REMOTE X-RAY SENSING METHODS FOR PLANETARY EXPLORATION

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The use of remote X-ray sensing methods for obtaining Al, Mg and Si elemental composition maps of the lunar surface was first successfully demonstrated during the Apollo 15 and Apollo 16 missions (1,2). Those methods are now being considered for missions to the Comets, asteroids and Mercury. As a result of these studies, a number of designs have been investigated that will significantly enhance the technique. Detectors with sensitivities to X-ray from .27 keV and greater will allow the determination of elemental composition from Z=6 (C) through Z=26(Fe). A design of an electron gun capable of producing observable X-ray emission at orbital altitudes for cometary mission has been completed. This electron gun combined with the X-ray remote sensing detectors can significantly increase the sensitivity of the technique for elemental analysis. Soft X-ray continuum observations carried out, for example, during a Halley flyby, will enable us to study the dynamic phenomena which result from the large-scale interaction of the cometary ionosphere with the solar wind and the possible release of magnetic-field energy when parts of the comet disconnect as the comet crosses solar-sector boundaries.

A major limitation in the detection of lower Z elements using solar X-ray excitation (i.e. less than Z=12 (Mg)) can be attributed to the large background produced by the coherent scatter of solar X-rays from the planetary surface. The elemental composition for these lower Z elements can be obtained through analysis if the incident solar X-ray spectrum is known. Sensitivity of X-ray remote sensing measurements have been calculated for elements C through Fe.

Several possible mechanisms for the production of soft X-rays by interactions of comets with the solar environment have been considered. Estimates of the temporal and spectral characteristics of these emissions have been obtained. Among those candidate sources of significant X-ray continuum flux are: rapid ionization leading to cometary aurora (3,4) disconnection of the comet tail at a solar-sector boundary (5) and shock-induced heating of the cometary ionosphere (6).

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