

CHAPTER- 4

X-ray diffraction studies and measurement of refractive indices, magnetic susceptibility anisotropy, density, splay and bend elastic constant of two members of isothiocyanatobenzenes.

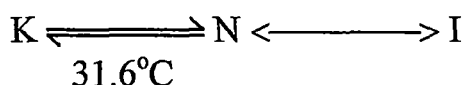
The chemical name, chemical structure and transition temperatures of the mesogenic compounds studied are given below.

I. 4-(trans-4' - n- decyl cyclohexyl) Isothiocyanatobenzene

(10 CPS in short)

C₁₀H₂₁-Cy-Ph-NCS

41.7 °C 50.7°C

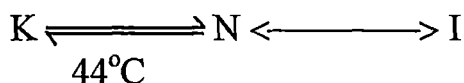


II. 4-(trans-4' - n- dodecyl cyclohexyl) Isothiocyanatobenzene

(12 CPS in short)

C₁₂H₂₅-Cy-Ph-NCS

50.8 °C 52.5°C



(Ph = Phenyl ring, Cy = Cyclohexane ring)

The chemicals were synthesised by Prof. R. Dabrowski and his co-workers in Institute of Chemistry, Military University of Technology, Warsaw, Poland and was supplied to us in the pure form. These mesogens were used by us without further purification. The transition temperatures were determined by us by observing their textures under polarising microscope using Mettler FP 80/82 thermosystem. The transition temperature obtained by us agreed with those in the literature [1,2] within 1 °C.

The experimental procedures used and the method of data analysis are given in Chapter 2 and so only the experimental data and calculated values are given in this chapter. The values of density, ordinary and extraordinary refractive indices at four different wave lengths for 10CPS are

tabulated in Tables 4.1a and 4.1b. The wavelengths used for refractive index measurements are 4358Å, 5461Å, 5780Å and 6907Å. The density and refractive index values in the isotropic phase of 10CPS are also given in the Tables. The density and refractive indices (at a different wave length of 589 nm) values of 10CPS have already been reported by Baran et al.[3] and their values agree with the present values within experimental errors. However, Baran et al.[3] did not analyse their data to calculate the order parameter of 10CPS, which have been determined by us. Tables 4.2a and 4.2b give the values of density and refractive indices at four different wave lengths for 12CPS in its mesophase and isotropic phase. The temperature variations of density for 10CPS and 12CPS are shown in Figure 4.1 and Figure 4.2 respectively. The density changes at the nematic to isotropic transition are small, the change is indeed very small for 12CPS. The temperature variation of ordinary and extra-ordinary refractive indices for 10CPS and 12CPS are shown in Figure 4.3 and Figure 4.4 respectively. The polarisabilities of 10CPS calculated using Vuks and Neugebauer methods (Chapter2) are tabulated in Table 4.3 and Table 4.4 respectively. The corresponding polarisability values for 12CPS using Vuks and Neugebauer procedure are given in Table 4.5 and Table 4.6 respectively. The order parameters at different temperatures for 10CPS calculated from Vuks and Neugebauer polarisabilities are tabulated in Tables 4.7 and 4.8 respectively. The polarisability anisotropy in the perfectly aligned phase, as obtained from Haller's extrapolation method are also given in the Tables. As seen in the last Chapter (Chapter 3), here also polarisability anisotropies calculated by Vuks method are larger than those from Neugebauer method but the order parameters calculated from the two methods are almost identical. Tables 4.9 and 4.10 give the order parameter

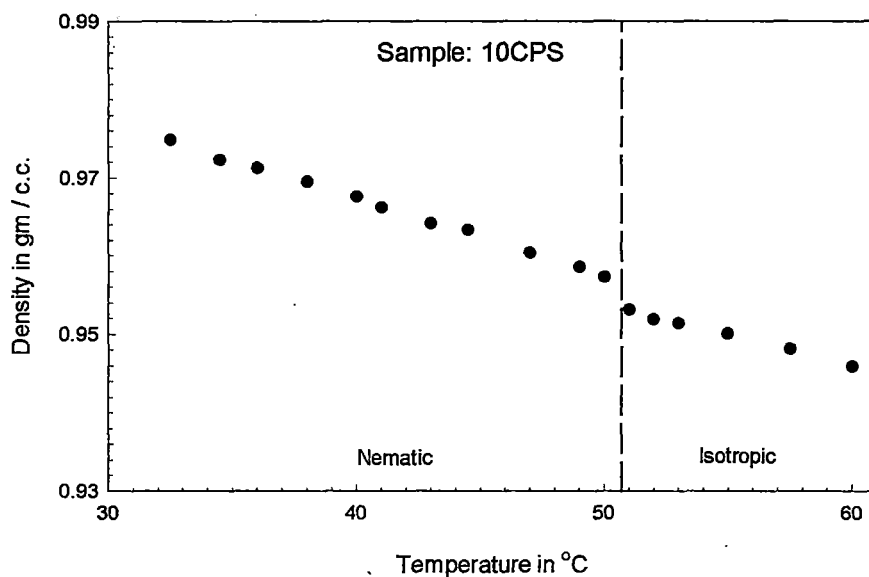


Figure 4.1. Density values as a function of temperature.

