

Sent: Thursday, June 14, 2012 10:30 AM

Subject: China redirects moon probe to asteroid fly-by -- astronauts to someday follow?

0. In a tour de force of interplanetary navigation based on ingenuity and boldness, Chinese space scientists have redirected a 'mission accomplished' moon probe to fly past a near-Earth asteroid next January.

1. The event, paired with the upcoming Shenzhou/Tiangong space linkup, could be laying the groundwork for a Chinese 'space spectacle' a few years from now when their own astronauts -- ahead of Americans, Russians, and anybody else -- venture out from low Earth orbit, into interplanetary space. COULD be -- at least these feats contribute to providing that option.

2. The probe, Chang'e-2 [pronounced "Chang-Eh-2"], completed a lunar surface photography survey last year, and with leftover fuel set out to the Sun-Earth Lagrange Point #2, a million miles 'down sun' [away from the sun] from Earth and four times as far as the moon. It arrived there in August 2011. see http://en.wikipedia.org/wiki/Lagrange_point

3. The region, abbreviated 'SEL2', is considered the "dynamic gateway" to the rest of the Solar System. Because it balances between competing gravitational forces, even a slight thrusting can throw it to great distances from Earth.

4. There is also military significance to this 'highest ground'. From SEL2, satellites can head back to Earth and slip into any desired orbit of a potential target satellite, such as navigation, communications, or other military applications vehicles -- and do so undetected from Earth by making the final braking burn on the sunwards side of Earth where sensors cannot observe it.

5. It is also a particularly valuable location to park astronomy satellites for uninterrupted deep space observations. Several such robot observatories are operating there now, and the much-delayed NASA Webb Space Telescope is to go out there too.

6. For long range exploration of the Solar System, the SEL2 point has been identified as the ideal parking region for assembling vehicles and supplies for human interplanetary missions.

7. For this reason, the most advanced strategic space plans call for human sorties to this region as an essential intermediate step for human missions to asteroids and eventually to Mars. See graf 18.

8. At the time Chang'e-2 arrived there [graf 2], Chinese experts said it would stay in this region until the end of 2011 and then possibly be redirected to another Lagrange Point, back to the Moon, or aim for a passing asteroid or comet. But no further news was released.

9. Then, at a China Academy of Science meeting this morning, top moon scientist Ouyang Ziyuan reported that the probe had since then been redirected, again, to drift farther away from Earth and into the path of the asteroid '4179 Toutatis' for a January 6, 2013, encounter. The departure maneuver occurred on April 15, but apparently went undetected by US sensors because of its great distance.

10. A video of the meeting can be found here: <http://www.cas.cn/zt/hyzt/16thysdh/zb/>

11. According to NASA's Jet Propulsion Lab data base, Toutatis will make a close (0.046 AU, 11 million miles) Earth flyby in mid-December. Encountering the

asteroid away from the closest approach to Earth may make relative speed lower, improving the performance of sensors.

12. Waiting until several weeks AFTER the Earth fly-by will also greatly improve navigation, since the very best close-range observations of Toutatis can be used. The Chinese probe's path can then be adjusted to improve the geometry of the final encounter.

13. A second advantage of not encountering the asteroid at its closest approach to Earth is that the probe would be looking back towards the Sun during that phase and solar radio noise could seriously degrade the readability of commands sent from Mission Control.

14. The greatest operational challenge will be radio reception at a range 40 to 50 times greater than the probe was designed for – that means the signals will be THOUSANDS of times weaker than normal.

15. The greatest navigation challenge will be in aiming the probe's cameras, including its narrow-angle high-resolution camera. It has other scientific instruments which could provide very important readings about the asteroid's composition.

16. For information on the asteroid http://en.wikipedia.org/wiki/4179_Toutatis

17. Asteroid Toutatis was to have been the target of the US DoD sensor-test mission 'Clementine-2', later cancelled. The Clementine-1 mission in 1994 orbited the moon and then set off for the asteroid Geographos but an operator error lost control of the probe and the asteroid mission failed.

<http://www.astronautix.com/craft/clentine.htm>

18. Now here is the zinger and the today-tie-in. A human spacecraft to visit the SEL2 point would look VERY much like the Shenzhou/Tiangong combination, to be assembled in Earth orbit this weekend. It would need a BIGGER booster, or a booster stage to linkup in orbit -- and the rocket capable of carrying THAT stage is now under development.

19. This is NOT to say that the Chinese are aiming for such a mission several years from now. But their hardware development, and their astonishingly bold unmanned mission to SEL2 and then onwards into interplanetary space, as a pathfinder, certainly allow them that option -- and years before ANY other nation will have developed it.

20. They could by doing this to break out of the methodical repetition of space achievements of the US and Russia, and blaze entirely new human paths into space. The first humans to venture beyond the Moon, into interplanetary space -- are we seeing, this week, two major strides in that direction? Could be.

21. This strikes me as a very, VERY attractive option for them.

22. I have a high-fidelity model of the Chang'e-2 spacecraft, purchased during my April visit to Beijing. And of both the Shenzhou and Tiangong spacecraft, too.