

## Total intensity and quasi-elastic light-scattering applications in microbiology

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The application of laser light-scattering techniques to the study of whole intact micro-organisms provides certain advantages and disadvantages compared with the study of smaller macromolecular assemblies and macromolecules. The advantages include the greater signal to noise ratio (i.e. the 'dust problem' is not as severe), the correspondingly smaller concentrations generally required to give a sufficient signal and, since the wavelength of the incident laser light can be of the same order as the maximum dimension of the microbe, potential internal structural information. On the other hand, interpretation of the scattering records can be rendered opaque because of the complexity of the analyses involved, and for the larger or denser microbes, sedimentation phenomena can also obscure this interpretation. Nonetheless, light-scattering methods can provide a powerful probe into the structure and dynamics of microbial systems, a probe which unlike electron microscopy, is non-destructive [1].

For smaller microbes like many spherical plant viruses, the simpler Rayleigh-Gans-Debye (as opposed to Lorenz-Mie) theory is applicable and it is possible from total intensity light scattering to use for example the 'Zimm Plot' method for molecular mass, size and non-ideality information. A combination of this information with intrinsic viscosity data can be used to model the gross confor-

mation in terms of a general ellipsoid [2]. Hydrodynamic modelling based on quasi-elastic light scattering for particles in this size range is also in excellent agreement with independent methods (based on e.g. sedimentation) [3].

The classical work on the use of dynamic light scattering for studying the motility and chemotaxis of bacteria has been well described; total intensity light scattering also features strongly now with the advent of flow cytometers [4]. We would like to draw attention here, however, to the use of the total intensity method for modelling the structure of isolated spherical bacterial spores – and the problems – and the use of quasi-elastic light scattering for following the dynamics of suspensions of bacterial spore ensembles during germination [1] and also during destruction by disinfectants [5].

1. Harding, S. E. (1986) *Biotech. Appl. Biochem.* **8**, 489–509
2. Harding, S. E. (1987) *Biophys. J.* **51**, 673–680
3. Harding, S. E. & Johnson, P. (1985) *Biochem. J.* **231**, 549–555
4. Steen, H. B. (1990) *Cytometry* **11**, 223–230
5. Molina-Garcia, A. D., Harding, S. E., de Pieri, L., Jan, N. & Waites, W. M. (1989) *Biochem. J.* **263**, 883–888

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## Quasi-elastic light scattering studies of membrane structure and dynamics

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For some years we have been studying various simple model membrane systems using light scattering from thermally excited capillary waves, leading to several advances concerning both structure and dynamics. The systems studied have included monolayers at the air-water interface and black lipid films.

One significant advance has come from the realization that the membrane properties probed by light scattering are local averages over the area illuminated by the laser beam. In this way phase separation within the membrane has been identified from fluctuations in the light scattering data [1, 2]. It

has proved possible, in favourable cases, to use this to investigate the sizes of phase-separated domains. The scale of these domains is somewhat controversial; our light-scattering estimates are in excellent accord with data reported in the literature for other methods which do not involve addition of molecular probes to the membranes. Recent technical advances making it possible to acquire statistically significant correlation functions very rapidly [3], should permit such studies to be extended to more rapid fluctuations owing to smaller domains. At the molecular scale some structural information has been gleaned from interference between scattering