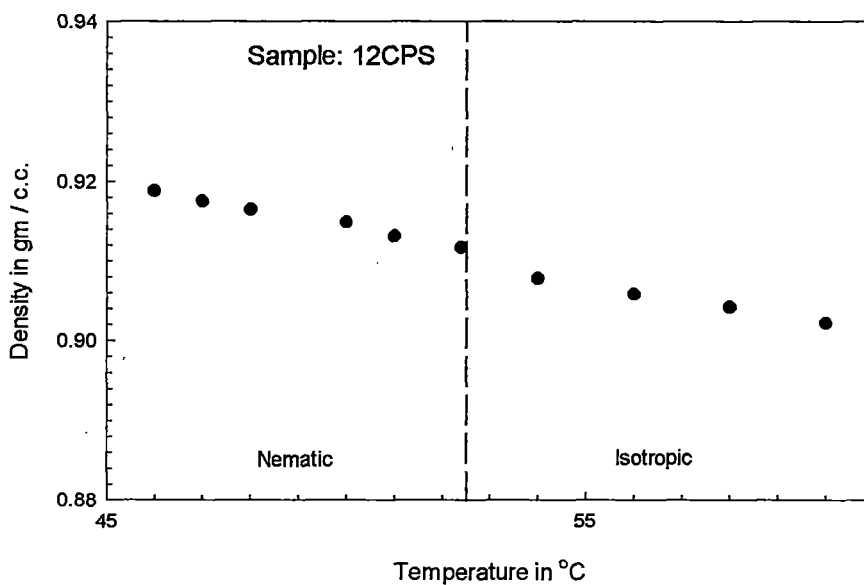


Figure 4.2. Density values as a function of temperature.

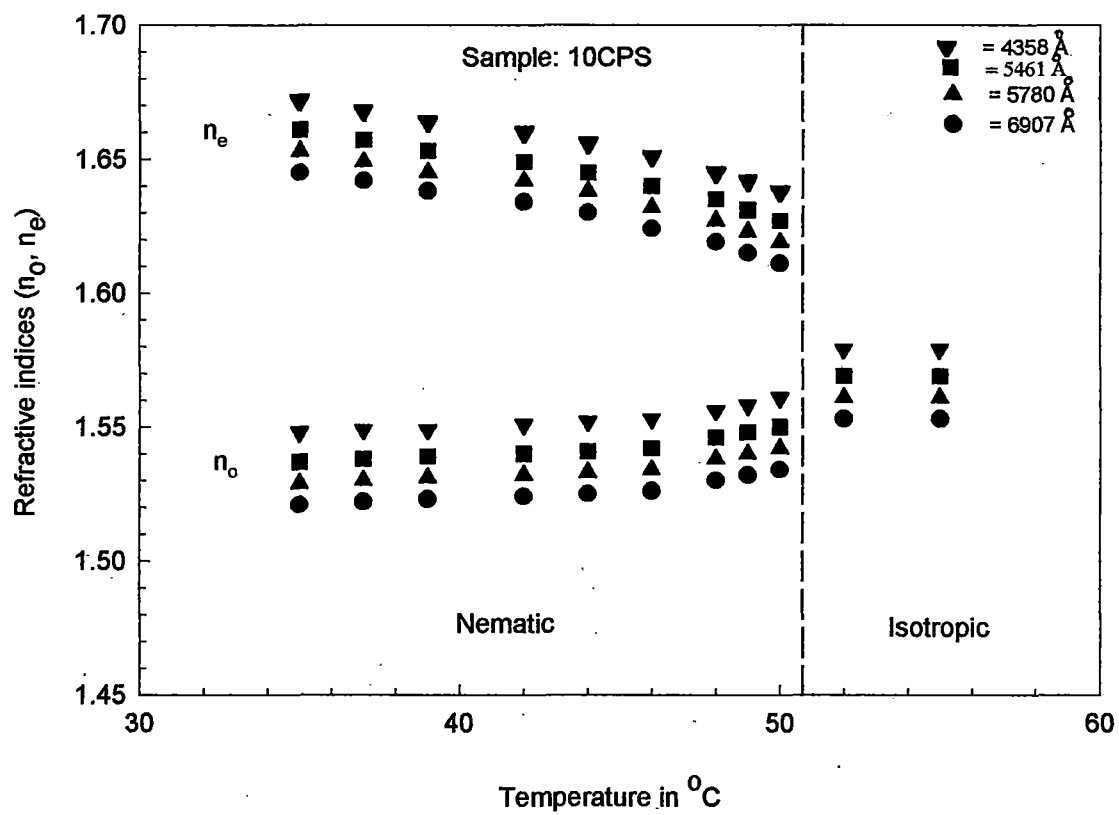


Figure 4.3. Variation of refractive indices (n_o, n_e) with temperature.

