THERMAL EMISSION SPECTROSCOPY OF SOLAR SYSTEM REGOLITHS. A. L. Sprague,
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Many years of difficult Earth-based observations, analysis, laboratory work, and modeling have laid a firm foundation for what can be learned from thermal emission spectroscopy of regoliths in the solar system. At first, most observations were of rather low resolving power and most ground-based successes lie in measuring absolute fluxes of the Moon, Mercury, the Galilean satellites, and asteroids through terrestrial atmospheric windows. Measurements in the 1960’s determined that these remote bodies have thermal flux characteristics indicative of silicate surfaced bodies. Systematic thermal spectral photometry of the Moon and many diverse asteroids allowed the study of the emissivity relation with phase and local illumination angle. More recently, spectrometers utilize technically advanced gratings, electronics, and detectors permitting high signal-to-noise ratio thermal emission spectroscopy using resolving powers suitable for examining spectral features that are diagnostic of the actual chemical makeup of rocks and minerals comprising the regolith.

To date, actual detailed compositional measurements of distant regoliths by thermal emission spectroscopic techniques are few because astronomers are inhibited by:

1. the Earth’s atmosphere – it restricts the use of spectral regions to those where atmospheric absorptions and emissions are slight and can be removed,
2. the lack of availability of reference laboratory emission spectra of rocks and minerals (ideally obtained in simulated conditions of insolation, low or no atmospheric pressure, and a variety of grain sizes),
3. the scarcity of facility instruments designed for remotely sensing regoliths at infrared telescopes—appropriate apertures and long-slit (near the diffraction limit and with array detectors for good spatial resolution)—large dynamic range (to accommodate both standard stars and warm planets)—suitable resolving power (idealized for spectral activity seen in particulate mineral and rock mixtures).

Actual identification of rock types on solar system bodies have been made by measuring the wavelength of the emissivity maximum that is associated with the Christiansen frequency (for silicates: normally between 7.5 and 9.5 microns). Such identifications have been made for several locations on the Moon and a few locations on Mercury. Emission spectra from asteroids, the Galilean satellites, the Moon and Mercury exhibit spectral features that are not yet fully understood. Actual mineral identifications resulting from thermal emission spectroscopy of regoliths are: 1. Moon: a spectral minimum at 10.5 microns identifying olivine, and 2. Mercury: spectra between 7.7 and 13 microns identifying plagioclase feldspar with the presence of sodium-rich albite at about 20 – 40%.

In the future, the deficiencies listed above may be overcome and ground-based observing and modeling may add more successes to the list. In addition, the Stratospheric Observatory For Infrared Astronomy (SOFIA) and the Space Infrared Telescope Facility (SITF) will offer spectroscopic platforms above most (SOFIA) and all (SITF) of the molecular absorptions of the Earth’s atmosphere. Both DLR (Institute for Planetary Exploration, Berlin) and NASA (Arizona State University) have funded measurements of emission spectra of rock, mineral, and particulate samples in one atmosphere environments.