The Search for Lunar Ice

UMBC

Lunar Exploration

The Space Race between the US & the Soviet Union

- 1957: SPUTNIK -- world's first artificial satellite
- 1960s
  - Soviet & US flybys and probes
  - 1962 – JFK "Moon Speech" at Rice University
  - 1969 - Apollo 11 – 1st Crewed Landing

Launched: 16 July 1969 UT 13:32:00 (09:32:00 a.m. EDT)
Landed on Moon: 20 July 1969 UT 20:17:40 (04:17:40 p.m. EDT)
Landing Site: Mare Tranquillitatis - Sea of Tranquility
Returned to Earth: 24 July 1969 UT 16:50:35 (12:50:35 p.m. EDT)

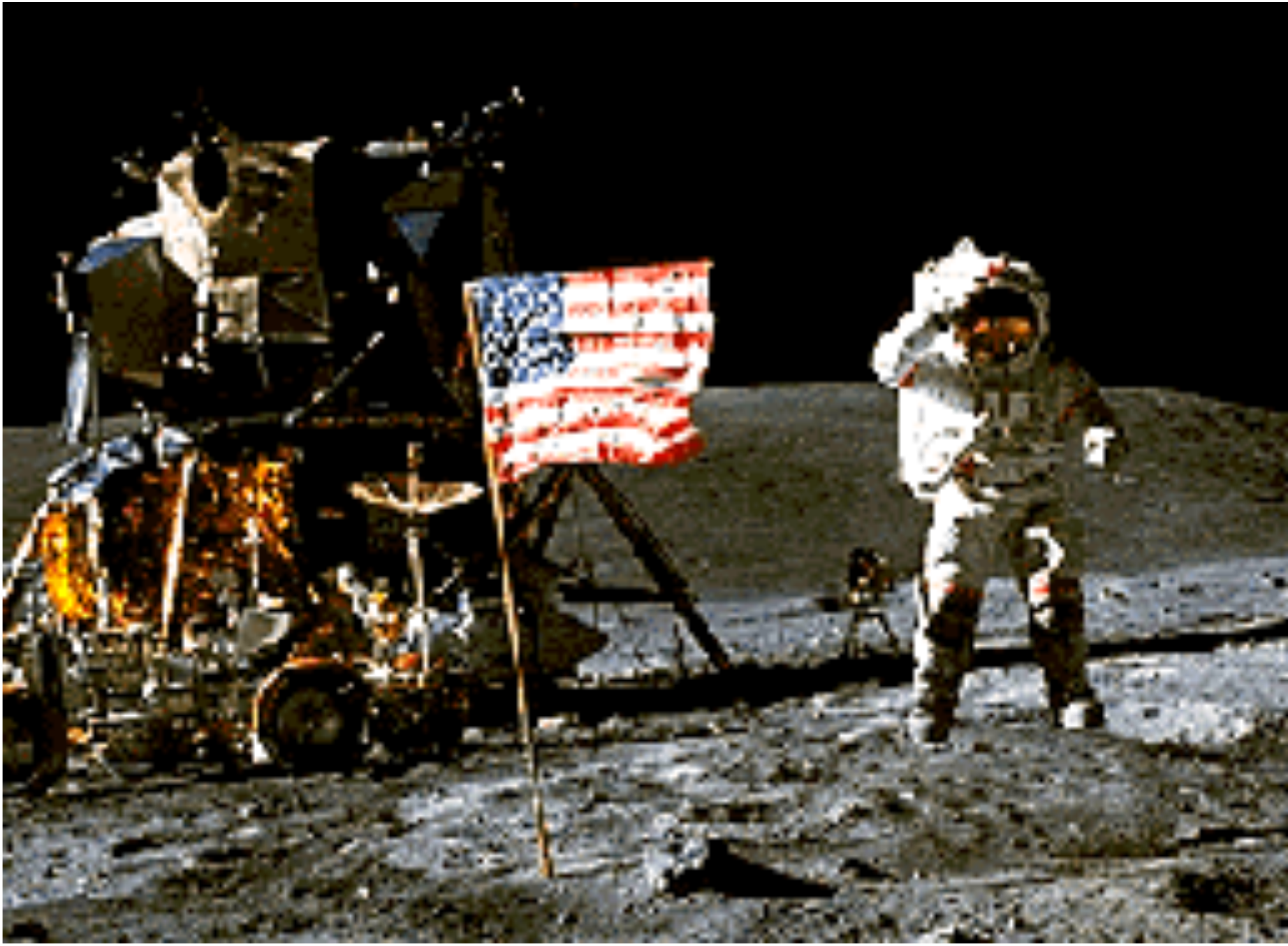
Neil A. Armstrong, commander
Michael Collins, command module pilot
Edwin E. Aldrin, Jr., lunar module pilot

