

Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this is *China and India*.

Like a lot of people, I grew up with NASA. We got sent home from school to watch the 1969 Apollo 11 EVA, which in Australia happened around 1pm on a Monday afternoon. For the record, this involved some long finger-tapping moments, listening to strained commentary about the video broadcast of a landed, and hence motionless, lunar module. Even when the door finally opened, Neil Armstrong took an excruciatingly long-time getting down that darned ladder. His caution was entirely understandable and appropriate, but not what you'd call great television. History is generally best viewed from the highlights reel.

And something else we learn from history is that the world is always changing. Here and now, 43 years after Apollo 11, NASA is still miraculously NASA, but the Soviet Space Program had to drop the Soviet title and instead became Roscosmos in 1992. On the other hand, the European Space Agency was established in 1975, even though the European Union wasn't formed until 1993.

But here in the 21st century we are apparently living in the Asian Century, although there are already some murmurings about South American economies taking off and, who knows, fifty years from now it might start looking like the African century. But OK, for now it's the Asian century. All going well, the 22nd century might just be the human race century – and not before time.

Anyhow, in the twenty-first century, countries in Asia really are making their mark in the space game. The Japan Aerospace eXploration Agency, JAXA, was formed in 2003, although this is just the latest iteration of a series of Japanese space organisations dating back to the 1950s. JAXA has delivered some great missions – including the legendary Hyabusa, which gave the first sample return from an asteroid, even if it was just a few dust grains. JAXA also conducted the first interplanetary solar sail mission IKAROS – and its mothership mission Akatsuki is currently on a return trajectory to Venus in 2015, having missed an orbital insertion window on its first attempt in 2010.

No doubt Japan has more things to surprise us with, but Cheap Astronomy has covered JAXA missions before. This podcast is about China and India. The China National Space Administration was established in 1993. Since, 2003, CNSA has launched eight taikonauts into Earth orbit since 2003 and their next big thing is Chang'e 3 – the Chinese Rover Mission.

Chang'e 3 is currently scheduled for launch in December 2013. If successful, this will be the first soft landing on the Moon that anyone has managed since the Russian Luna 24 mission in 1976.

The previous Chang'e 1 and 2 lunar orbiting missions, launched in 2007 and 2010, represented the first phase of the Chang'e program. Chang'e 3, to be followed by Chang'e 4, represent the second phase, both involving rovers. The third phase, with Chang'e 5, will be a sample-return mission, currently scheduled for 2017. After that, it anticipated that a new program will commence, which might just culminate in a manned landing.

Chang'e is the name of a Chinese goddess who ascended to the Moon after consuming an immortality pill and befriended a jade rabbit who was already a lunar resident. The elements

of this legend were relayed by NASA to the Apollo 11 crew ahead of the 1969 Moon landing. Michael Collins famously responded "Okay. We'll keep a close eye out for the bunny girl".

The Chang'e 3 lander will set down in Sinus Iridum, which is on the opposite side of Mare Ibrum from the Apollo 15 landing site. After landing, a solar-powered rover will roll off the lander and commence its mission, which is expected to last for at least three months, although presumably half of that period will be down-time while the two-week-long lunar nights prevail.

The Chang'e 3 lander itself will continue to operate as a stationary science platform. It will be powered by a, RTG, a radioisotope thermoelectric generator, and hence will be largely unaffected by the presence or absence of direct sunlight. The lander will operate a number of science instruments, including an optical telescope and a probe to analyse the lunar regolith.

The Chang'e 3 rover will have a mass of 120 kilograms, including a 20 kg science payload. It is reported that it will explore widely over an area within a 5 kilometer radius of the lander. That might sound a little ambitious when you consider that the Spirit and Opportunity rovers travelled just 2 to 3 kilometers over their first year of operation, but the Chang'e 3 rover will have more advanced technology and a lot more solar flux than you could get on Mars.

The rover's science payload will include an alpha particle X-ray spectrometer, which has been standard issue on all the NASA Mars rovers to date, to enable geochemical analyses. The rover will also have a radar device on its underside, to investigate the structure and depth of the lunar regolith and even the underlying structure of the lunar crust. The rover will have the usual rover autonomous hazard avoidance and navigation capacity, but with a radio delay of only 1.3 seconds from Earth, it will mostly be under the direct control of an Earth-based driver.

And if China landing on the Moon isn't enough, India is preparing to land on Mars, The India Space Research Organisation, ISRO, is preparing for the launch of its Mars Orbiter Mission in November 2013. ISRO's primary goal for the mission is simply to prove its technological capability to achieve Mars orbit, which would make it the fourth space agency to achieve such a feat after NASA, Roscosmos and the European Space Agency.

If a successful orbit is achieved, the Mars probe, currently called *Mangalyaan*, which is Hindi for Mars-craft, will then pursue some more science objectives.

India's first Moon mission, *Chandrayaan-1*, is credited for discovering water molecules in lunar regolith. It is expected that *Mangalyaan* will look for the presence, and even the source, of methane in the atmosphere of Mars. It will also be looking for signs that the atmosphere of Mars may have been much thicker in the past. Everyone always assumes that it was, but we don't actually have a lot of evidence to back that theory up.

The Indian government approved the Mars Orbiter Mission on 3 August 2012, a few days before NASA's Curiosity rover touched down on Mars. Now ISRO is scrambling to be ready for the next launch window to Mars around November 2013. If they miss it, there won't be another launch window for 26 months around February 2016.

But recent media from India suggests that the mission is on track and the 1,350 kg *Mangalyaan* spacecraft is due to be introduced to its launch vehicle in August 2013. Further

details about the spacecraft are scant, but it is expected to be of a similar design to *Chandrayaan-1*, excepting that its solar panel surface area will be increased by a factor of 3 to ensure adequate electrical power can be generated from the lower solar flux that is available in Mars orbit compared with a lunar orbit.

All going well, *Mangalyaan* will reach Mars at about the same time as the NASA mission MAVEN (standing for Mars Atmosphere and Volatile Evolution), which is also scheduled for the November 2013 Mars launch window. Interestingly, their arrival at Mars in September 2014 is one month ahead of the possible collision with Mars of comet *C/2013 A1 Siding Springs*. However, since the comet's discovery in January 2013 and the subsequent February 2013 announcement that it might be on a collision course with Mars, further measurements of the comet's trajectory have revised the chance of it striking Mars down to only 1 in 120,000.

Whatever happens, there's plenty to look forward to, particularly when the US government starts realizing that it is danger of being left behind.

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website because that's about all we can do from Australia. No ads, no profit, just good science. Bye.

Pronunciations:

Chang'e: Chahng (rhymes with tongue) - uh (like the e in her)

Mangalyaan; Man gal-yun

Chandrayaan: Charn dray-yun

(I think...)