ASTR 4800:
Today - **Back to The Moon, Back To the Future**

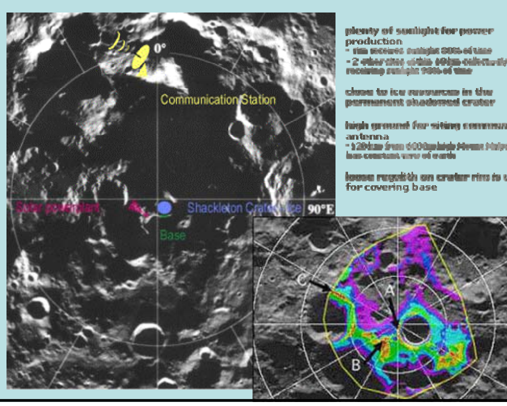
Friday:
Dr. John Grunsfeld
NASA Astronaut
Hubble Reservicing Mission

Back to the Moon and Back to the Future

The New Rockets (Ares I & V) and the New Spacecraft (Orion)

Exploring the Moon

Possible Site for a Lunar Base – Shackleton Crater



plenty of sunlight for power production

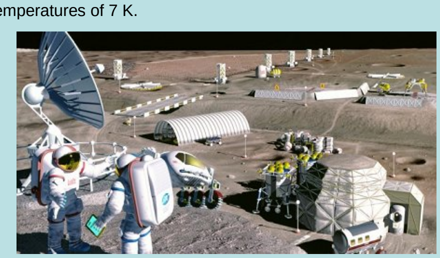
close to ice resources in the permanent shadowed crater

high ground for siting communication antenna

loose regolith on crater rim is useful for covering base

Potential Advantages of the Lunar Surface for Telescopes
following Smith (1990) in *Observatories in Earth Orbit & Beyond*

- *Ultra-hard vacuum* (about 10^5 cm^{-3}). Accessible at all wavelengths.
- *Large, solid, stable surface.* Minimal tectonic activity (10^{-8} of Earth).
- *Cosmic ray protection* for humans who service telescopes & detectors.
- *Dark & Cold Sky.* Telescopes in Shackleton crater may achieve temperatures of 7 K.



Potential Advantages of the Lunar Surface for Telescopes
(continued)

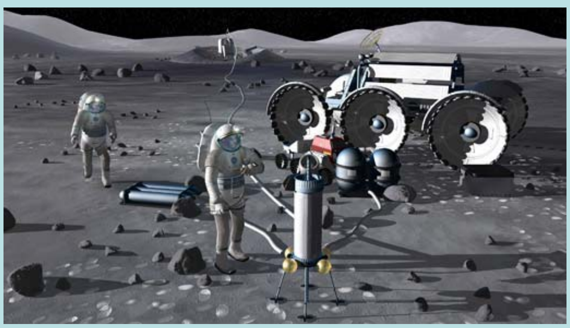
- *Proximity to Earth.* Easy access for servicing telescopes.
- *The Lunar Farside.* Shielding from terrestrial interference, AKR, & solar flares.
- *Raw materials.* Potential water, fuel for nuclear power generators (He^3), and building materials.
- *Landforms.* Use craters for large-collecting area apertures.
- *Access to people & infrastructure.* Telescope support for deployment, repair, & upgrades. Lowers technology risk & possibly the cost.

Concerns with the Moon's Surface
following Lester, Yorke, & Mather, 2003 in *Space Policy*

- *Dirt & Dust* threaten contact bearings & optical surfaces. Electrostatic charging leads to "static cling".
- *Solid surface* may not be ideal for telescopes.
- *Gravity* presents loading problems with structural deformations.
- *Ultra-cold crater* may be a challenge for both astronauts & equipment to function.
- *People pollute.* May stir up dust near telescopes. Mining may grow the atmosphere. Communication satellites may destroy radio-quiet environment of farside.

Harrison Schmitt at Apollo 17 site. Note dust clinging to space suit.

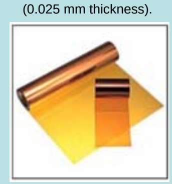
A Low Frequency Lunar Radio Telescope



ROLSS: Radio Observatory for Lunar Science Sortie

- A Pathfinder for a future long-wavelength farside lunar array (10-100 sq. km).
- Operating at 1-10 MHz (30-300 m), produces factor of 10 increase in resolution and sensitivity over previous space missions (e.g., RAE).
- Array consists of three 500-m long arms forming a Y; each arm has 16 antennas.