UMBC

"We choose to go to the moon. We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win…"

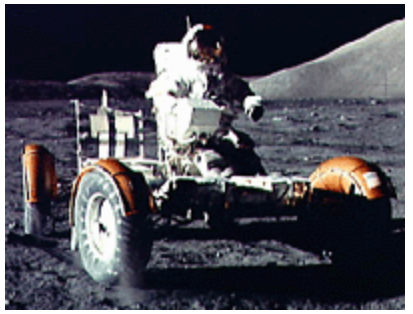
JFK, Rice University, September 12, 1962

UMBC



...more Lunar Exploration ...

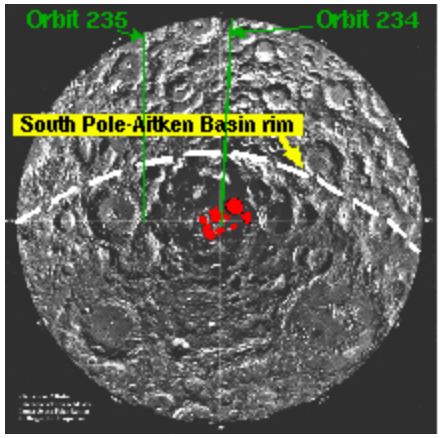
- 1970s
  - Multiple US crewed landings
    - Dec 7, 1972 – Apollo 17
      last crewed landing to-date
  - Soviet orbiters, rovers and sample returns
- 1980s .....
- 1990s – US & Japan send orbiters
- New Millennium...dawn of new lunar exploration



For a detailed timeline of events in lunar exploration history:
http://nssdc.gsfc.nasa.gov/planetary/lunar/lunartimeline.html

Recent Visits

- 1994: Clementine
  - Radio Instrument detects potential ice deposits in shadowed regions of south polar crater



(Courtesy of Lunar and Planetary Institute, basemap from the Clementine Project; USGS image processing.)

- 1998: Lunar Prospector
  - Neutron Spectrometer records evidence suggesting that ice may be present in northern and southern polar regions

