

## B I O - D A T A



1. Name : **DR. MUKUL KUMAR MITRA**
2. Nationality : **INDIAN**
3. Date of Birth : **March 18, 1958**
4. Profession : **Associate Professor in Physics**
5. Affiliation : **Bangabasi Morning College**  
**19, Rajkumar Chakraborty Sarani**  
**Kolkata – 700 009, INDIA**
6. Marital Status : **Married**

7. Educational Qualification :-

Examination	Year	Board/University	Major Subjects taken	Division/Class
Higher Secondary (Science)	1975	West Bengal Board of Secondary Education	English, Phys., Chem., Math., Biology	1 <sup>st</sup> Division
B. Sc. (Physics Honours)	1979	North Bengal University, India	Phys. (Honours) Mathematics Chemistry	1 <sup>st</sup> Class
M. Sc. (Physics)	1981	North Bengal University, India	Physics (Solid State Physics as Special)	1 <sup>st</sup> Class
Ph. D. (Science)	1988	North Bengal University, India	<b>Liquid Crystal</b>	***** *****

## 8. Research Experience :

### ***A. Pre-doctoral :- 1982-1986***

- i) Title of Thesis : ***Determination of Order Parameter of Liquid Crystals by X-ray, Optical and Magnetic Birefringences Studies.***
  
- ii) Name and address : Professor Ranjit Paul  
Of Supervisor Department of Physics  
North Bengal University  
Siliguri, Darjeeling  
INDIA.
  
- iii) Fabrication of : ***A Sensitive Electro-magnetic Balance of Faraday-Curie Apparatus Type for Diamagnetic Susceptibility Materials.***

### **Brief Write-up of the Works**

In this period I had investigated a number of liquid crystalline materials including homologous series by X-ray Diffraction, Optical and Diamagnetic Anisotropy techniques to determine the orientational order parameters  $\langle P_2 \rangle$  and  $\langle P_4 \rangle$  (from X-ray only) at different temperatures and in different mesophases. The purpose of this work was to compare experimental results with different mean field theories and to justify the different assumptions involved in different techniques. In addition to the order parameters I also determined some other properties like inter-molecular distance, apparent molecular length (for nematics), layer thickness (for smectics), short-range correlation length and molecular association in mesophases by X-ray diffraction method. From X-ray diffraction I could also detect a second order transition order transition in the smectic B phase in one sample.

In optical birefringences technique, the refractive indices ( $n_o, n_e$ ) and density of the liquid crystalline materials have been measured to get the optical polarizabilities ( $\alpha, \alpha_e$ ) assuming both isotropic and anisotropic internal field models and hence order parameter  $\langle P_2 \rangle$  as a function of temperature. In course of this work I could detect anomalous behavior of refractive index ( $n_o$ ) and density values of a compound by this technique and confirmed with X-ray diffraction data. The  $\langle P_2 \rangle$  values have been found to be suffered much deviation from the mean field theories near clearing temperature.

In the diamagnetic anisotropy studies I measured the diamagnetic susceptibilities ( $\chi_o, \chi_e$ ) of the liquid crystal samples at different temperatures by an **instrument designed and fabricated by myself**. A very sensitive electro-magnetic balance had been fabricated for this purpose. The experimental susceptibility values and the density data were analyzed to obtain the orientational order parameter  $\langle P_2 \rangle$ . Calculation of order parameter in this technique is very straightforward and involved no internal field problem.

In general order parameter values  $\langle P_2 \rangle$  obtained from X-ray diffraction method are slightly higher than those obtained from other two methods. This apparent contradiction may be the result of different types of approximations and averaging involved in calculating orientational order parameter from experimental data obtained from X-ray studies in one hand, and optical birefringence and magnetic susceptibility measurements on the other hand. Besides, in case of X-ray diffraction the micro structure of the samples is involved whereas in cases of the other two methods the macro structure is in the picture. So the short range ordering may influence the  $\langle P_2 \rangle$  values obtained from X-ray diffraction.

## **B. Post-doctoral Research :-**

### **i) 1987 to 1989 :**

At North Bengal University, India in collaboration with Professor Ranjit Paul and Dr. (Mrs.) Sukla Paul in the field of Liquid Crystal under my **Minor Research Project sponsored by University Grants Commission, New Delhi, India**.

### **Brief Write-up of the Works**

During this period I had investigated a homologous series possessing Smectic-A (Sm-A) phase by optical birefringence technique. The experimental order parameter values in the smectic-A phase were compared with McMillan's mean field theory for Sm-A phase. The corresponding software for calculations following McMillan's theory had been developed in this period. The experimental results showed a pronounced odd-even effect in this series. In another compound (CBOOA) I could observe a first order transition from Sm-A to nematic phase by our density and refractive index data. Besides, I had carried out X-ray diffraction and magnetic anisotropy studies on some compounds during this period. Moreover, I could do some computational works on two homologous series of nCB and nOCB from their refractive index data to observe odd-even effect in their order parameter values.