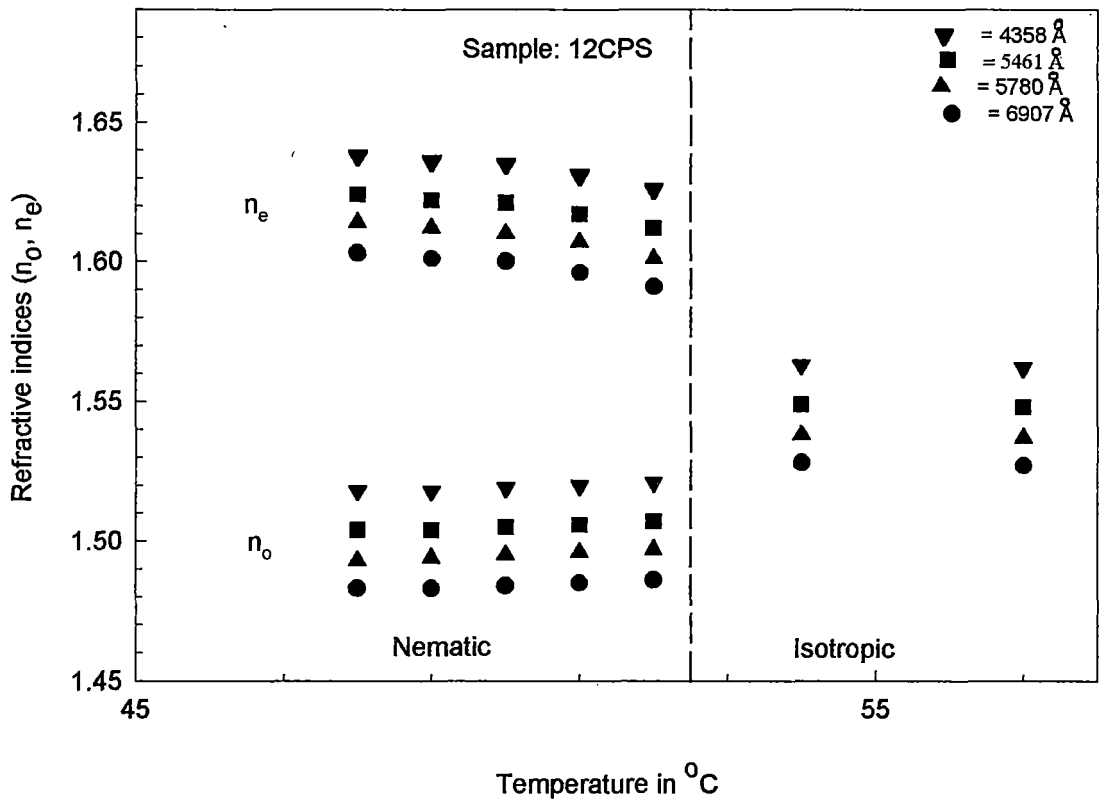


Figure 4.4. Variation of refractive indices (n_o, n_e) with temperature.

values for 12CPS as calculated from Vuks and Neugebauer methods respectively. Extrapolated values of polarisability anisotropy at $\langle P_2 \rangle = 1$ are also given in the Tables. Again the order parameter values from the two procedures agree very well.

X-ray diffraction photographs were taken for the aligned samples of 10CPS and 12CPS in their mesophase. A magnetic field of about 5 Kilogauss was used to align the samples. No x-ray diffraction photograph could be taken in the super cooled nematic phase of 12CPS as the sample crystallised below 50.8°C . Hence, only one diffraction pattern for the sample was taken between 50.8°C and 52.5°C , the clearing temperature. However, for 10CPS x-ray diffraction studies could be performed in the supercooled nematic phase. Plates 4a and 4b show the x-ray diffraction patterns from 10CPS at 46°C and from 12CPS at 51.5°C respectively.

The angular distributions of the x-ray intensity along the outer arc of the diffraction pattern for 10CPS after necessary background correction, are tabulated in Table 4.11. The corresponding angular distribution functions calculated using Leadbetter formula (Chapter 2, equation 2.16) are given in Table 4.12. For 12CPS both the angular distribution of x-ray intensity and the corresponding angular distribution function at only one experimental temperature are given in Table 4.13. The order parameter values for 10CPS and 12CPS, calculated following the equation 2.17 are tabulated in Table 4.14 and Table 4.15 respectively. The apparent molecular lengths as calculated from the inner arc of the x-ray diffraction pattern, for 10CPS and 12CPS are given in Table 4.16. The temperature variation of apparent molecular length for 10CPS is shown in Figure 4.5. The single value of apparent molecular length of 12CPS is also plotted in the same figure. It can be seen that apparent molecular length of 10CPS is

