A Study of Earth's "Technosignatures" from the Lunar Surface

A White Paper

By

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This white paper describes a simple concept for observing "technosignatures" resulting from anthropogenic activities on Earth from the surface of the Moon. During the new phase of Earth as observed from the lunar surface, it should be possible to observe artificial lighting emitted by inhabited cities. A hyperspectral camera system deployed on the lunar surface could be used to produce spectral cubes with each pixel in the scene containing the Earth representing both spatial and spectral information. An imaging spectrometer operating across the visible to shortwave-IR region of the electromagnetic spectrum (defined here as 400 to 2500 nm) could be used to image the presence of nighttime lighting originating from cities over a contiguous series of narrow spectral bands. In addition to providing imagery of nightlights, the hyperspectral camera would allow the identification of the type of lighting used as a function of spatial location on the Earth. The study of technosignatures from the Earth would allow ground truth data to be collected in support of future space-based interferometer missions that will eventually have the capability to search for technosignatures from Earth-like extrasolar planets. For example, a large space-based interferometer equipped with imaging spectrometer might have the capability to detect the presence of artificial light originating from the existence of extraterrestrial cities and transport networks constructed by technologically advanced civilizations.

Terrestrial technosignature data collected from an imaging spectrometer deployed on the lunar surface could be resampled to the appropriate resolution of a future space-based optical/IR interferometer to simulate the observation of a distant Earth-like exoplanet.

A second type of technosignature that could be observed from the surface of the Moon is artificially produced gases emitted by terrestrial industrial facilities as a result of anthropogenic activities. A lunar surface imaging spectrometer (i.e. hyperspectral imaging system) could be used to search for man-made greenhouse gases, including hydrofluorocarbons, perfluorocarbons,

chlorofluorocarbons, hydrochlorofluorocarbons, halons, and sulfur hexafluoride (SF_6). Identification of these gases, especially SF_6 would be best accomplished using an imaging spectrometer that is sensitive across longwave-IR spectral bands (defined in this paper as 7.5 to 13.5 microns). The spectral signature of SF_6 is easily detectable at a wavelength near 10.6 microns, and since this extremely potent greenhouse gas have a long resident lifetime on the order of thousands of years, even a minor abundance can have a large affect on global climate change. It is proposed that industrialized extraterrestrial civilizations inhabiting other rocky worlds might utilize sulfur hexafluoride for its favorable dielectric properties, and for its potential climate control/modification properties. Furthermore, both perfluorocarbons and sulfur hexafluoride represent useful tracers of tropospheric and stratospheric transport, since the only sinks for these two gases are photolytic and ionic reactions in Earth's atmosphere. The same may apply for other extraterrestrial civilizations inhabiting Earth-like, or even super-Earth planets.

It is of interest to pursue research in the area of these atmospheric "Technosignatures" by simulating the spectra of different anthropogenically produced gases with varying concentrations, such as chlorofluorocarbons, perfluorocarbons, and sulfur hexafluoride. NASA's Planetary Spectrum Generator (PSG) is well-suited for the simulation of planetary atmospheric spectra under different observing geometries, spectral instrument parameters, imaging system parameters, atmospheric concentrations, and noise. The PSG could be improved by adding anthropogenically produced gases to the modeling tool's database for this proposed project.

The search for both nighttime lighting and anthropogenically produced gases on the Earth using an imaging spectrometer deployed on the lunar surface could be carried out using an automatic approach, or by operation of a lunar surface crew. Such an endeavor would mark the initial beginning of a research effort that could prove the feasibility of detecting the existence of technological extraterrestrial civilizations on other terrestrial planets.