Neither detection is conclusive

UMBC

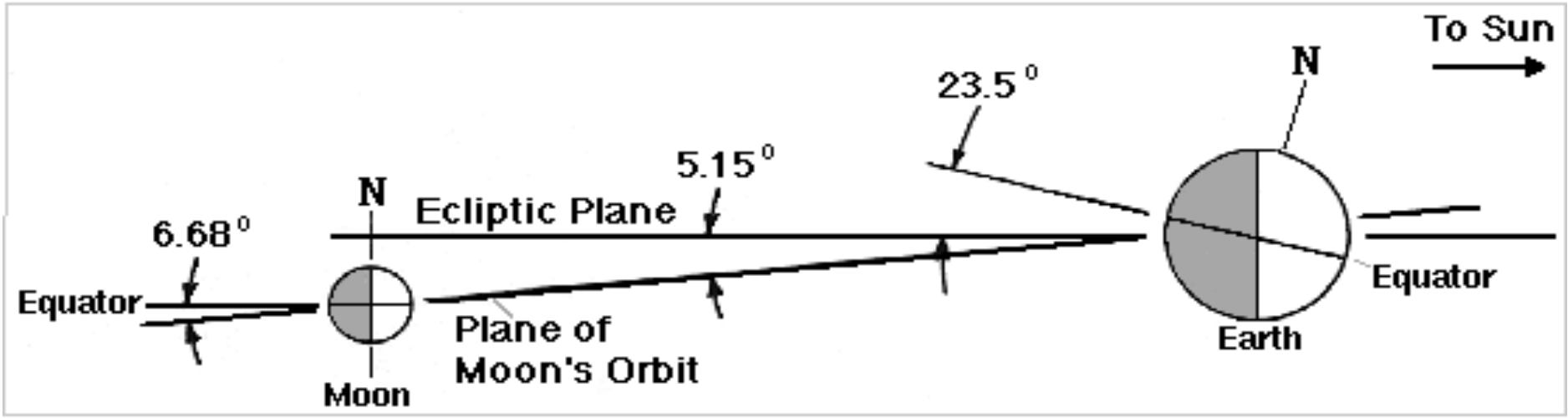
Ice on the Moon

- Why is NASA interested in finding ice?
  - Provides water source for human use
  - Provides hydrogen for rocket fuel
  - Water is too heavy to carry from Earth
- Do we expect there to be ice on the Moon?
  - It may have come from collisions with comets
  - Even so, it shouldn't stay long
    - Vaporizes in sunlight and escapes....so look....

To learn more about the search for ice on the Moon:
Ice on the Moon, http://nssdc.gsfc.nasa.gov/planetary/ice/ice_moon.html
Ice on the Bone Dry Moon, http://www.psrd.hawaii.edu/Dec96/IceonMoon.html

UMBC

Where the Sun doesn't shine



(Diagram by Paul Spudis.)

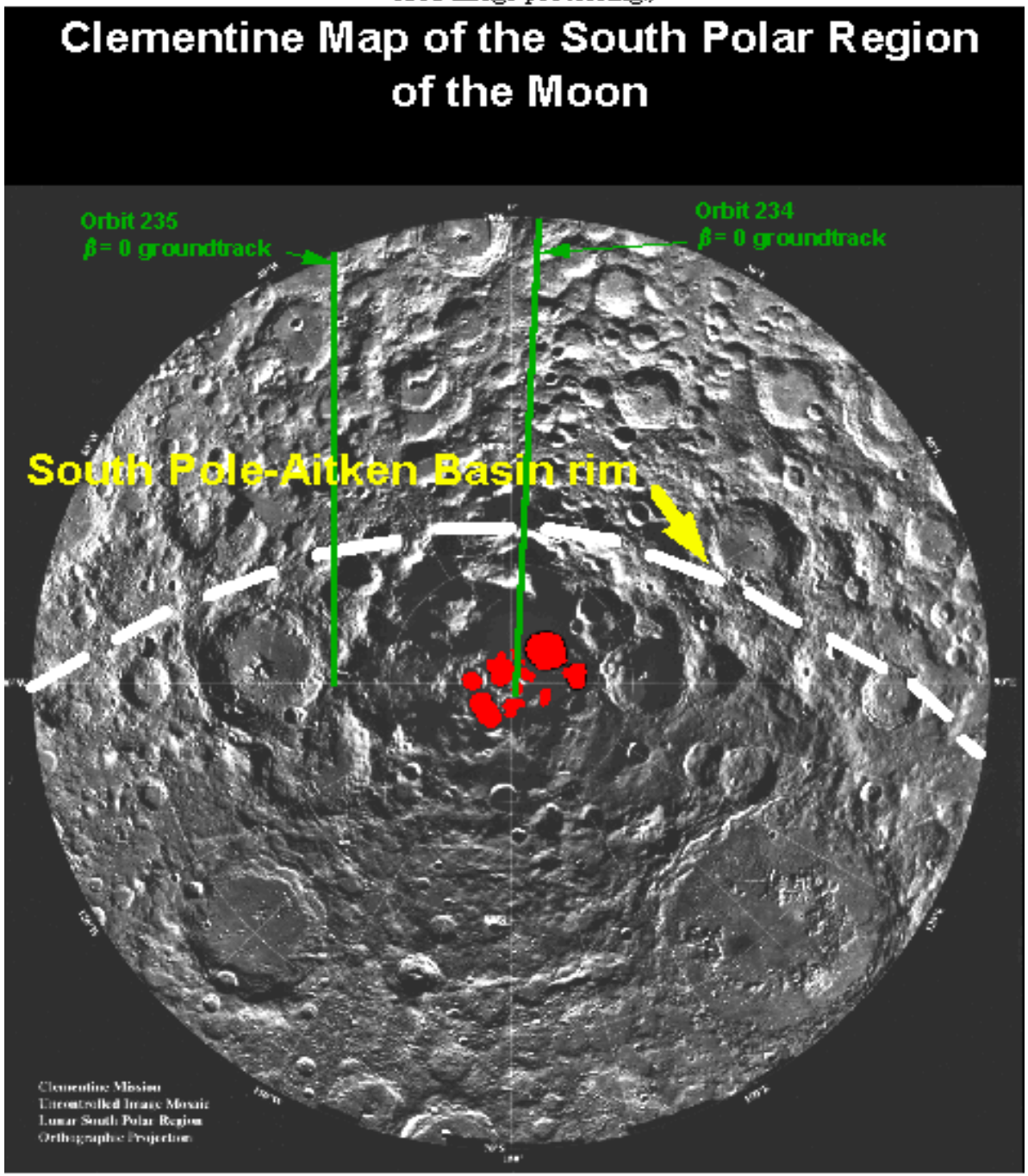
The Moon's axis is not tilted like the Earth's.