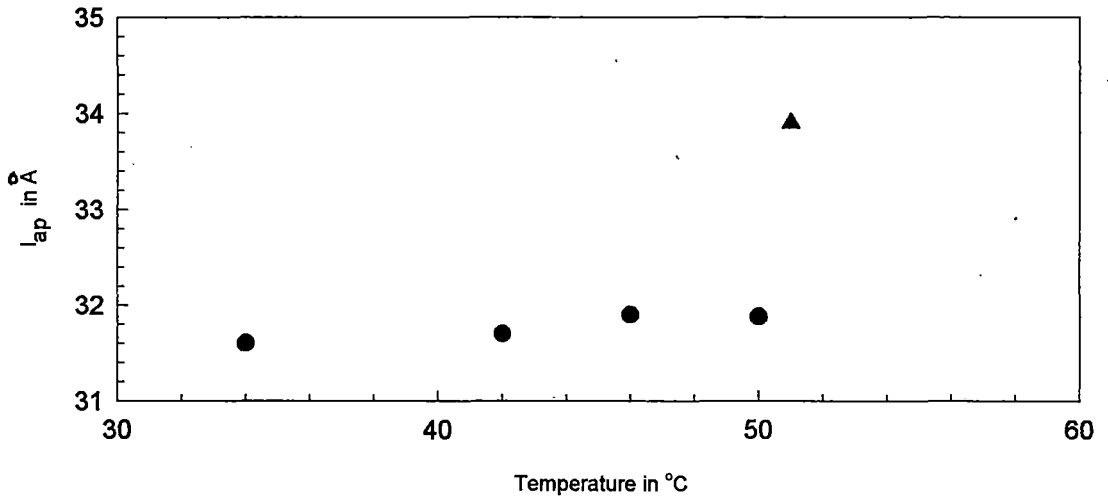


Figure 4.5. Temperature variation of apparent molecular length (l_{ap}).

- data for 10CPS
- ▲ data for 12CPS

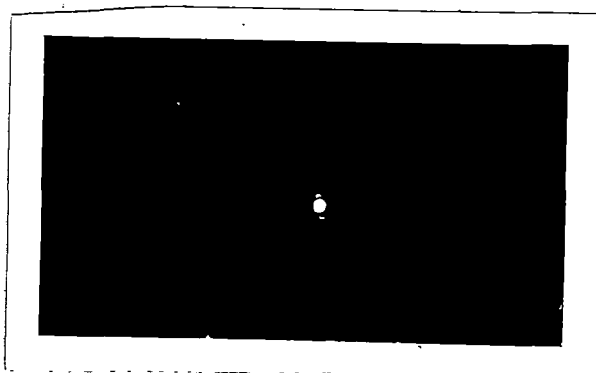


Plate 4a: X-ray diffraction photograph of the oriented sample in the nematic phase of 10CPS at 46°C.

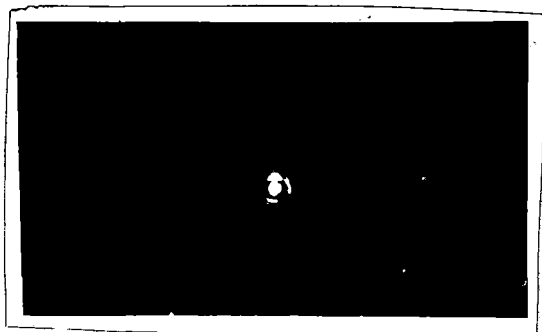


Plate 4b: X-ray diffraction photograph of the oriented sample in the nematic phase of 12CPS at 51.5°C.

almost constant at 31.7 Å. The molecular model length of 10CPS in its fully extended form is 25.7 Å. Thus the ratio of apparent molecular length to the model length is 1.23. The values of apparent molecular length, model molecular length and their ratio for 12CPS are 33.9 Å, 28.1 Å and 1.21 respectively. Thus the ratios of the apparent to model molecular lengths are almost the same for the two CPS compounds and this ratio is much smaller than the value (1.4) in the case of cyanobiphenyls which form dimers. So there is some association of molecules in the mesophases of 10CPS and 12CPS, though it is much weaker than that in cyanobiphenyls.

The magnetic susceptibility along the director, χ_{\parallel} , the magnetic susceptibility anisotropy, $\Delta\chi$, and the order parameter values at different temperatures for 10CPS are tabulated in Table 4.17. The density values given in the Table have been interpolated from our experimental values given in Table 4.1a. The magnetic susceptibility anisotropy for perfectly ordered sample has been obtained by Haller's extrapolation method (described in Chapter 2) and is given in the Table. The magnetic susceptibility χ_{\parallel} , $\Delta\chi$, order parameter and interpolated density values for 12CPS are given in Table 4.18. The experimental values for 12CPS could be obtained at only one temperature in the mesophase since no supercooled nematic phase was observed in the magnetic field. The temperature variation of magnetic anisotropy of 10CPS is shown in Figure 4.6.

The temperature variation of order parameter values for 10CPS as obtained from refractive index, magnetic susceptibility and x-ray diffraction studies, are shown in Figure 4.7. In this figure the Maier-Saupe theoretical values are also shown. The $\langle P_2 \rangle$ values calculated from x-ray diffraction data agree very well with the Maier-Saupe theoretical values throughout the mesomorphic temperature range. The order parameter