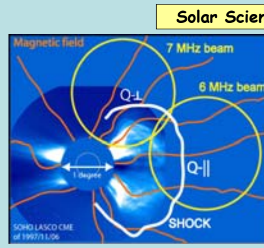
- Arms are thin polyimide film on which antennas & transmission lines are deposited.
- Arms are stored as 25-cm diameter x 1-m wide rolls (0.025 mm thickness).



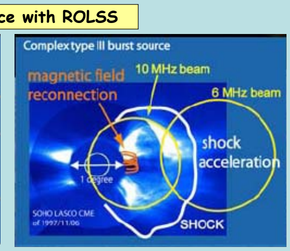
Advantages to Radio Observations from the Moon

- No interference from radio/TV broadcasting.
- No atmospheric distortions.
- Ability to observe the universe at ultra low-frequencies (<15 MHz, redshifts =100-1000) which are blocked by the ionosphere.

Solar Science with ROLSS

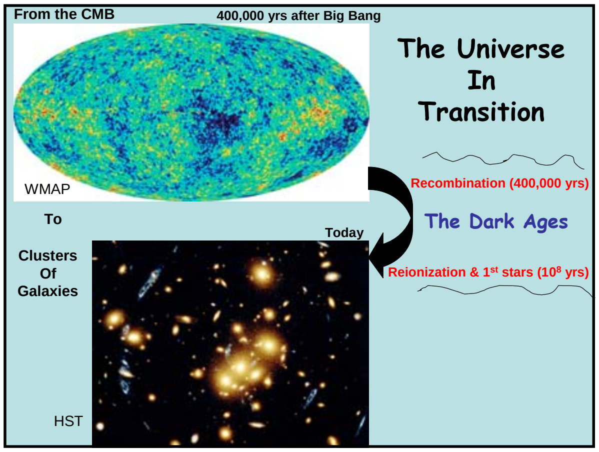


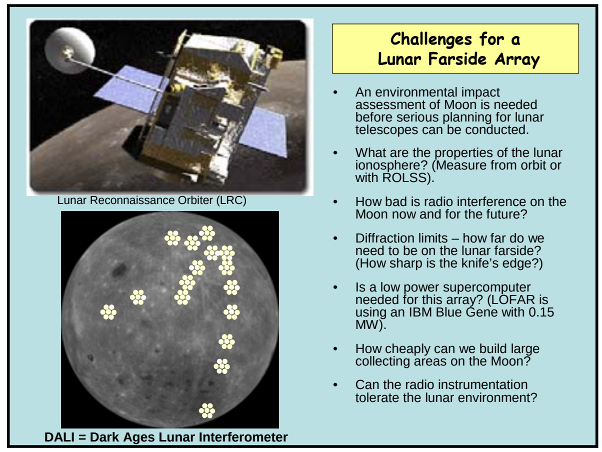
Type II Burst source location



Complex Type III source location

- ROLSS will produce the first high angular resolution (<1º at 10 MHz), high time resolution images of solar radio emissions (outer corona).
- ROLSS will determine source locations of coronal shock acceleration (Type II radio bursts) and magnetic field reconnection (Type III radio bursts).


From the CMB
400,000 yrs after Big Bang
The Universe In Transition
WMAP
Recombination (400,000 yrs)
The Dark Ages
To
Today
Clusters Of Galaxies
Reionization & 1st stars (10^8 yrs)
HST


Lunar Reconnaissance Orbiter (LRC)
DALI = Dark Ages Lunar Interferometer
Challenges for a Lunar Farside Array
• An environmental impact assessment of Moon is needed before serious planning for lunar telescopes can be conducted.
• What are the properties of the lunar ionosphere? (Measure from orbit or with ROLSS).
• How bad is radio interference on the Moon now and for the future?
• Diffraction limits – how far do we need to be on the lunar farside? (How sharp is the knife's edge?)
• Is a low power supercomputer needed for this array? (LOFAR is using an IBM Blue Gene with 0.15 MW).
• How cheaply can we build large collecting areas on the Moon?
• Can the radio instrumentation tolerate the lunar environment?