Back light scattering is a single event

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Light scattering is traditionally considered a multievent diffusive process, where light is scattered several times within the scattering material before it reaches an observer. This process leads to Lambert's cosine law. The law states that the scattered intensity is proportional to the cosine between the illuminating light and the perpendicular to the scattering surface. The case of backscattering from a sphere leads to maximal light at the sphere center, which dwindles to zero at the periphery by the cosine function.

With all that, one looks at the full moon, preferably after moonrise, and sees a uniform moon. The moon image does not comply with Lambert's law.

In 1905, Umov [1] discovered that light scattered from dark surfaces conserved light polarization. In this case, the scattering must be a single event because the polarization direction is lost in multiple scattering steps.

The polarization of the scattered light was tested on a minimal optical bench using a setup consisting of a quartz halogen lamp, first linear polarizing filter, scattering surface, second linear polarizing filter, and camera. Polarized light illuminates the surface, and the backscattered light is observed using a camera through a second polarizer. It is also observable by eye.

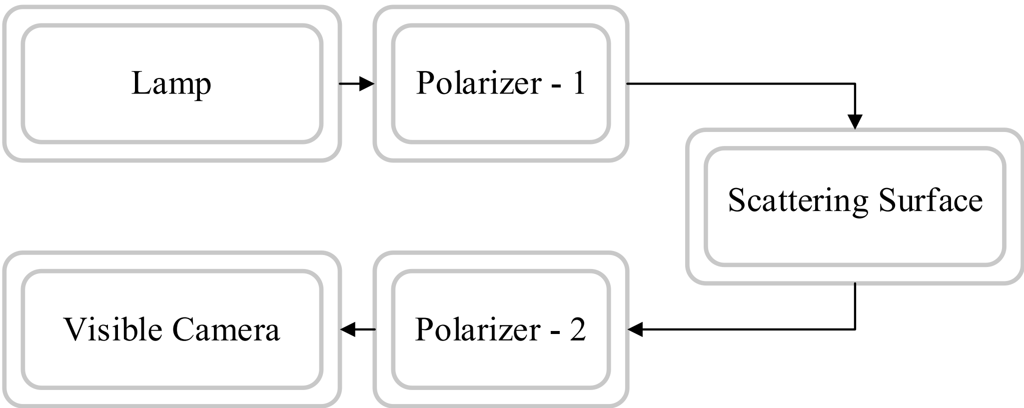

Figure 1: Setup for observing the polarization conservation.

Light is first observed with parallel polarizers, and then one polarizer is rotated by 90°. The reduction in light passing through the crossed filters indicates polarization conservation. No change in light indicates the absence of polarization conservation.

Testing on many white surfaces, such as cardboard, paper, and white walls, produces marginal effects or no effect at all. Similar black surfaces exhibited a strong effect in all cases. No polarization was observed under unpolarized illumination.

Figure -2: Polarization conservation in illuminated dark stone. (a) between parallel polarizers, (b) between cross polarizers.

Figure 2 shows an image of light scattered from a dark stone in the garden. (a) With parallel polarizers (b) with crossed polarizers. Polarization conservation is evident, and it is a positive indication of a single scattering event because the polarization is lost in multiple events.

The moon surface is dark, and its rocks are not different from the tested garden stones. Therefore, the polarization conservation in them is a positive indication that the light scattered back from the Moon is a single event. NASA has samples of moon rocks, and their polarization conservation can be readily observed.

In single-event scattering, all polarizing dipoles are driven by a single light wave from the sun and oscillate perpendicular to it. Therefore, the scattered backlight (Mie scattering) is coherent and independent of the surface inclination, yielding constructive interference in the backward direction and amplifying the backward signal. This signal is the opposition effect. The uniform image of the full moon and the opposition effect, considered separate effects, are the same phenomenon.

The scattering response of the material is calculated by summing the single events and all multiple events with their weights. Another approach is to devise an analog computer. In this case, the moon is a readymade computer. This indicates that single-event scattering is the dominant contributor because multiple events contribute to Lambert scattering.

Uniform or nearly uniform celestial full images are quite common on planets and their moons. Terrestrial images observed in a similar geometry are also nearly uniform. No observed single image obeys Lambert's cosine law. [2]

Of particular interest is the "Blue Marble" the full Earth image that includes areas of gas clouds, liquid water, and solid land. Each phase is uniform separately and does not depend on surface inclination.

References:

[1] Umov effect in single-scattering dust particles: effect of irregular shape, E. Zubko, A. J. Weinberger, N. Zubko, Y. Shkuratov, and G. Videen, Optics Letters, Vol. 42(10), pp. 1962-1965 (2017)

[2] The Sun and the Moon a Riddle in the Sky
https://arxiv.org/pdf/1808.01024v5
https://arxiv.org/abs/1808.01024

https://www.researchgate.net/publication/341370146_The_Sun_and_the_Moon_a_Riddle_in_the_Sky

Model Images for Regolith Light Scattering
https://www.researchgate.net/publication/367361566_Model_Images_for_Regolith_Light_Scattering