MICROWAVE AND LASER FACILITIES TO DETERMINE SCATTERING AND COLOUR SIGNATURES RELATED TO THE PHYSICAL PROPERTIES OF DUST PARTICLES

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ABSTRACT. At Bochum there exist three experimental setups for measurements of the scattering properties of dust particles. The microwave analog experiment is the best choice for systematic studies of particles in the size range between 0.5 and 10 times the wavelength (correspondig to about 0.25 to 5 µm in the optical region). The multicolour laser experiment providing electrodynamic suspension of single dust particles is optimized for studies of particles in the size range between 20 and 150 µm. Another laser experiment is designed for rapid analysis of particle mixtures in view of in-situ applications. The measuring principles of all instruments are shortly summarized.

1. MICROWAVE ANALOG EXPERIMENT

The Bochum microwave analog experiment operates at a frequency of 35 GHz, corresponding to a wavelength of 8.57 mm. The range of scattering angles is between 15° and 170°. The size range of scattering particles is between 0.5 and 10 wavelengths. The lower limit is due to the sensitivity of the receiver and error signals of the suspension mechanism, whereas the upper limit is determined by observing the far field condition. These limits correspond in the optical range ($\lambda = 0.5$ µm) to particle sizes between 0.25 and 5 µm. For further details of the equipment see Zerull, 1976. For investigations of larger particles our laser facilities have to be used.

2. MULTICOLOUR LIGHT SCATTERING EXPERIMENT

With the multicolour light scattering experiments (Fig. 1) the scattering properties of single particles of the size between 20 µm and 150 µm can be measured.

We extended our former light scattering experiment (Weiss, 1981; Weiss-Wrana, 1983) to the investigation of colour effects. A Crypton

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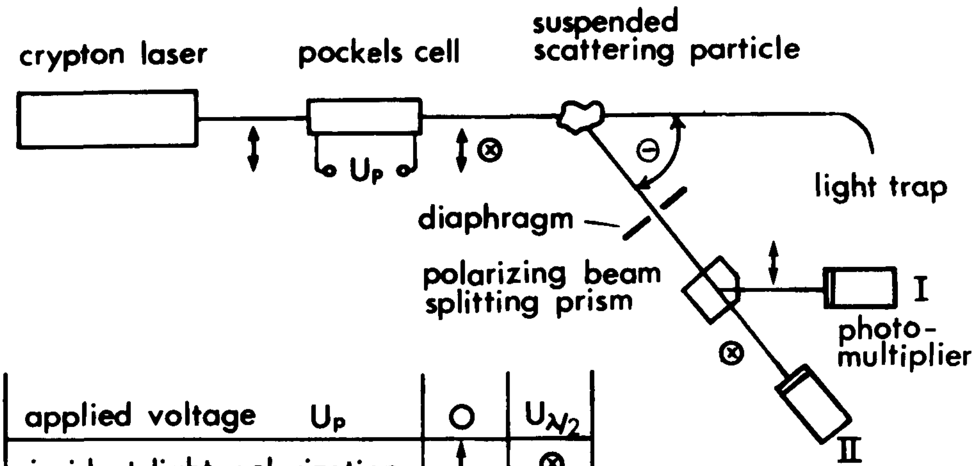
Ion laser emits blue (λ = 476 nm), green (λ = 531 nm), yellow (λ = 568 nm) and red (λ = 676 nm) light. The direction of the linearly polarized light can be turned 90° by applying the half wave voltage to a pockels cell. The charged solid particle is suspended by using the electrodynamic balance which is a superposition of a Millikan-field acting against the gravitational force and a nonuniform alternating field which has a focusing effect (Weiss-Wrana 1983). The charged particle is kept within a small region in space over a long period of time.



applied voltage U_P	O	$U_{\lambda/2}$
incident light, polarization	↕	⊗
scattered light PM I	I_{11}	I_{21}
PM II	I_{12}	I_{22}

Figure 1. Schematic diagram of the multicolour light scattering experiment.

The optical device for detecting the scattered intensity is mounted on an arm which may be rotated through an angle from 15° to 165° by a stepping motor. The scattered intensity is analyzed in the following way: A polarizing beam splitter prism (Foster prism) splits the two orthogonaly polarized components of the scattered light. Photomultiplier I and II detect simultaneously the intensity with the direction of polarization like the illuminating light and the intensity with the direction of polarization rotated by 90°, the so called "cross polarization". The polarization of the illuminating light changes periodially from perpendicularly to parallel polarized with respect to the scattering plane.

For the investigation of colour effects the measurement of the intensity of the four matrix elements can be repeated for four wavelengths. The absorption coefficient of the material mainly depends

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on the wavelength. Furthermore in the case that surface elements or building stones of agglomerates are in the same order as the wavelength effects of diffraction are expected, which result in colour dependence of both, intensity and especially of linear polarization. This will be proved by experiments in the near future.

3. PHOTOPOLARIMETER FOR RAPID PARTICLE ANALYSIS

For rapid analysis of particle mixtures a special photopolarimeter was built up, restricted to measurements at only 3 scattering angles, as illustrated in Fig. 2.

One sensor at 5° measures the near forward scattered intensity, which is important for size determination. The sensors at 90° measure intensity, linear polarization, and cross polarization in order to discriminate different types of particles. For the same reason a third sensor at 175° is provided which measures the degree of enhancement of backscattering. For details see Zerull, 1982.

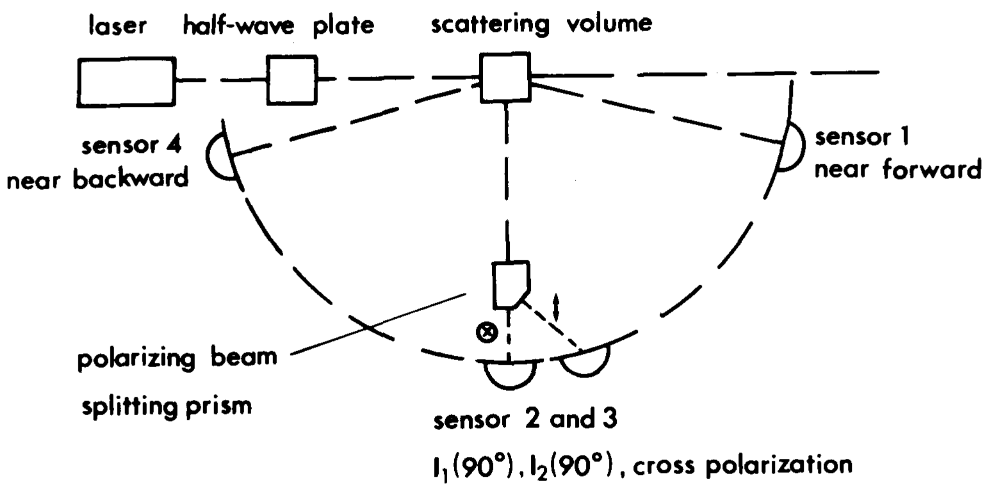

Figure 2. Schematic diagram of the particle analyzing photopolarimeter.

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