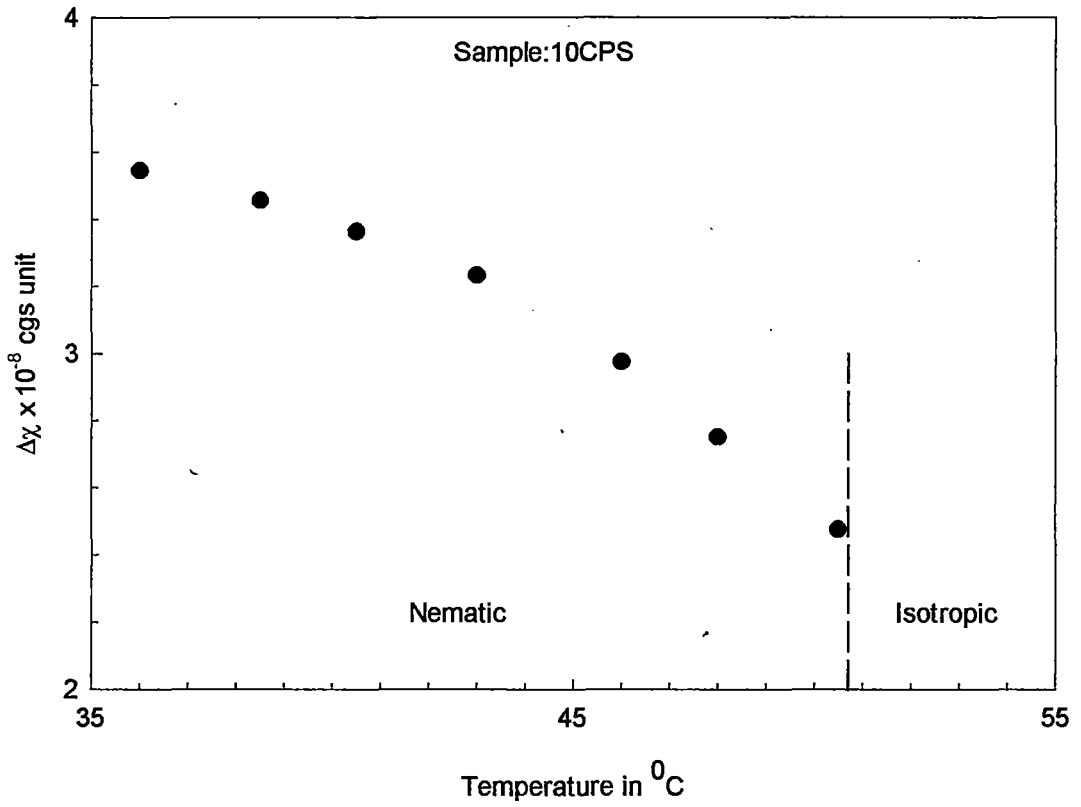


Figure 4.6. Temperature variation of the anisotropy of the diamagnetic susceptibility ($\Delta\chi$).

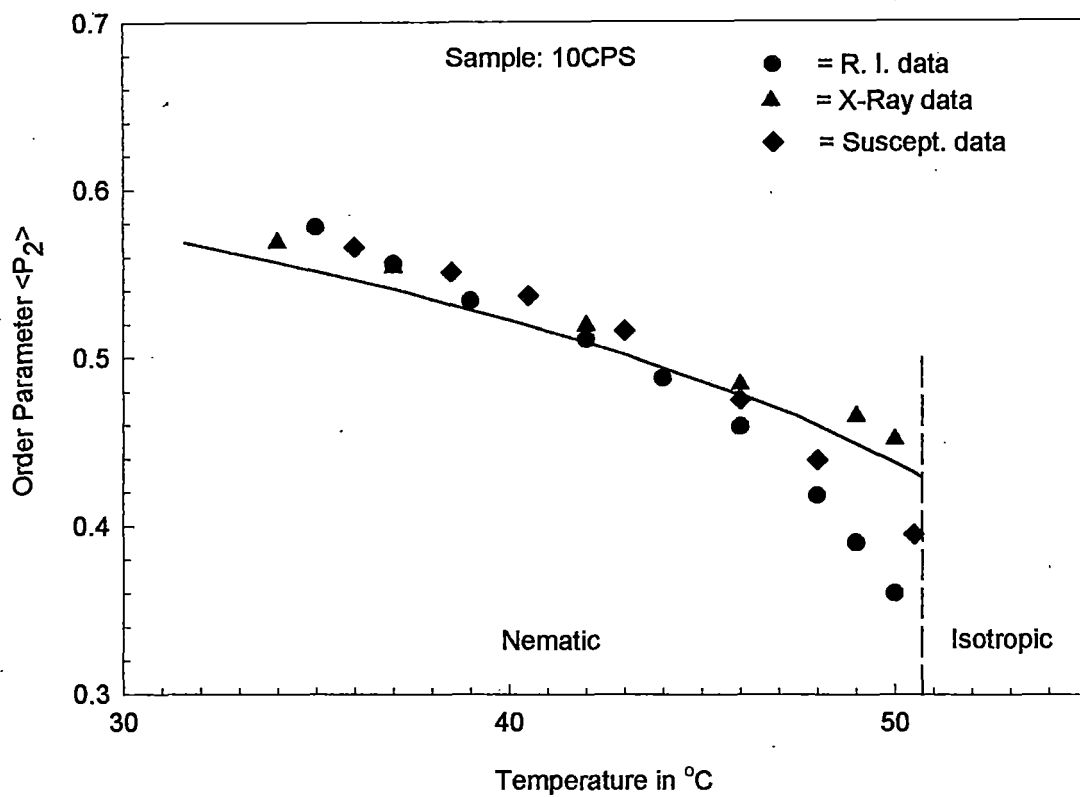


Figure 4.7. Temperature variation of Order Parameter $\langle P_2 \rangle$. Continuous curve corresponds to Maier-Saupe theoretical values.