If you are standing on top of a hill on one of the Moon's poles, would you see the Sun?

How about if you were in a deep hole that happened to be on one of the poles?

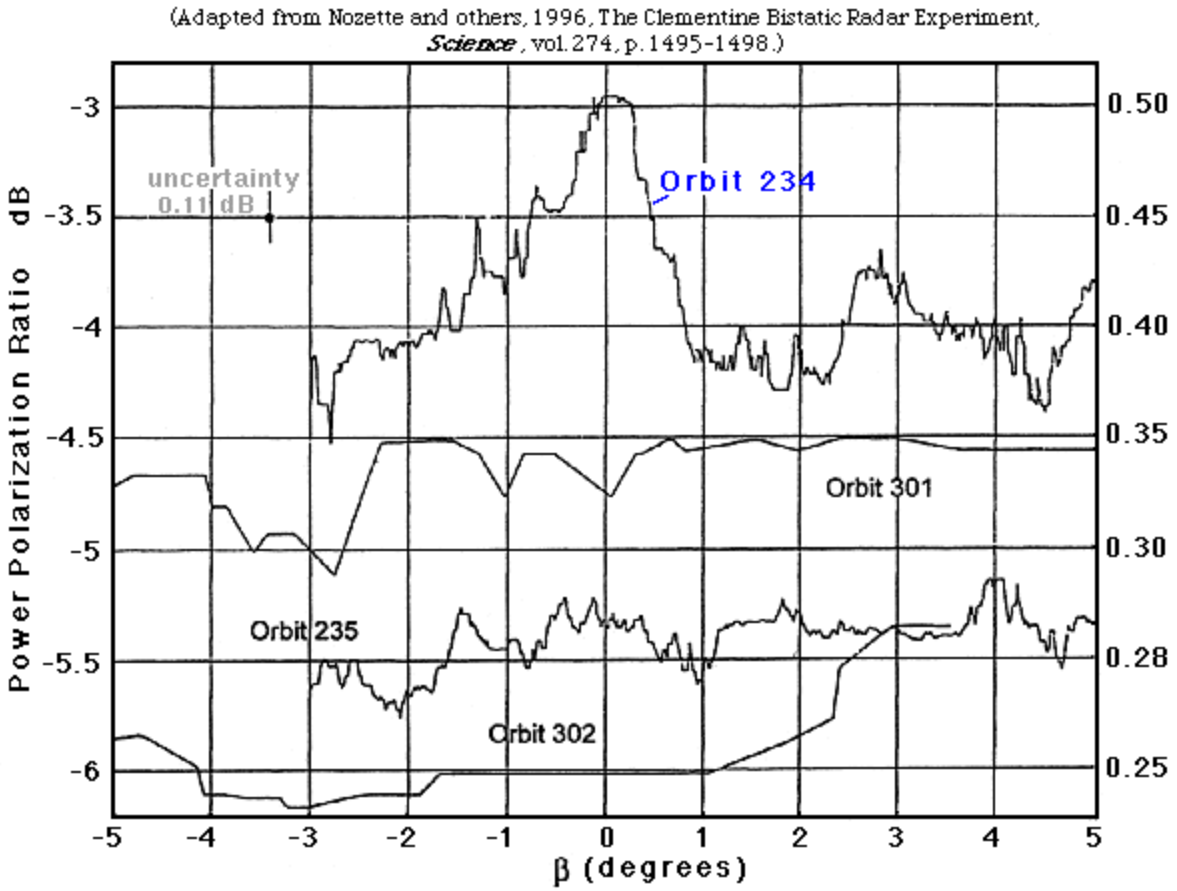
UMBC