### **ii) 1990 to 1996 :**

In the Department of Spectroscopy, Indian Association for the Cultivation of Science (IACS), India in collaboration with Dr. Subir Kumar Roy in the field of Dielectric Properties Studies on Ferroelectric and Ordinary Liquid Crystalline Materials.

ALSO

At Bhabha Atomic Research Centre (BARC), Trombay, India in collaboration with Dr. (Mrs.) K. Usha Deniz and Dr. S. K. Paranjpe of Solid State Physics Division in the field of Neutron Scattering Studies on Liquid Crystal Binary Mixtures by getting one ***Project from Inter-University Consortium for Department of Atomic Energy Facilities, Indore, India.***

### **Brief Write-up of the Works**

In the **Department of Spectroscopy, IACS** the dielectric properties of ferroelectric and ordinary liquid crystalline materials had been studied. We studied here the dipole-dipole association for two ordinary liquid crystalline samples by measuring dielectric constant in para-xylene solvent at different concentrations. The results in terms of Kirkwood correlation factor ( $g_1$ ) suggest that the molecular association depends on the molecular shape and polarizability anisotropy of the system. Besides, the dielectric properties of two ferroelectric liquid crystal mixtures of low spontaneous polarization had been studied with and without D.C. bias voltage, frequency and cell thickness. The well-known Goldstone relaxation mode in the smectic-C\* (Sm-C\*) phase and soft mode in the smectic-A (Sm-A) phase were observed. In one of the two samples we could observe an unknown relaxation mode. The relaxation frequencies, dielectric strength and the rotational viscosity (Goldstone mode only) had been determined with and without D.C. bias field.

In **Bhabha Atomic Research Centre** I had investigated two types of liquid crystal binary mixtures showing, (i) re-entrant nematic phase and (ii) injected smectic-A phase by neutron scattering technique. The purpose of this study was to know how the short range correlation length ( $\xi$ ) perpendicular to the director would change with the change of composition i.e. in different phases.

#### **c. Post Doctoral Research in abroad : STA Fellow.**

(From October, 1996 to March, 1998)

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|---------------------------------|---|
| a) Sponsored by                 | : <b><i>Japan International Science and Technology Exchange Center (JISTEC), JAPAN</i></b>  |
| b) Name and address of the Host | : <b><i>Professor Akihiro Abe<br/>Department of Industrial Chemistry<br/>Tokyo Institute of Polytechnics<br/>1583 Iiyama, Atsugi-shi<br/>Kanagawa 243-02, JAPAN</i></b> |

### **Brief Write-up of the Works**

During the of STA Fellowship I have carried the following research works in Tokyo Institute of Polytechnics, Atsugi, Kanagawa, Japan :

The phase diagrams of the transition for solutions of poly ( $\gamma$  - benzyl L – glutamate ) [PBLG] ( $M_w = 110K, 69K$  and  $26K$ ) in the mixed solvents comprising dichloroethane (DCE) and dichloroacetic acid (DCA) have been constructed. In most cases the ratio of DCE : DCA = 20 : 80, w/w was maintained but other ratios of DCE : DCA were also used. Around the room temperature, PBLG exists in the  $\alpha$ -helical form, and thus a lyotropic system changes in the order — isotropic, biphasic and liquid crystalline phases with increasing concentration of PBLG. At lower temperature, PBLG tends to take up a random-coil form and the system becomes isotropic over the entire range of concentration.

$^1H$  and  $^{13}C$  NMR techniques were employed to elucidate the molecular mechanism of the transition of representative mixtures chosen from the phase diagram. The resonance peaks due to amide- and  $\alpha$ -proton as well as  $\alpha$ -carbon are sensitive to the backbone conformation. For all the mixtures investigated, the signal arising from the helix and coil segments were found to co-exist in the intermediate transition region, suggesting that the rate of interconversion between the two segments are slow relative to the NMR time scale.

By using amide – deuterated PBLG, the rate of deuterium – proton exchange rate was also investigated in all the characteristic regions, i.e.,  $\alpha$ -helix, coil and intermediate transition states. The activation energies in the helix and coil states have been calculated. It is found that the magnitude of the activation energy in the helix state is higher than in coil state.