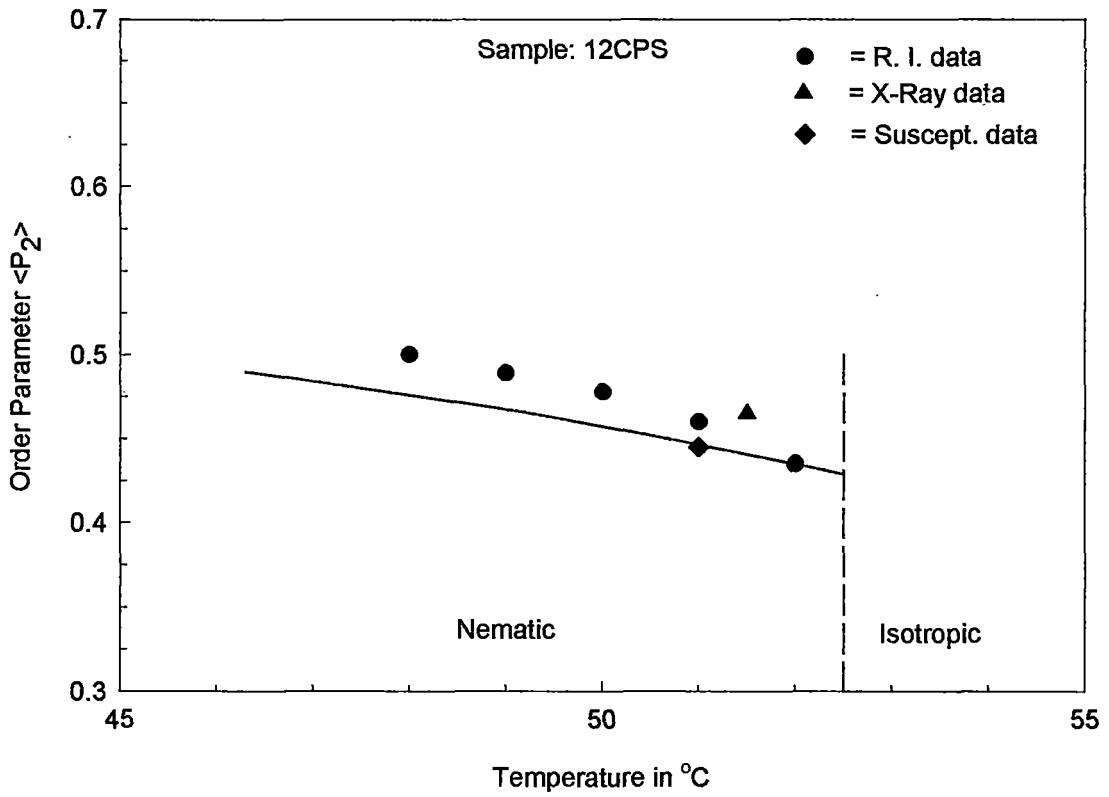


Figure 4.8. Temperature variation of Order Parameter $\langle P_2 \rangle$. Continuous curve corresponds to Maier-Saupe theoretical values.

values obtained from refractive index and magnetic susceptibility measurements agree with the theoretical values at lower temperatures. But, near the nematic to isotropic transition temperature these order parameter values decrease more rapidly than the theoretical values. This trend is more pronounced in the $\langle P_2 \rangle$ values obtained from the refractive index data.

The temperature variation of order parameter values of 12CPS, obtained from different experimental methods, are shown in Figure 4.8. Since the mesomorphic temperature range of 12CPS is very small, not much can be inferred from this figure. However, like 10CPS for 12CPS also the $\langle P_2 \rangle$ values obtained from x-ray diffraction data are somewhat greater than those obtained from refractive index and magnetic susceptibility at the same temperature.

The splay and bend elastic constants of these two mesogens were determined by observing Freedericksz transition in magnetic field. The details of the method have already been described in Chapter 2 of the present thesis.

The splay and bend elastic constants at different temperatures for 10CPS are given in Tables 4.19 and 4.20 respectively. The critical magnetic field and the thickness of the sample are also given in the tables. The splay and bend elastic constant values of 12CPS are tabulated in Tables 4.21 and 4.22 respectively for only one temperature, since in a magnetic field the mesophase of 12CPS was stable in the temperature range of 1.7 °C only.

