Classification of Single Particle Optical Scattering Patterns

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Some experimental methods such as *TAOS* [1] are capable of collecting the light scattered by single airborne particles in the micrometer size range when the latter are illuminated by a triggered laser source (wavelength = 532 nm). Data consist of intensity patterns (Fig. 1) collected in a suitable solid angle at a high rate (>100 patterns per second).

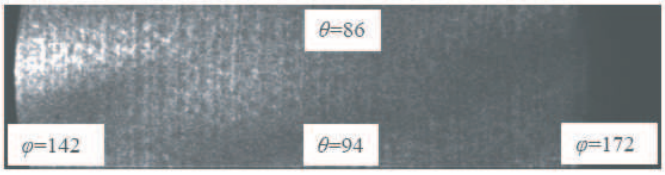

Figure 1.

Typical scattering pattern (***a07b03b***) produced by an aerosol particle from skid braking tests on a car racing track. Aerosol was collected by an 8-stage impactor device, re-suspended in water and injected into the *TAOS* apparatus.

There is no known theoretical method capable of dete rmining the particle size, shape and complex refractive in dex from such incomplete data. As a consequence a heu ristic algorithm was developed, which relies on spectrum enhancement for feature extraction and on principal com ponents (*PC*) analysis for classification. Spectrum en hancement of an image includes spatial differentiation, possibly of fractional order, followed by non-linear transformations aimed at separating structure from tex ture. *PC* analysis maps each input pattern into a point in the *PC* space. The classifier was trained with the aim of maximizing discrimination between suitable sets of *TAOS* patterns e.g., those labelled 1 and 2 in Fig. 2. New sets of patterns e.g., those from skid braking aerosol particles (labelled 4), were then submitted to the classifier. The result is also displayed by Fig. 2. From the PCs of a given pattern one can estimate how much the shape of the particle deviates from the spherical one.

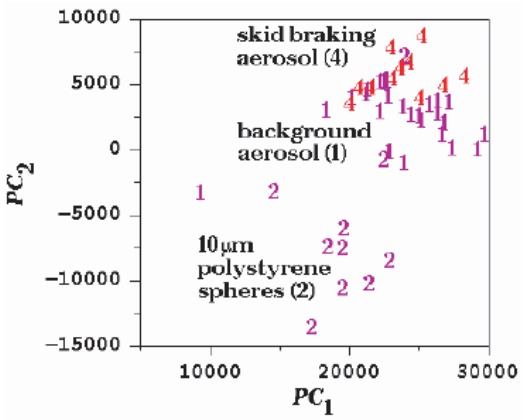

Figure 2: Classification of TAOS patterns from environmental aerosol particles: train on{1,2}→recognize{4}, $142.88432 < \varphi < 168.517815$, $86.083414 < \vartheta < 93.948435$, Exec = w05, $\delta = 45$deg, $p = 2.2$, $d + 1 = 10$, axis = u_1, $0 <= |u| <= 255$, dim[{PC}] = 10.

REFERENCES

1. Holler, S., S. Zomer, G. F. Crosta, Y.-L. Pan, R. K. Chang, and J. R. Bottiger, "Multivariate analysis and classification of two dimensional angular optical scattering (TAOS) patterns from aggregates," *Applied Optics*, Vol. 43, No. 33), 6198–6206, 2004.