

16. Photon Correlation Spectroscopy and Applications

Academic and Research Staff

Prof. S.-H. Chen

Graduate Students

D. Bendedouch, Y.S. Chao, M. Kollarchyk, C. Mizumoto

16.1 Research Program

National Science Foundation (Grant PCM78-15844)

Sow-Hsin Chen

A high-resolution spectroscopic technique based on scattered light intensity fluctuation measurement has been in use for some time. Our method is a variation of the digital time-domain pulse correlation technique using a 256-channel clipped correlator developed in the laboratory. The correlator-multichannel memory system is controlled by a PDP 11/MINC computer system which is capable of high-speed data acquisition and analysis necessary for the study of time-varying phenomena.

We have developed theoretical methods to calculate quasi-elastic light-scattering spectra from cells undergoing Brownian motions or self-propelled motions in liquid media. The methods have been successfully tested with a model bacterium *Escherichia coli*, and applicability of the model calculation to cells of dimensions of the order of a micron has been ascertained. The photon correlation technique is further developed to incorporate a flow method which permits us to study time-dependent phenomena with a temporal resolution greater than the time taken for the accumulation of the correlation function. The combined theoretical and experimental progress now enables us to perform the following three categories of experiments:

1. Motility characteristics of bacteria in response to external stimuli such as light and chemical
2. Study of traveling-band formation of bacteria as a result of chemotaxis
3. Study of conformational change in globular protein induced by disruption of hydrophobic interactions
4. Study of Dynamics in strongly interacting colloids.

Recently another powerful technique has been brought into our study of macromolecular solutions.

Small angle neutron scattering has been demonstrated by us to be an exceptionally versatile tool for studies of structure and interaction in strongly interacting colloidal solutions. Active experimental program is being pursued at small angle scattering centers at Oak Ridge and Brookhaven National Laboratory.

Publications

- Holz, M. and S.-H. Chen, "Structural Effects in Quasi-Elastic Light Scattering from Motile Bacteria of *E. Coli*," *Appl. Opt.* 17, 1930 (1978).
- Holz, M. and S.-H. Chen, "Rotational-Translational Models for Interaction of Quasi-Elastic Light Scattering Spectra of Motile Bacteria," *Appl. Opt.* 17, 3197 (1978).
- Holz, M. and S.-H. Chen, "Quasi-Elastic Light Scattering from Migrating Chemotactic Bands of *E. Coli*," *Biophys. J.* 23, 15 (1978).
- Holz, M. and S.-H. Chen, "Tracking Bacterial Movements Using One-Dimensional Fringe System," *Opt. Lett.* 2, 109 (1978).
- Holz, M. and S.-H. Chen, "Spatio-Temporal Structure of Migrating Chemotactic Bands of *E. Coli* - I. Travelling Band Profile," *Biophys. J.* 26, 243 (1979).
- Kotlarchyk, M., S.-H. Chen, and S. Asano, "Accuracy of Rayleigh-Gans-Debye Approximation for Computing Light Scattering Properties of Diffusing and Motile Bacteria," *Appl. Opt.* 18, 2470 (1979).
- Wang, P. and S.-H. Chen, "Quasi-Elastic Light Scattering from Migrating Chemotactic Bands of *Escherichia Coli* - II. Analysis of Anisotropic Bacterial Motions," *Biophys. J.* 36, 203 (1981).
- Chen, S.-H. and Hallett, F.R., "Determination of Motile Behavior of Prokaryotic and Eukaryotic Cells by Quasi-elastic Light Scattering," *Quarterly Rev. Biophys.* 15, 1 (1982).
- Tanner, R.E., Herpigny, B., Chen, S.-H. and Rha, C., "Conformational Change of Protein/SDS Complexes in Solution - A Study by Dynamic Light Scattering", *J. Chem Phys.* 76, 3866, 1982).
- Benedouch, D., Chen, S.-H., Kochler, W.C. and Lin, J.S., "A Method for Determination of Intra- and Inter-Particle Structure Factors of Macroions in Solution from Small Angle Neutron Scattering", *J. Chem. Phys.* 76, 5022 (1982).
- Kotlarchyk, M., S.H. Chen, and J.S. Huang, "Temperature Dependence of Size and Polydispersity in a Three Component Microemulsion by Small Angle Neutron Scattering," *J. Phys. Chem.* 86, 3273 (1982).