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SEPARATING MIE SCATTERING FROM RAYLEIGH WITH A BISTATIC IMAGING LIDAR

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In a previous paper[1], we reported abilities of a bistatic imaging lidar using a high sensitive cooled-CCD camera which could give a range resolution by processing image data of a laser beam trajectory. One of features of a bistatic lidar is to make measurement at various scattering angles. In this presentation, we discuss the possibility of aerosol detection without Rayleigh scattering signals with the bistatic imaging lidar.

In general, the differential scattering cross section $d\sigma/d\Omega|_M$ of the TM polarized laser beam (the direction of electric field of the incident wave is parallel to the scattering plane) depends on scattering angle as given by equation (1)[2].

$$\left.\frac{d\sigma}{d\Omega}\right|_M = \frac{C}{\lambda^4}\cos\theta \qquad (1)$$

where C is physical constant, λ is wavelength of the incident light, and θ is scattering angle. It can be seen from equation (1) that the differential scattering cross section is zero at the scattering angle of 90°. This suggests that the Mie scattering signals can be separated from the Rayleigh scattering signals.

In order to confirm this relation, we have made experiments on the dependence of linear polarized laser beam on scattering angle. The schematic diagram of experiment is shown in Fig. 1. A YAG laser (SHG) was used for linear polarized light source and the scatted signal was detected by a CCD camera. The system specifications are summarized in table 1. A clean air was obtained by flowing dry nitrogen gas into scattering vessel and an air including aerosols by flowing laboratory air.

The experimental results of the scattering angle dependence of the incident light polarized parallel (TM) and perpendicular (TE) to the scattering plane are shown in Fig. 2. In the case of clean air, it is found that the results for both polarized incidents light agree with Rayleigh theory. On the other hand, in the case of air including aerosols, it can be seen that the scattered signals rapidly increase with decreasing scattering angle (<70°) due to the Mie scattering. The value obtained at scattering angle of 90° gives only Mie scattering signals without Rayleigh component. On the basis of these results, it is suggested that the scattered signal from an air including aerosols at a scattering angle of 90° gives only aerosol information.

In conclusion, this experimental result indicates the possibility of a lidar measurements separating Mie scattering from Rayleigh one when a bistatic lidar is operated at a constant scattering angle of 90°. Now we are making field experiments for measuring vertical profile of aerosols by use of the bistatic imaging lidar as shown in Fig 3.

References

[1] K.Yamaguchi, A.Nomura, Y.Saito, T.Kano, "A range-resolved bistatic lidar using a high-sensitive CCD camera", p.p.431–432, 16th ILRC abstracts of papers, 1992

[2] K.Parameswaran, K.O.Rose, B.V.Krishna Murthy, "Aerosol characteristics from bistatic lidar observations", p.p.2541–2552, No. D2, Vol. 89, J. Geophys. Res., 1984

Table 1: Specifications of system

Nd:YAG laser	surelite-10, continuum
output power	6mJ/pulse, 10pps
wavelength	532nm
Focus lens	f=500mm
Light collector	f=55mm, F=2.8, Nikon
CCD camera	C-3140, Hamamatsu Photonics
operational temperature	-30°C

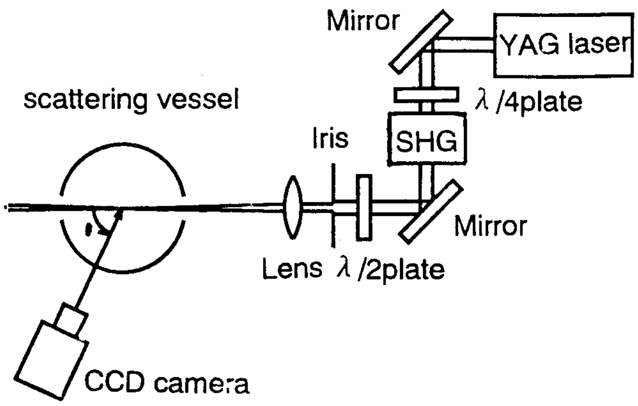

Figure 1: Schematic diagram of experiment.

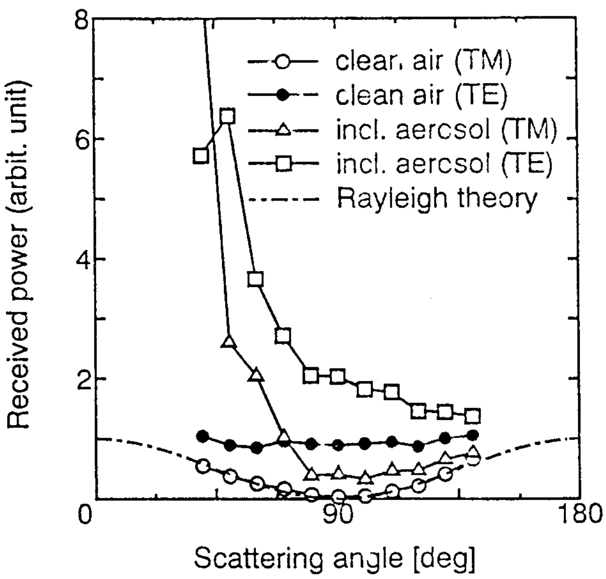

Figure 2: The experimental results of the scattering angle dependence.

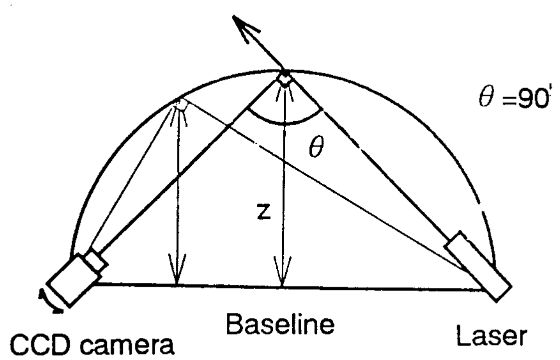

Figure 3: A plan of field experiments for aerosol measurements.