

OBSERVATION OF ENERGETIC ELECTRON MIRRORING FROM THE LUNAR REMNANT MAGNETIC FIELD. K.A. Anderson, H.C. Howe, R.P. Lin, R.E. McGuire, U of Calif, Space Sciences Lab, Berkeley, Calif. 94720, L.M. Chase, FMC, 1185 Coleman Ave., Santa Clara, Calif. 95052, and J.E. McCoy, Johnson Space Center, Houston, Texas 77058.

The plasma and energetic particle experiment on the Apollo 15 Subsatellite included a curved plate electrostatic analyzer to measure the pitch angle distribution of 13.6-14.8 keV electrons. Using the magnetic field direction measured by the onboard UCLA magnetometer the flux of electrons in each of four pitch angle sectors ( $0^\circ$ - $45^\circ$ ,  $45^\circ$ - $90^\circ$ ,  $90^\circ$ - $135^\circ$ ,  $135^\circ$ - $180^\circ$ ; hereafter called sectors I, II, III, IV respectively) was measured every 24 seconds (see Anderson *et al.*, 1972 for complete instrument description). On September 3, 1971, the moon was in the southern lobe of the high latitude magnetotail (solar magnetospheric coordinates  $Y_{SM} = 20 R_E$ ,  $Z_{SM} = -10 R_E$ ) and the measured magnetic field was quiet ( $B \approx 10 \gamma$ ) and directed radially away from the sun. During the dark-side portions of the Subsatellite orbit, sectors III and IV looked away from the moon and observed particles coming from the distant magnetotail while sectors I and II looked at the lunar surface. This geometry is illustrated in Figure 1.

As the Subsatellite traversed the dark side of the moon, large, steady, and isotropic fluxes of 13.6-14.8 keV electrons were observed in sectors III and IV. These electrons were flowing earthward from an unknown source in the distant magnetotail. These electrons may have come from the interplanetary medium along open field lines (Anderson and Lin, 1969) after being produced by an earlier solar flare. Concurrently, measurements in sectors I and II showed weaker, irregular and anisotropic fluxes coming from the lunar surface. These fluxes are interpreted to be electrons from the distant magnetotail which are magnetically mirrored near the lunar surface by the remnant lunar magnetic field.

Several factors argue in favor of a mirroring interpretation.

1. Remnant lunar fields over  $300 \gamma$  have been measured at the lunar surface by the Apollo astronauts. Although the geometry of field reconnection is complicated, fields this large, when reconnected to the magnetotail field of  $10 \gamma$ , could mirror a substantial fraction of the observed incoming particles.

2. The measured flux of mirrored electrons with pitch angles between  $45^\circ$  and  $90^\circ$  (sector II) is always larger than the flux between  $0^\circ$  and  $45^\circ$  (sector I). For a given increase in field magnitude along a single field line this is expected because small pitch angle electrons may strike the surface before mirroring.

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3. Reflected electrons are never observed in the absence of incident electrons. This argues against the possibility that the electrons are generated at the lunar surface. Backscattering from the lunar surface can contribute no more than 10% of the observed reflected flux.

It is interesting to note that when  $0^\circ$ - $45^\circ$  (sector I) mirrored fluxes are observed (Figure 2) the flux in the  $45^\circ$ - $90^\circ$  sector (sector II) is still less than the incident flux. If the field reconnection were smooth over the distant of the electron gyroradius ( $\sim 40$  km), a field strong enough to mirror any  $0^\circ$ - $45^\circ$  electrons should mirror all  $45^\circ$ - $90^\circ$  electrons. That this is not observed indicates that some pitch angle scattering by magnetic irregularities is occurring near the surface. For scattering to occur, the scale size of the irregularities must be of the order of the gyroradii of the mirrored particles. Thus, we may infer that the scale size of the lunar remnant field which gives rise to the irregularities is of the order of 40 km or less.

Acknowledgements

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References

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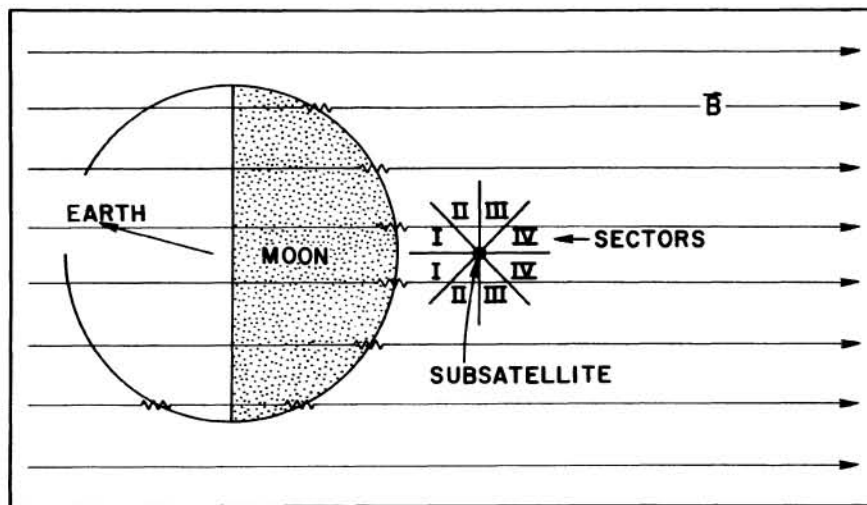
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Figure 1. Geometry of measurements showing pitch angle sectors and orientation of magnetic field during time of observation.

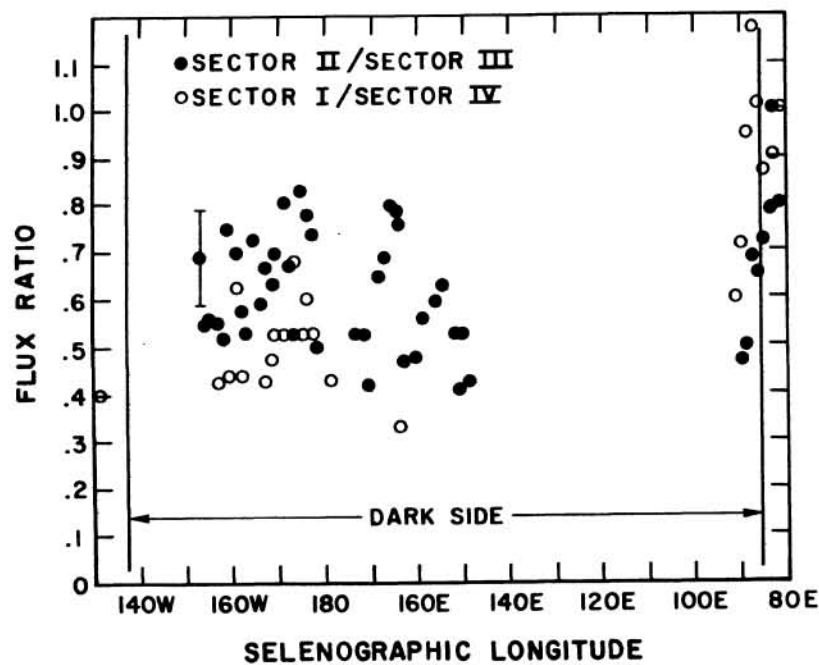


Figure 2. Electron flux ratios from single pass of Subsatellite across dark side of moon between 0506 UT and 0552 UT, September 3, 1971.