Earth light: Terrestrial vegetation detected in the spectrum of the earthshine

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A team including Luc Arnold, Sophie Gillet and Olivier Lardièere of the OHP-Observatoire de Haute Provence and Pierre Riaud and Jean Schneider of the Paris Observatory, detected for the first time the color characteristic of the terrestrial vegetation in the "Earthshine" (i.e. the dark part of the Moon only hit by the Earth light).

Earth seen from the Moon at the epoch of the observations of June 24 2001 (This simulation is not an image calculated from the observations of earthshine. It is based simply on the relative positions of the Sun, the Moon and the Earth, represented here without clouds). Image computed by Home Planet 3, John Walker http://www.fourmilab.ch/homeplanet/homeplanet.html

To observe the light of the Earth by reflexion on the Moon enables us to characterize the aspect of our planet as seen by a remote observer. We need this observation to prepare the detection of extra-solar planets similar to the Earth.

The color of the Earth by reflexion on the Moon, detected for the first time, is characterized by an abrupt increase in intensity in the spectrum starting from 750 nm in wavelength (cf figure 1).

Two characteristics are clearly seen:

1 / It is especially intense towards the blue, below 600 nm. It is simply the reflection of the blue color of the sky. Thus, we confirm that the Earth is indeed a "blue planet". [Let us remind that the blueness of the sky is due to the different amount of light scattering in the various colors: among the white light of the Sun, blue is more scattered (deviated) than red by the molecules of the atmosphere: the red rays of the Sun carry on their straight path while the blue ones turn towards the observer.]

2 / It shows a clear increase in intensity towards the long wavelengths starting from 725 nm. This increase is characteristic of the average spectrum of the terrestrial vegetation and is interpreted as being a reflexion of the color of the vegetation on the Moon.

The increase longwards of 750 nm is characteristic of the average spectrum of the terrestrial vegetation and is interpreted as being a reflexion of vegetation color on the Moon.

The observations were made from April 2001 at the 80 cm telescope of the OHP. At the time of the observations, in the morning the Moon sees Asia and in the evening it sees America (Northern and Southern). Similar observations were made at the Steward Observatory (Arizona) from June 2001 (see here). At the time of these observations, the Moon saw primarily the Pacific Ocean and a small portion of Asia. The long-term purpose of these observations is to test the detectability of the vegetation on the extra-solar planets by the space missions of the DARWIN type, modified for observations in visible light, in project for years 2015. Why not be satisfied with the direct observation of the terrestrial vegetation seen from satellites of the SPOT type or others? Because those do not see the Earth from a remote enough point, thus do not have an instantaneous global vision of it. Moreover they have only a quasi vertical vision of the terrestrial ground and thus do not take account of all angles of sight, and of the effects of absorption due to the oblique crossing of the atmospheric layers. So the conditions of observation similar to that of a remote extra-solar planet are not met. On the contrary, the Moon being far enough from the Earth, it sees it overall; moreover the roughness of its surface makes that it reflects in all the directions the terrestrial light, thus mixing the luminous rays resulting from all the terrestrial areas, which makes it possible to have the average color of the Earth.

Moreover, the Earth is the only planet of the solar system to have the blue color characteristic of its atmospheric
scattering; the atmosphere of Mars is too tenuous and that of Venus too opaque to have this blue color. This color will thus be a simple, but invaluable indicator for the studies of exobiology, of the state of the atmosphere of an extra-solar planet.

Reference


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