The temperature variation of splay and bend elastic constant values of 10CPS are shown in Figure 4.9 and Figure 4.10 respectively. These variations are normal. The temperature variation of bend to splay elastic constants of 10CPS is shown in Figure 4.11 and tabulated in Table 4.23. In

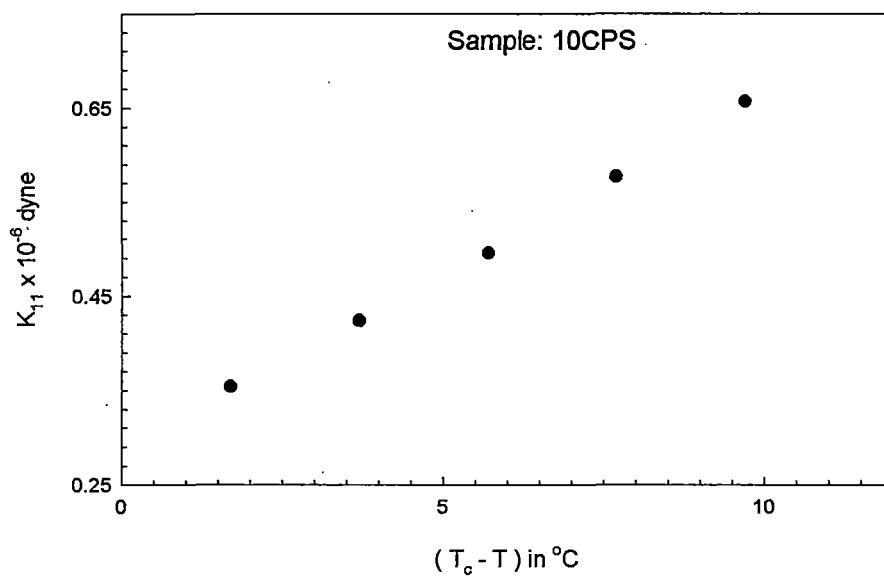


Figure 4.9. Splay elastic constant (K_{11}) as a function of relative temperature ($T_c - T$).

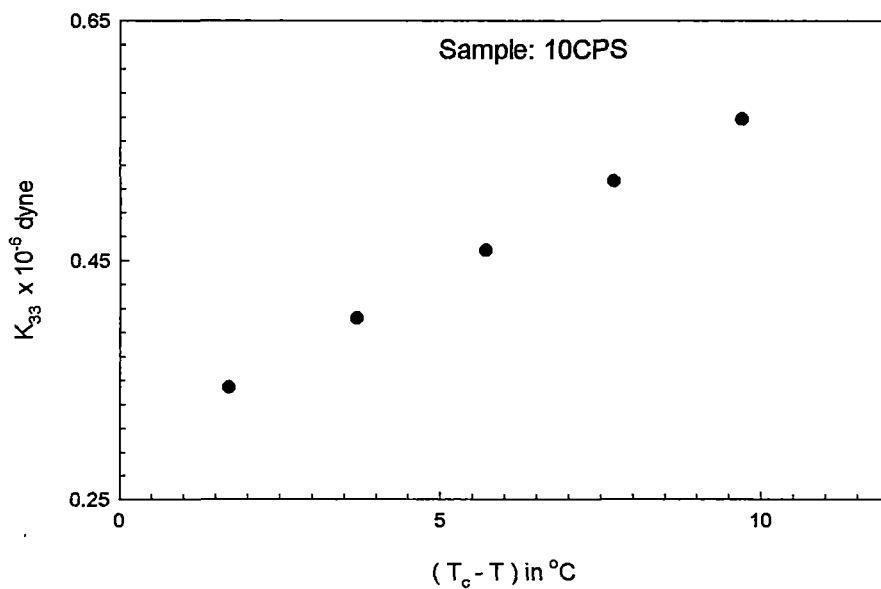


Figure 4.10. Bend elastic constant (K_{33}) as a function of relative temperature ($T_c - T$).

