

longer times for sample analyses. Early tests with these sources would be very desirable. Additional work with  $HgI_2$  detectors and their performance under lunar conditions (e.g., high temperatures) will also have to be investigated.

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**HIGH-RESOLUTION ELEMENTAL MAPPING OF THE LUNAR SURFACE.** Bradley C. Edwards, Frank Ameduri, Jeffrey J. Bloch, William C. Priedhorsky, Diane Roussel-Dupré, and Barham W. Smith, Los Alamos National Laboratory, Los Alamos NM 87545, USA.

New instruments and missions are being proposed to study the lunar surface as a result of the resurgence of interest in returning to the Moon. One instrument recently proposed is similar in concept to the X-ray fluorescence detectors flown on Apollo, but utilizes fluorescence from the L- and M-shells rather than the K-shell. This soft X-Ray Fluorescence Imager (XRFI) will be the topic of this presentation.

As was proven by the Apollo missions, the elemental composition of the lunar surface can be mapped using X-ray fluorescence from lunar orbit [1,2]. However, the spatial resolution and precision of the Apollo experiments were limited by both exposure time and flux. Although future missions will have longer lifetimes, the flux for K-shell fluorescence is still a primary limiting factor and imaging keV radiation with a wide field of view is difficult. However, the L- and M-shell fluorescence may provide a solution because the much more intense solar radiation at less than 1 keV will make the lower energy fluorescence flux up to  $10^4$  times more intense.

The theory behind the XRFI was discussed recently in Edwards et al. [3] and indicates that the fluorescent emission should be intense enough to be observed from lunar and even Earth orbit. Preliminary concepts and designs have been worked out for an XRFI that could be flown in lunar orbit in three years. XRFI is one in the suite of instruments on the Lunar Resource Mapping mission. The proposed instrument will provide maps with high

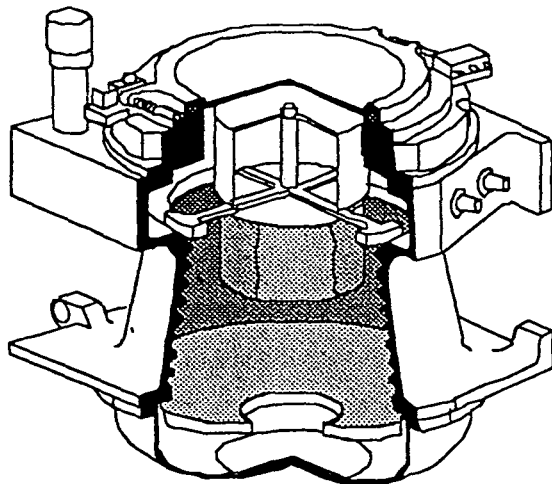


Fig. 1. Diagram of current ALEXIS telescope design. A similar design is to be used for the XRFI instrument on the LRM mission.

spatial resolution (1 km) of the surface distribution of a valuable suite of elements (Al, Mg, Si, Ca, Na, Fe, Ti, etc.).

Although this design is not ideal for the lunar study, optimized instruments with improved capabilities are only in the conceptual stage and may not be feasible for many years.

The XRFI set of soft X-ray telescopes would fly in lunar orbit to observe the fluorescent emission. The telescopes are of the same design to be used on the ALEXIS mission with a normal incidence multilayer mirror, a microchannel plate detector, and thin film filters. The technology, facilities, and software developed and tested for ALEXIS are to be directly applied to the XRFI.

Each telescope would be tuned to an energy that corresponds to an L- or M-shell fluorescent line. The intensity of each line is proportional to the elemental abundance, surface structure, and incident solar flux level. Details of the instrument, its requirements, specifications, and limitations will be presented.

Results from current feasibility studies of the XRFI concept being done at Brookhaven will be discussed and presented along with their implications. Future plans for studies, design, and construction of the XRFI and the lunar community's involvement is also a planned topic for this presentation.

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**LUNAR AND ASTEROID COMPOSITION USING A REMOTE SECONDARY ION MASS SPECTROMETER.** R. C. Elphic, H. O. Funsten, B. L. Barraclough, D. J. McComas, and J. E. Nordholt, Space Plasma Physics Group, Los Alamos National Laboratory, Los Alamos NM 87545, USA.

Laboratory experiments simulating solar wind sputtering of lunar surface materials have shown that solar wind protons sputter secondary ions in sufficient numbers to be measured from low-altitude lunar orbit. Secondary ions of Na, Mg, Al, Si, K, Ca, Mn, Ti, and Fe have been observed sputtered from sample simulants of mare and highland soils [1]. While solar wind ions are hundreds of times less efficient than those used in standard secondary ion mass spectrometry, secondary ion fluxes expected at the Moon under normal solar wind conditions range from  $\sim 10$  to  $>10^4$  ions  $cm^{-2} s^{-1}$ , depending on species. These secondary ion fluxes depend both on concentration in the soil and on probability of ionization; yields of easily ionized elements such as K and Na are relatively much greater than those for the more electronegative elements and compounds. Once these ions leave the surface, they are subject to acceleration by local electric and magnetic fields. For typical solar wind conditions, secondary ions can be accelerated to an orbital observing location. The same is true for atmospheric atoms and molecules that are photoionized by solar EUV. Here we discuss the instrumentation to detect, identify, and map secondary ions sputtered from the lunar surface and photoions arising from the tenuous atmosphere.

**Solar Wind-sputtered Secondary Ions and Surface Composition:** Our laboratory experiments subjected three simulants of Apollo soil samples to ion bombardment, and measured the relative efficiencies of solar wind ions in sputtering secondary ions. The