Modelling the degree of linear polarization (DoLP) of the Moon's light with a Cimel CE318-TP9

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Although the surface of the Moon is illuminated by non-polarized solar radiation, the scattered light from the Moon becomes polarized to some degree of linear polarization (DoLP), which varies with the Moon's phase angle. A notable feature of this variation is the wide negative polarization branch that appears at small phase angles [1]. The interpretation of polarimetric measurements taken from the Moon and other atmosphere-less celestial bodies is still not entirely clear [1].

Polarimetric observations of the Moon's light are rare, and the lunar calibration community has shown great interest in deriving a model using ground-based polarimetric observations performed with a Cimel CE318 radiometer, the standard instrument of the AERONET network.

Continuous CE318-TP9 photometric measurements have been conducted since March 2018 at the Izaña and Pico Teide AERONET (Aerosol Robotic Network) stations, situated in Tenerife (Spain) at altitudes of 2373 and 3555 meters above sea level, respectively. These measurements were carried out as part of the LIME project [2], which is funded by ESA and aims to derive a lunar irradiance model with sub-2% radiometric uncertainty. The polarization capabilities of the CE318-TP9 version, equipped with three linear polarizer filters oriented at 0, 60, and 120 degrees, enable us to expand the objectives of the LIME project to include the development of a simplified model for the linear polarization of lunar reflected light and its dependence on phase angle.

CE318-TP9 raw polarized observations will be utilized to retrieve the DoLP for the Moon, employing a linear regression model defined per band. This model comprises two distinct 4th-degree polynomial functions: one for positive phase angles and one for negative phase angles.

References

[1] Optical measurements of the Moon as a tool to study its surface, Y. Shkuratov et al., 2011.

[2] LIME: Lunar Irradiance Model of ESA, a new tool for absolute radiometric calibration using the Moon, Toledano, et al.: Atmos. Chem. Phys., 24, 3649–3671, https://doi.org/10.5194/acp-24-3649-2024, 2024.

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