(Courtesy of Lunar and Planetary Institute, basemap from the Clementine Project; USGS image processing.)

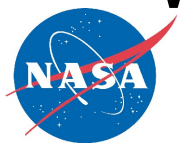


UMBC

Clementine's Radio Experiment

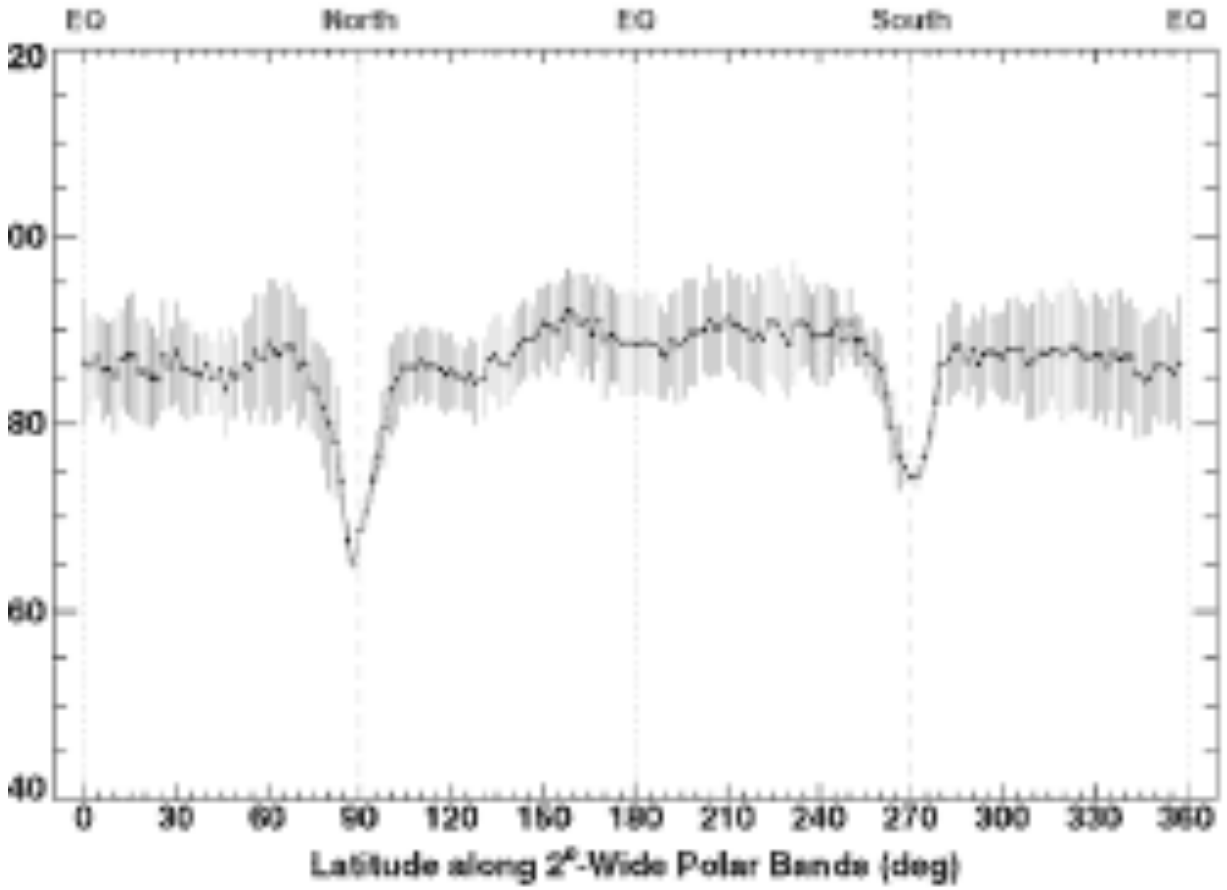


What looks different about orbit 234?



