, as an explosion almost aborted the mission.

The mission brought back a few hundred kilograms of lunar rocks as did the unmanned Russian moon missions like Luna 15 and 16. Apollo 15 also employed a lunar rover to traverse the terrain, and earlier the robotic Russian Lunokhod had covered quite a distance on the lunar surface. Later, there was a sharp decline in lunar space missions, the focus shifting to Mars, Venus and the outer planets, explored by the Pioneer and the Voyager missions. Two Viking spacecraft landed on Mars in 1976. In the late 1990s, there was renewal of interest in the space exploration of the moon, the Clementine probe and the Lunar Surveyor being launched by the US.

In the new millennium, European probe SMART-I entered lunar orbit around mid-march 2005. It was the so-called 'Green Spacecraft', being the most fuel efficient moon mission (at 4,000 kilometres per litre of fuel!), but took 13 months to get there following a long spiral path. It used solar electric propulsion. A 15-metre solar panel converted sunlight to electric power which ionised Xenon gas, the propellant being the ions ejected at 8km/s creating a small but continuous thrust. The 360kg craft included just 80kg of Xenon. The fuel efficient spacecraft finally ended its mission by a controlled crash, near the 'Lake of Excellence' (on the moon) on September 3, 2006. The past two years have seen an Asian lead in lunar exploration. In 2007, September and October, respectively, the Japanese Kaguya spacecraft and the Chinese Chang'e I spacecraft were launched. Chang'e ended its mission with a planned crash on the lunar surface on March 1 of this year, while Kaguya (which had two smaller subsatellites Okina and Ouna) also crashed last month. Kaguya was the heaviest lunar mission, after Apollo.

Unmanned missions

But after Apollo, all the above missions have been unmanned. Manned moon missions would be far more expensive, as humans are indispensable. At today's rates, the cost of the Apollo probe would be about 120 bn dollars. Still, there are ambitious plans to restart manned moon missions as follow-ups of Apollo, perhaps starting 2020. The Altair lunar module (ALM) would be the new equivalent of the LM of Apollo missions. It can deliver four astronauts to the moon, as compared to two for the LM. It would have a volume three times that of the earlier LM and can stay on the surface from seven days up to more than 200 days, waiting to deliver the crew to the orbiting Orion spacecraft (new equivalent of the Apollo Command Module).

Different from Apollo missions

Unlike the Apollo mission, where one astronaut remained in lunar orbit, in the new mission, all four would descend to the moon's surface while the unmanned Orion would continue to orbit till the crew rejoin it. The Orion Command Service Module, carrying the crew of four, has an internal volume twice that of Apollo module and is powered by solar panels. It would also splashdown in the ocean, like the Apollo mission. The massive Saturn V rocket, weighing 3000 tons at start and standing over 100 metres tall, boosted the 120 ton Apollo spacecraft in orbit. The new planned mission has Ares I and Ares V as counterparts to Saturn V. Ares V can carry 22 tons of maximum load in orbit.

INTO SPACE

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- The next generation of lunar rovers would be three ton pressurised vehicles, with twelve wheels, that move at 10 km/hr

The new plan is different from that followed for Apollo missions. The heavy lift Ares V blasts off first carrying only the massive Altair lunar lander into the earth's orbit. Ares I then launches the Orion capsule, with the crew of four inside, into the earth's orbit. Orion then docks with Altair and Orion capsule joins with the earth departure stage and Altair lunar lander in orbit. The earth departure stage then fires to send the spacecraft to the moon. The Orion and Altair separate from earth departure stage and combined spacecraft enters the lunar orbit. The departure stage is jettisoned and dispensed with.

The crew then transfers to Altair and descend to the lunar surface while Orion continues to orbit the moon unmanned. After the exploring and other work is done, Altair's ascent from the surface and rejoins Orion in lunar orbit. Orion then fires its rockets and heads back to earth. Altair's ascent stage needs to climb hundred kilometres above lunar surface before it can rendezvous with the unmanned Orion. Orion and Altair again separate and re-enter the earth's atmosphere. The astronauts transfer to Orion which now decelerates through earth's atmosphere and lands (in water).

Generation next

The next generation of lunar rovers would be three ton pressurised vehicles, with twelve wheels (compared to Apollo's 200kg moon buggy), that move at 10km/hr. They can easily carry three astronauts and have an expected range of 240km from landing site (compared to 10km for Apollo 15 rover). The new moon suits would be lighter, stronger and would be serviceable on rovers. Suits used in Apollo missions were useful only for brief trips outside the lander.