Besides, the conformational studies on 1,2 –dimethoxyethane (DME), a model compound of poly (oxyethelene) (POE) and ethylene glycol dibenzoate, model compound of poly (ethylene terephthalate) (PET) have been carried out by using NMR technique. The observed temperature dependance of the vicinal coupling constants was analyzed on the basis of the rotational isomeric state scheme. The three state Rotational Isomeric State (RIS) models are also being adopted to describe the conformation dependent properties of POE and PET. The mean-square dimension ratio ( $\langle r^2 \rangle_0/M$ ), persistence length, dipole moment and trans gauss fraction of C-C and C-O bonds are mostly calculated with RIS models in substantial accord with the available experimental data.

## **9. List of Major Instruments Operated :-**

- i) X-ray Generator (15 mA, 30kV), Radon House,
- ii) Optical Micro Densitometer, VEB Carl Zeiss, model : MD100,
- iii) Abe's Refractometer,
- iv) Impedance Analyzer, Hewlett-Packard, model : HP4192A,
- v) Profile Analysis Spectrometer for Scattered Neutrons,
- vi) Mettler Hot State, model : FP 82HT,
- vii) Polarizing Microscope, Olympus, model : BX50,
- viii) DSC Apparatus, TA Instruments, model : 2920 modulated DSC,
- ix) NMR machine (500 MHz), JEOL, model : JNM-LA-500.

## **10. National Seminar/Symposia/ Workshops attended :**

- i) Solid State Physics Symposium, BARC, Bombay, 1984.
- ii) Seminar on Phys. of Positionally Disordered Materials, B.H.U., 1986.
- iii) National Seminar on Ferroelectrics and Dielectrics, Kharagpur, I.I.T., 1986.
- iv) Solid State Physics Symposium, BARC, Bombay, 1988.
- v) Course on Neutrons as Probes in Condensed Matter, BARC, Bombay and I.I.T., Madras, June, 1991.
- vi) Solid State Physics Symposium, B.H.U., 1991.
- vii) Winter Workshop on Liquid Crystals, Dept. of Phys., N. B. U., December, 1992.
- viii) Solid State Physics Symposium, BARC, Bombay, 1993.
- ix) National Seminar on Liquid Crystals, NERIST, Itanagar, December, 1994.
- x) Workshop on Computational Techniques of Neutron Scattering Data, Indore, March, 1995.
- xi) Solid State Physics Symposium, BARC, Bombay, 1994.
- xii) Seminar on Environment Studies in Collegiate Education, Bangabasi College of Commerce, Kolkata, September, 2000.
- xiii) Refresher Course on Physics, Academic Staff College, University of Calcutta, from December 22, 2000 to January 13, 2001.
- xiv) Refresher Course in Electronic Science, Academic Staff College, University of Calcutta, from July 26, 2001 to August 16, 2001.
- xv) National Seminar on Globalization and its Impact on Higher Education in India, Presidency College, Kolkata on January 01, 2003.
- xvi) Seminar on Global Scenario of Cyber World & Communication, New Alipore College, Kolkata, December 21, 2002.
- xvii) National Seminar on Current Trends in Research at the Cross-roads of Physics, Chemistry and Biology, Scottish Church College, Kolkata, December 20, 2003.
- xviii) Seminar on Environmental Change and its Impact, Bangabasi Morning College, Kolkata, March 18-19, 2004.
- xix) Seminar on U.G.C. Proposed Model Act for the University, Bangabasi College, Kolkata, April 03, 2004.
- xx) National Seminar on Hundred Years of Three Seminal Papers of Albert Einstein and Contemporary Ideas, North Bengal University, January 03-05, 2005.
- xxi) Seminar on Science Philosophy Interface, Bangabasi College, Kolkata, March 04-05, 2005.
- xxii) Master Resource Person's Training Programme on **"World Year Physics 2005"**, Institute of Physics, Bhubaneswar, July 27-29, 2005.
- xxiii) Seminar on Physics in the Light of 21<sup>st</sup> Century, Bangabasi Evening College, Kolkata, September 19, 2005.
- xxiv) Workshop in Microprocessor for College Teachers, Dept. of Physics, C. U., December 26-31, 2005.
- xxv) Seminar on New Dimension of Human Rights in the 21<sup>st</sup> Century, Bangabasi Morning College, Kolkata, March 21-22, 2006.
- xxvi) Seminar on Undergraduate Physics Education & Advancement in Physics Research, Sammilani Mahavidyalaya, Kolkata, November 24-25, 2006.

## **11. International Seminar/Symposia/ Conferences/Workshops attended :**

- i) IX International Liquid Crystal Conference, Bangalore, India, December,1982.
- ii) XIV International Meeting and General Assembly of Crystallography, Perth, Australia, August, 1987.
- iii) Seminar on Japanese Polymer Society, Nagoya, Japan, October 1-13, 1997.
- iv) 5<sup>th</sup>. Pacific Polymer Conference, Kyongju, Korea, October 26-30,1997.
- v) International Workshop on Structural Biology, Tokyo, Japan. March 5-6,1998.
- vi) II International School on Powder Diffraction – 2001, IACS, Jadavpur, Kolkata, November 12-14, 2001.