UMBC

Lunar Prospector's Neutron Spectrometer

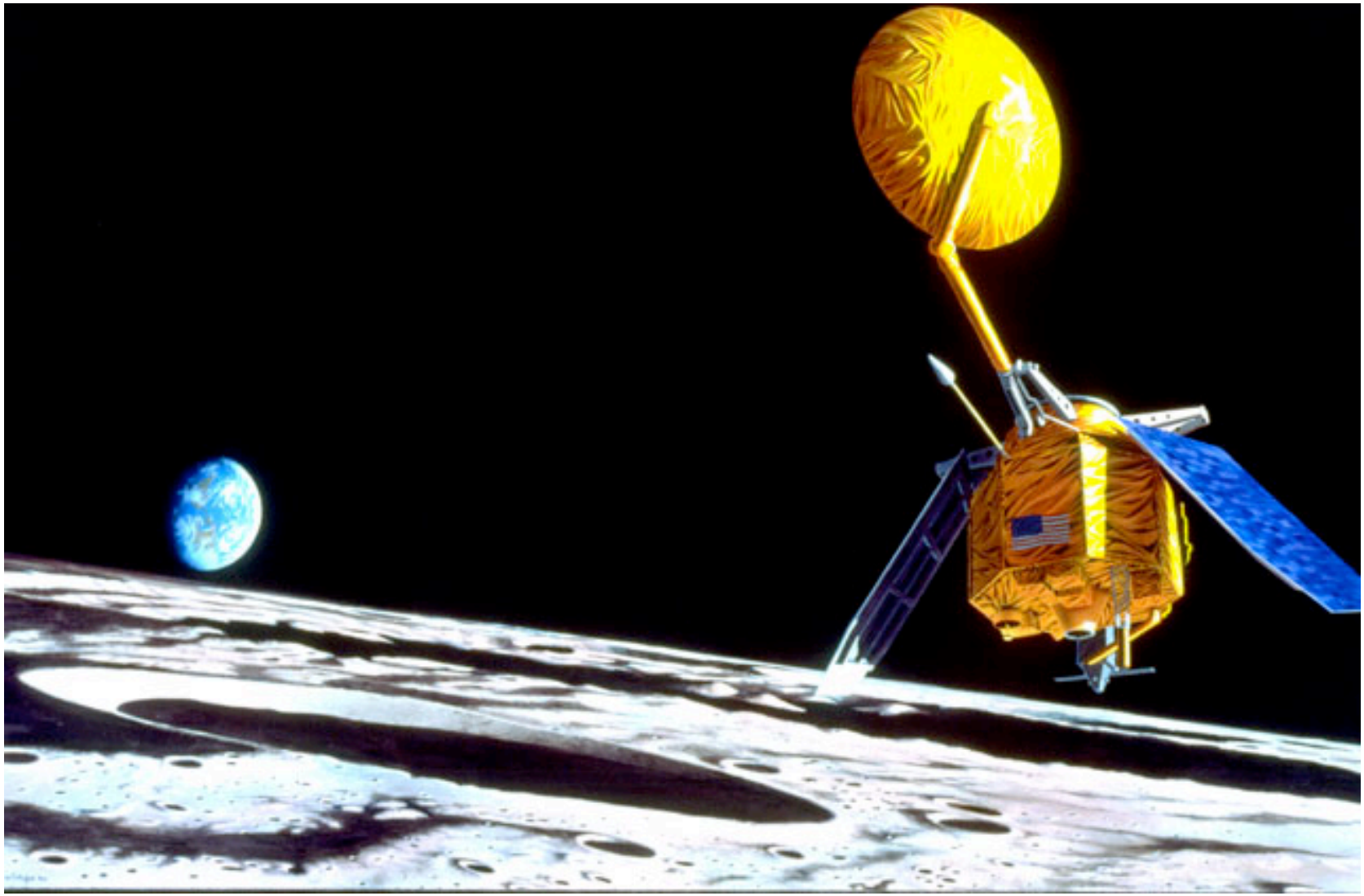


Decreased neutron counts may indicate the presence of hydrogen in water ice

Los Alamos National Laboratory

http://lunar.arc.nasa.gov/NewResults/neutron_spectrometer.html

What's Next?



