Theoretical assessment of the lidar polarizing sensitivity

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A good paper, each step of the theoretical modeling is reasonably well explained except the definition of the Stokes vector used and consequently the corresponding Muller matrices.

Following Del Guasta et al. [1]; most of polarization lidars use linearly polarized light and a linear depolarization ratio defined as

$$\delta_{lin} = \frac{I_{\perp}}{I_{//}} = \frac{S_0 - S_1}{S_0 + S_1} . \qquad (1)$$

To define circular depolarization, we have to take into account the fact that light with a left circular polarization incident on a spherical particle is changed to right circular polarization when it is backscattered. In comparison, for an incident linearly polarized light, the polarization state is preserved although the electric field sign is changed. To maintain a definition consistency between the linear and circular depolarization ratios, the depolarization ratios must be a measure of the backscattered signal polarization departure. So, the circular depolarization in conformity with [2] by using

$$\delta_{cir} = \frac{I_{C\perp}}{I_{C//}} = \frac{S_0 + S_3}{S_0 - S_3} . \qquad (2)$$

However, as stated in Eq. 2.23, it is the depolarization parameter that is truly a measure of the depolarisation caused by the aerosol independently of the polarization state (linear or circular) of the lidar. I understand depolarisation ratio measurement inherited from strong a legacy; at the minimum a reference to Gimmestad [3] (see at the bottom a list of pertinent references) and a short paragraph explaining how to transform depolarisation ratio to depolarisation parameter is required. Your definition of the Muller matrix for randomly oriented is inconsistent with the one use the references above:

$$M_{atm} = p(180^o)\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1-d & 0 & 0 \\ 0 & 0 & d-1 & 0 \\ 0 & 0 & 0 & 2d-1 \end{pmatrix}$$

Unless ‘a’ the polarisation parameter is define as ‘1-d’, ‘d’ being the depolarisation parameter. It needs to be clarified.

The work and references are highly EARLINET center:

> On the effect of mirror on depolarization measurement reference should be made to Bissonnette [4].
>
> On measurements techniques that cancel out most of system depolarisation artifacts, reference to Cao [5] should be of interest.

In the following some specific recommendations;

The figure caption for figure 1 is anemic; identify each component; if I understood correctly, R should be identify as a lambda/2 waveplate in the text and in the figure caption.

In eq 2.1, why 2 alpha instead of alpha.

For Eq. 2.2 a reference is required.

In Eq. 2.13, why 2 beta instead of beta

For Eq 2.23, it should be specify it is the scattering matrix for randomly oriented particle; reference to Michenko [2], Gimmestad [3] and Roy [6] should be made;

Eq. 2.27, how Gs and Hs are obtained?

The authors should know that the average reader what to have a good idea of the meaning of a graphic by simply reading the caption. So for figure 3, 4, 5, 6, 7 and 8 spell out clearly all the meaning of variables. It is important.

Recommended references

[1]. M. Del Guasta. et al., “Use of polarimetric lidar for the study of oriented ice plates in clouds,” Appl. Opt. **45**, pp. 4878-4887 (2006).

[2]. M.I. Mishchenko, J.W. Hovenier, “Depolarization of light backscattered by randomly oriented nonspherical particles,” Optics Letters 20, pp.1356-1358 (1995).

[3]. G. G. Gimmestad, “Reexamination of depolarization in lidar measurements,” *Appl. Opt*. 47, 3795-3802 (2008).

[4]. L.R. Bissonnette, G. Roy and F. Fabry, “Range-height scans of lidar depolarization for characterizing the phase of clouds and precipitation,” J. Atmos. and Oceanic Tech., 18, 1429-1446 (2001).

[5]. X. Cao, G. Roy and R. Bernier, “Lidar polarization discrimination of bioaerosols,” *Opt. Eng. 49(11) 116201-1-12* (2010).

[6]. G. Roy , X. Cao, and R. Bernier, “On linear and circular depolarization lidar signatures in remote sensing of bioaerosol – experimental validation of the Mueller matrix for randomly oriented particles,” *Opt. Eng. xx(11) 116201-1-12* (2011).