## **12. Organize Seminar :**

- a. Title of the Seminar : **Environmental Change and its Impact**
- b. Sponsors : **U. G. C., New Delhi  
and  
Dept. of Science and Technology, Govt. of West Bengal**
- c. Venue : **Bangabasi Morning College**
- d. Dates : **March 18-19, 2004**
- e. Convener : **Dr. Mukul Kumar Mitra**

## **Present Field of Interest**

### **Computer Simulation of X-ray Diffraction Pattern in Low ordered Liquid**

#### **Crystalline Phases**

Liquid Crystals are in between or better to say integrate the long-range order with the liquid short-range order. For rod-like molecules a series of liquid crystalline (LC) phases exist.

- Highly ordered crystalline smectic phases like smectic B, E, G, H, J and K phases which possess long-range molecular orientational and positional order within the layers, accompanied by long-range molecular bond-orientational order. All these phases show three-dimensional bond-orientational order. All these phases show three-dimensional lattice with collective lattice distortion within a finite size;

- Medium ordered LC smectic phases like hexatic smectic B phase and the tilted smectic I, F phases, which are characterized by long-range orientational order and short-range positional order between the layers, accompanied by long-range bond-orientational order. All these phases show two-dimensional lattice structure with strong collective and incommensurated distortions;
- Low ordered tilted LC smectic C phase, characterized by long-range orientational order and long-range bond-orientational order;
- Low ordered smectic A phase, characterized by long-range orientational order and short-range bond-orientational order;
- LC Nematic phase with a quasi-long-range orientational order, characterized as one-dimensional anisotropic liquid with very strong density fluctuation.

My interest is concentrated to deal with LC Nematic and smectic A phases under special consideration of molecular orientational and structural correlation. Attempts are being done to simulate small-angle scattering patterns. My simulated data will be compared with the experimental data taken by me previously. I shall also try to determine the structural parameters in LC phases quantitatively. A few important references are listed below for this purpose.

### **References**

1. L. E. Alexander, *X-ray Diffraction Methods in Polymer Science*, Wiley-Interscience, New York, 1969.
2. L. A. Feigin and D. I. Svergun, *Structural Analysis by Small-angle X-ray and Neutron Scattering*, (Plenum Press, New York), 1987.
3. A. J. Leadbetter, *The Molecular Physics of Liquid Crystals*, Editor: G. R. Luckhurst and G. W. Gray, ( Academic Press, London ), Chapter 13, *Structural Studies of Nematic, Smectic A and Smectic C Phases*, 1979.
4. P. S. Pershan (Editor), *Structure of Liquid Crystal Phases*, (World Scientific, Singapore, New Jersey, Hong Kong), 1988.
5. J. D. Gaskill, *Linear Systems, Fourier Transformations and Optics*, ( John Wiley & Sons), 1978.

## **Other Major Academic Activities**

### 1. **Research projects completed** :

- i) I had successfully completed a **Minor Research Project** sponsored by U. G. C., New Delhi during 1991-1993.



ii) I had also completed a research project sponsored by **Inter- University Consortium for DAE Facilities**, Indore, during 1992-1995 in the field of **Neutron Scattering Studies on Liquid Crystal Mixtures**.

2. **Post-doctoral fellowship abroad** : In recognition of my research activities on liquid crystalline materials I received **STA Fellowship** for the period from October 1996 to March 1998.

a) Sponsored by : ***Japan International Science and Technology Exchange Center (JISTEC), Japan***

b) Name and address of the Host : ***Professor Akihiro Abe  
Department of Industrial Chemistry  
Tokyo Institute of Polytechnics  
1583 Iiyama, Atsugi-shi  
Kanagawa 243-02, JAPAN***

3. **Convener of a Seminar** : A seminar on **Environmental Change and its Impact** was organized at our college on March 18-19, 2004. The seminar was sponsored by U. G. C., New Delhi and D. S. T., Govt. of West Bengal. I was Convener of this seminar.

4. **Delivered seminar talk** : In the process of celebrating hundred years of three seminal papers of Albert Einstein and contemporary ideas I delivered a seminar talk on "**Liquid Crystal – a Fourth State of Matter**" at our college on February 20, 2005.

5. **Science popularization programme** : Attended as a D.P.I. nominee on **Master Resource Persons' Training Programme for Eastern Zone on World of Physics 2005**, Institute of Physics, Bhubaneswar, July 27-29, 2005.