Observing Earth as an Alien World and the Planet Spectral Library

Ramsey Lundock[1]; Takashi Ichikawa[2]

[1] Tohoku University, Astronomy; [2] Astronomical Institute, Tohoku Univ.

The Planet Spectral Library (PSL) is the first library to contain visible and near infrared spectra (0.45 - 2.50 microns) for all of the Sol system planets. Data for moons and dwarf planets is also included where available. The spectra were obtained during May 2-13 and November 19-27 of 2008, using TRISPEC (A simultaneous Optical and Near-Infrared Imager, Spectrograph, and Polarimeter) (Watanabe 2005) on East Hiroshima Observatory 1.5 meter Kanata telescope.

With the successful direct imaging of extrasolar planets last year, we hope reflection spectra for extrasolar planets will soon be available. The scientific community knows a great deal about each of the Sol system planets and details of some extrasolar planets, but the framework for discussing lanets in general has lagged behind.

Using the PSL, we are able to compare the spectra for 19 different objects: Mercury, Venus, Earth, Luna, Mars, Ceres, Jupiter, Io, Ganymede, Europa, Callisto, Saturn, the Saturnine Ring system, Dione, Titan, Rhea, Uranus, Neptune and Pluto.

Patterns emerge from the juxtaposition of spectra, particularly from 1.4 to 2.5 microns. By observing extrasolar planets with low resolution spectroscopy it should be possible to distinguish three classes of objects: gas planets, rocky planets, and ice planets. (We use the term planet loosely to include moons and rings as well).

Gas planets are easily identified by their strong methane absorption lines in the infrared. Ice planets and rock planets have smoother spectra, but the overall slope for the two is vastly different across the near infrared. The only terrestrial planet which can not be correctly classified on the basis of its spectra alone is Venus. Venus thick CO2 atmosphere completely hides the physical surface underneath. This is why we refer to our model as a ock planet and not a terrestrial planet.

The spectrum for Earth is surprisingly similar to other rock planets, but important differences also exist. The most outstanding feature of Earth spectrum is the deep narrow oxygen absorption line at 0.76 microns. We don claim that oxygen is a requirement for extraterrestrial life, but when we look at Earth spectrum as an lien planet, the unique feature which we notice first is oxygen.

Earth also shows several water features. These are less distinct, and a number of other objects exhibit water markers either in the form of ice or water trapped in clays. The strong water absorption features around 1.4 and 1.8 microns in Earth atmosphere are probably indicative of the large amounts of water vapor found only on Earth. Unfortunately, these strong absorptions also make it difficult for ground based telescopes to observe these wavelengths.

There have been many papers published about the possibility of detecting the dramatic change in the reflectivity of green land plants which occurs around 0.7 microns, the so called vegetation ?ed edge. nbsp; This search is complicated by the presence of an oxygen absorption line at 0.69 microns. Searching for the red edge requires watching a planet for prolonged periods as it rotates and searching for changes in the slope of the spectra. Our PSL and our planet type models can quickly determine if a planet is rocky, therefore capable of supporting surface vegetation. This will identify the best planets for follow up red edge observations.

The information in the PSL will be helpful, for understanding each of the heavenly bodies individually, provide deeper insight into the nature and development of planets in general, and serve as an observational tool for interpreting the spectra of extrasolar planets as they become available. Our results show that the near infrared is particularly rich in easily obtained information about a planet nature. We hope planned planet hunter telescope satellite missions will take this into account in their design.