Lunar Reconnaissance Obiter

UMBC

LRO - Instrumentation

- **Cosmic Ray Telescope for the Effects of Radiation**
  The Cosmic Ray Telescope for the Effects of Radiation (CRaTER) will characterize the lunar radiation environment and determine its potential biological impacts. CRaTER will also test models of radiation effects and shielding, which may enable the development of protective technologies.
- **Diviner Lunar Radiometer Experiment**
  The Diviner Lunar Radiometer (DLRE) will provide orbital thermal mapping measurements, giving detailed information about surface and subsurface temperatures (identifying cold traps and potential ice deposits), as well as landing hazards such as rough terrain or rocks.
- **Lyman Alpha Mapping Project**
  The Lyman Alpha Mapping Project (LAMP) will map the entire lunar surface in the far ultraviolet. LAMP will search for surface ice and frost in the polar regions and provide images of permanently shadowed regions illuminated only by starlight.

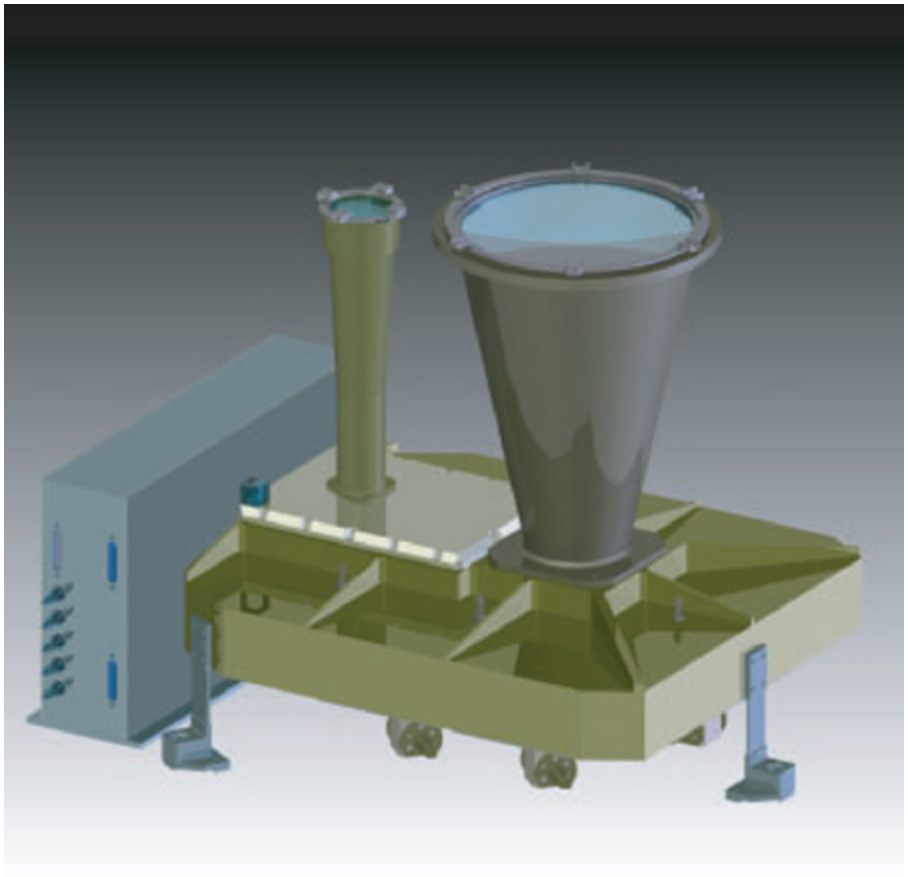
http://lunar.gsfc.nasa.gov/mission.html

UMBC

- **Lunar Exploration Neutron Detector**
  The Lunar Exploration Neutron Detector (LEND) will create high resolution hydrogen distribution maps and provide information about the lunar radiation environment. LEND can be used to search for evidence of water ice on the Moon's surface, and will provide space radiation environment measurements useful for future human exploration.
- **Lunar Reconnaissance Orbiter Camera**
