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Autor(en): **Lorusso, G.F. / Minafra, A. / Capozzi, V.**

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CORRELATION SPECTROSCOPY OF SOLID MICROPARTICLES SUSPENDED IN ACQUEOUS MEDIUM

G.F. Lorusso, A. Minafra, V. Capozzi, D. Loiacono
Dipartimento di Fisica, Universita' di Bari and Unita'
CISM-GNSM di Bari,Via Amendola 163, 70126 Bari, Italy

To study the optical and morphological properties of solid microparticles, the tecnique of the intensity fluctuation spectroscopy can be used [1,2].A correlator set up employing a personal computer has been carried out. This apparatus is able to analyze the intensity fluctuation of the scattered light by microparticles suspension, at room temperature, illuminated by a He-Ne laser. We have used Polystirene spheres sizing from 0.1 to 0.2 μm for the calibration of the correlation system. From the analysis of the correlation function it is possible to obtain the size distribution of suspended solid particles.

The theory of intensity fluctuation can be carried out by using a model developed by Einstein and Smoluchowski in 1908, which assumes an homogeneus medium whith dielectric constant fluctuation

$$\epsilon(\mathbf{r},t) = \epsilon_o\mathbf{I} + \delta\epsilon(\mathbf{r},t)$$

The theory gives scattered electric field and scattered intensities. So, information on the medium inhomogenity (i.e. $\delta\epsilon$) can be achieved experimentally by measuring the spectral density of the scattered light $I_s(\mathrm{q},w)$, or, alternatively, by analizing the fluctuation of integrated scattered intensity $I_s(\mathrm{q})$. This last approach is developed by measuring the intensity correlation function $g^{(2)}$, which is connected to the field correlation function $g^{(1)}$ by the Siegert relation

$$g^{(2)} = (g^{(1)})^2 + 1$$

Note that $g^{(1)}$ is the Fourier transform of the spectral density.

In the particular case of spherical particles suspended in a liquid $g^{(1)}$ is given by

$$g^{(1)} = exp[-q^2Dt]$$

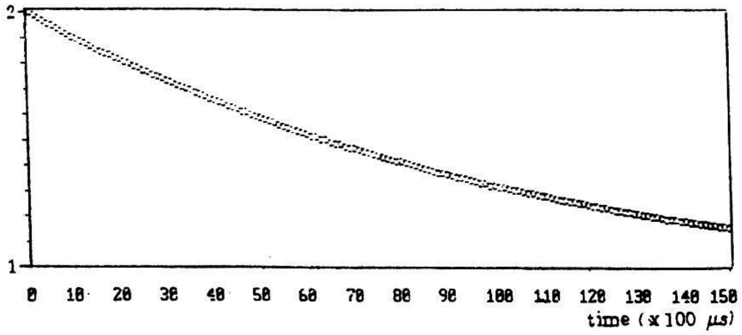

FIG.1 Correlation function $g^{(2)}$

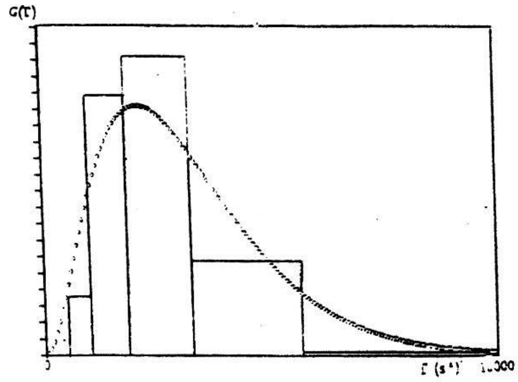

FIG.2 Histogram analysis

where $q = 4\pi(n/\lambda)sen\theta/2$ and $D = (k_B T_m)/(6\pi\eta a)$, in which n is the medium refractive index, λ the laser wavelenght, θ the angle of the scattered photons, a the particle radius, T_m the medium temperature and η its viscosity. The intensity correlation function $g^{(2)}$ can be obtained by measuring the photon counting correlation function

$$g^{(2)} = \frac{< n(0,T)n(\tau,T) >}{< n >^2}$$

where T is the sampling time and τ is the delay time. By dividing the measuring time in r channels of duration T, $g(2)$ is written as

$$g_T^{(2)}(rT) = \frac{N \sum_N n_T(rT)n_T(0)}{[\sum_N n_T(0)]^2}$$

The correlation function $g^{(2)}$ obteined for 215 nm nominal diameter particles is shown in fig.1, where T is 100 μs. The analysis has made on $6 \cdot 10^5$ counts. The obteined diameter is d=209.38 nm, $\Delta d/d$=0.02.

Determination of size distribution for particles of different diameters requires an analysis of experimental risults using a convolution integral of the type

$$g^{(1)} = \int G(\Gamma)exp(-\Gamma t)d\Gamma$$

where $G(\Gamma)$ is the size distribution of particles. $G(\Gamma)$ can be approximated by various methods; one of the most effective is the histigram one [3]. The software necessary for the histogram analysis has been developed and tested by using a computer simulated size distribution. A typical result is shown in fig.2.

[1] Berne B.J.,Pecora R."Dynamic Light Scattering",Wiley and Sons
[2] Chu B."Laser Light Scattering",Academic Press
[3] Fletcher G.C.,Ramsay D.J.,Optica Acta, 1983, 30, 8, 1183