# HIGH RESOLUTION RADAR MAP OF THE MOON

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Previous radar mappings of the Moon at 70 cm wavelength in the late 1960s by Thompson (1974) have been replaced with a new set of observations conducted between 1981 and 1984 using the 430 MHz radar at the Arecibo Observatory, Puerto Rico. Radar resolution was reduced to 2-5 km radar cell-size and a "beam-sweep", limb-to-limb calibration was conducted. Advances in computer technology provided the principal means of improving lunar radar mapping at this wavelength. These new lunar radar maps are described in greater detail by Thompson (1986).

The antenna beamwidth for the 430 MHz radar at Arecibo is only 10 arc-minutes, about one-third of the angular width of the lunar disk when viewed from Earth. Thus, some 18 separate beam positios were needed to map the entire disk. Twelve of these were placed in an "outer ring" surrounding the center of the disk. To tie the eighteen separate beam positions together, a limb-to-limb, beam swing calibration was conducted. Here the antenna beam was slowly swept across the lunar disk at a rate of 2 arc-minutes per minute. This was repeated north and south of the apparent equator on several different days. This calibration was conducted at somewhat coarser resolution than that for the individual beam positions described above.

Radar observations of the Moon were conducted by transmitting pulses from the main antenna and receiving echoes at an auxiliary antenna located some 11 km NNE of the main antenna. Circular polarization was used to obviate the adverse effects of Faraday rotation in Earth's ionosphere. Post-observation data reduction used the delay-Doppler techniques described by Thompson (1978). Radar echoes from the Moon are separated into time-delay (range) bins and Doppler-frequency bins which provides a two-dimensional separation and eventual mapping to lunar latitude and longitude. Radar echo strengths are also normalized in the mapping by removing predictable variations. This processing removes background noise levels, accounts for antenna gain and scattering area differences across the beam, divides by an average scattering law, and adjusts final map values so their averages on a $5^{o}$ x $5^{o}$ squares agree with the limb-to-limb, beam-sweep calibration described above. The final map is a square array of pixels separated by $0.1^{o}$ in latitude and longitude. Two 1800 by 1800 pixel arrays represent the lunar earthside hemisphere (+$90^{o}$ in latitude and longitude) in the two radar polarizations. These data have been shipped to the Planetary Data Centers.

The data from these observations is shown in Figure 1, which shows an orthographic projection of the new radar data. The weakest scattering differences in these displays show scattering differences on the order of ten to twenty percent. The largest scattering differences in Figure 1 are those places which saturate as totally white areas have radar echoes ten or more times stronger than the average. Most echo deviations tend to be stronger than the average (whiter in the photographs of Figure 1).

References:

T.W. Thompson, 1974, Atlas of Lunar Radar Maps at 70-cm Wavelength, The Moon, 10, 51-85.

T.W. Thompson, 1979, A Review of Earth-based Radar Mapping of the Moon, The Moon and Planets, 179-198.

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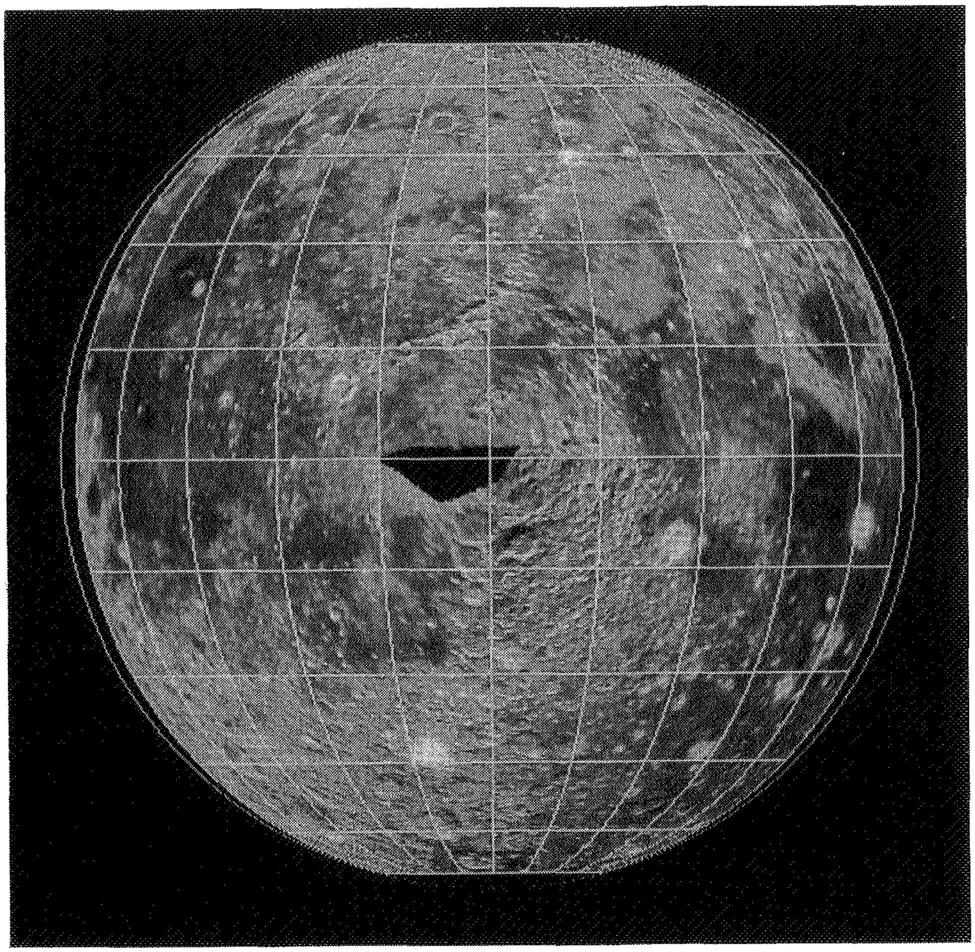

Figure 1. New high resolution radar map of the moon at 70 cm wavelength. North is at the top and grid lines are every $15^{0}$ in latitude and longitude. Thus, photograph shows "polarized" echoes; the expected polarization from a plane mirror reflection.