  The Lunar Reconnaissance Orbiter Camera (LROC) will retrieve high resolution black and white images of the lunar surface, capturing images of the lunar poles with resolutions down to 1m, and will image the lunar surface in color and ultraviolet. These images will provide knowledge of polar illumination conditions, identify potential resources & hazards, and enable safe landing site selection.
- **Mini-RF Technology Demonstration**
  The Mini-RF technology demonstration's primary goal will be to search for subsurface water ice deposits. In addition, Mini-RF will take high-resolution imagery of permanently-shadowed regions.

LOLA – Lunar Topography

Lunar Orbiter Laser Altimeter
The Lunar Orbiter Laser Altimeter (LOLA) will measure landing site slopes, lunar surface roughness, and generate a high resolution 3D map of the Moon. LOLA will also identify the Moon's permanently illuminated and permanently shadowed areas by analyzing Lunar surface elevations by constructing topographic maps.



http://lunar.gsfc.nasa.gov/lola.html

UMBC

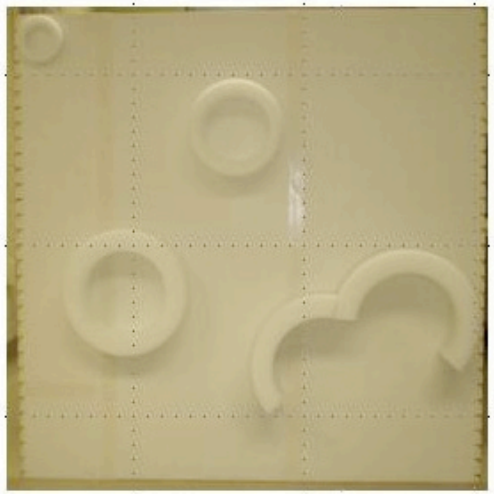
Your Mission

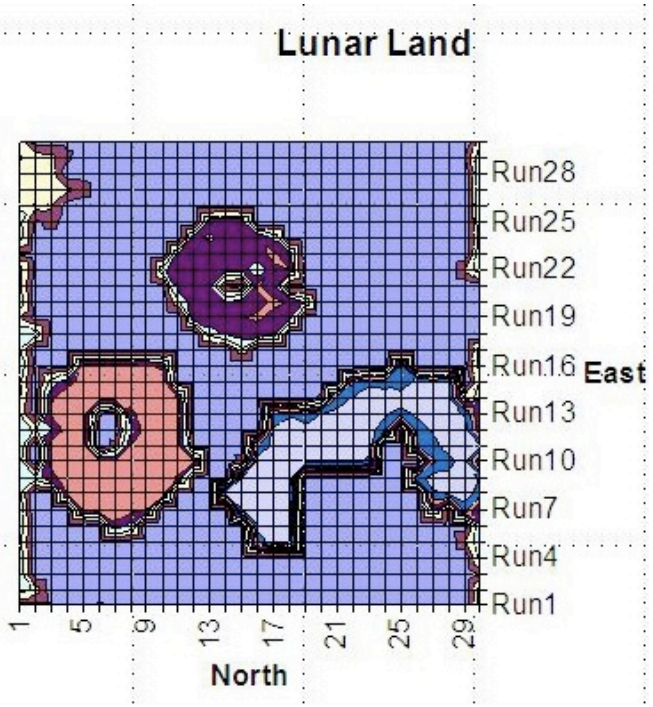
The Search for Ice in Lunar Land

– Make a topographic map
  - Design and build TopoBot
  - Conduct TopoBot mission to gather data on Lunar Land
  - Import data into Excel to make a map

UMBC

Topographic Maps





UMBC

Find the Ice in Lunar Land

- Add sensors to your Rover Bot
- Use topographic map to plan mission
- Conduct RoverBot mission and find the ice!

UMBC