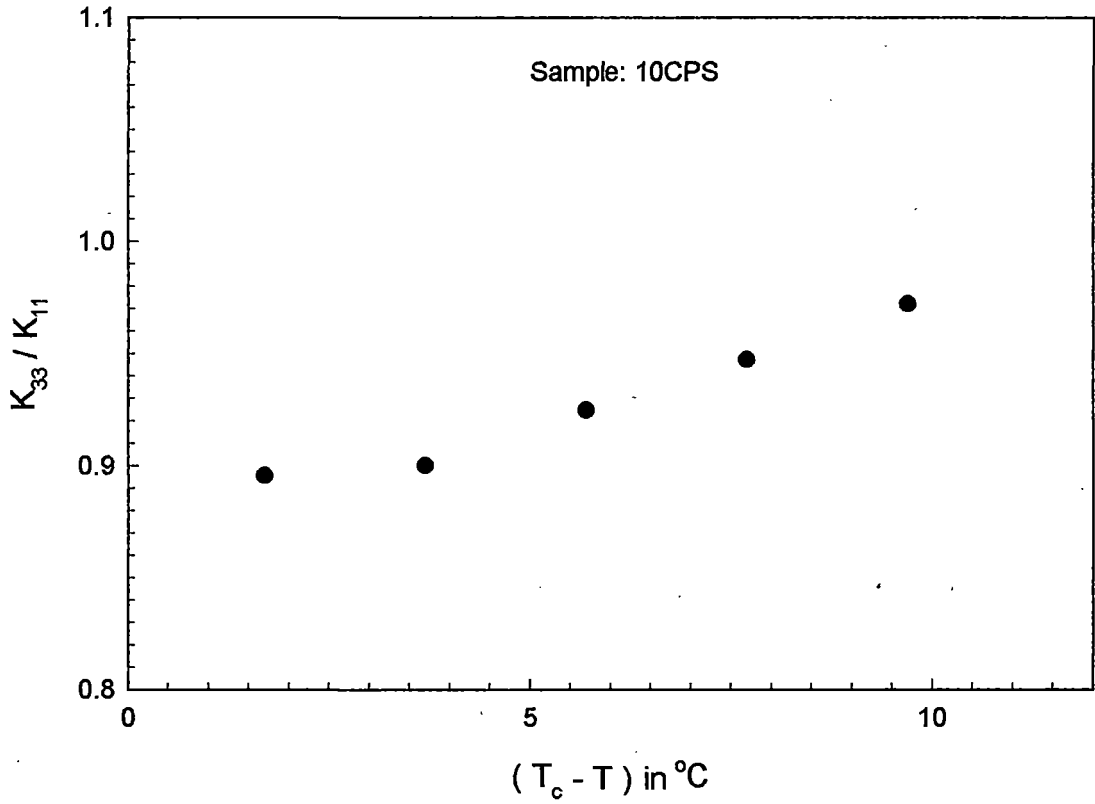


Figure 4.11. Bend to Splay elastic constant ratio (K_{33}/K_{11}) as a function of relative temperature ($T_c - T$).

this Table the K_{33}/K_{11} ratio for 12CPS has also been given. It can be seen that the ratios are less than 1 for 12CPS and 10CPS at all temperatures. It may be noted that for cyanophenyl compounds this ratio is larger than 1. In nCPS compounds K_{33} values are much smaller than K_{33} values for corresponding cyanocompounds [4]. According to Schadt et al. [5] the K_{33}/K_{11} ratio decreases with decreasing polarity of the compounds. It has also been found by Schadt et al. [6] that K_{33}/K_{11} ratio is affected by the type of ring structure in the rigid part of the molecules. In non-polar azoxybenzene homologous series, de Jeu et al. [7] found that the K_{33}/K_{11} value decreases with increasing chain length. The K_{33}/K_{11} value for 6CPS is 1.11, at $T_c - T = 21$ °C [4], whereas for 10CPS our value is 0.972 at $T_c - T = 9.7$ °C. Thus the values of the ratio K_{33}/K_{11} , for 10CPS obtained by us is consistent with the experimental observations of other researchers.

Table 4.1a

Density (ρ) and refractive indices (n_o , n_e) at different temperatures of Sample 10CPS.

Temp. in ° C	Density in gm/cc	$\lambda = 6907 \text{ \AA}$		$\lambda = 5780 \text{ \AA}$	
		n_o	n_e	n_o	n_e
35	0.972	1.521	1.645	1.529	1.653
37	0.970	1.522	1.642	1.530	1.649
39	0.969	1.523	1.638	1.531	1.645
42	0.965	1.524	1.634	1.532	1.642
44	0.964	1.525	1.630	1.533	1.638
46	0.962	1.526	1.624	1.534	1.632
48	0.960	1.530	1.619	1.538	1.627
49	0.959	1.532	1.615	1.540	1.623
50	0.957	1.534	1.611	1.542	1.619
52	0.953	1.553		1.561	

Table 4.1b

Density (ρ) and refractive indices (n_o , n_e) at different temperatures of Sample 10CPS.

Temp. in ° C	Density in gm/cc	$\lambda = 5461 \text{ \AA}$		$\lambda = 4358 \text{ \AA}$	
		n_o	n_e	n_o	n_e
35	0.972	1.537	1.661	1.548	1.672
37	0.970	1.538	1.657	1.549	1.668
39	0.969	1.539	1.653	1.549	1.664
42	0.965	1.540	1.649	1.551	1.660
44	0.964	1.541	1.645	1.552	1.656
46	0.962	1.542	1.640	1.553	1.651
48	0.960	1.546	1.635	1.556	1.645
49	0.959	1.548	1.631	1.558	1.642
50	0.957	1.550	1.627	1.561	1.638
52	0.953	1.569		1.579	

Table 4.2a

Density (ρ) and refractive indices (n_o , n_e) at different temperatures of Sample 12CPS.

Temp. in ° C	Density in gm/cc	$\lambda = 6907 \text{ \AA}$		$\lambda = 5780 \text{ \AA}$	
		n_o	n_e	n_o	n_e
48	0.917	1.483	1.603	1.493	1.614
49	0.916	1.483	1.601	1.494	1.612
50	0.915	1.484	1.600	1.495	1.610
51	0.913	1.485	1.596	1.496	1.607
52	0.912	1.486	1.591	1.497	1.601
54	0.909	1.528		1.538	

Table 4.2b

Density (ρ) and refractive indices (n_o , n_e) at different temperatures of Sample 12CPS.

Temp. in ° C	Density in gm/cc	$\lambda = 5461 \text{ \AA}$		$\lambda = 4358 \text{ \AA}$	
		n_o	n_e	n_o	n_e
48	0.917	1.504	1.624	1.518	1.638
49	0.916	1.504	1.622	1.518	1.636
50	0.915	1.505	1.621	1.519	1.635
51	0.913	1.506	1.617	1.520	1.631
52	0.912	1.507	1.612	1.521	1.626
54	0.909	1.549		1.563	

Table 4.3

**Polarisability (α_o, α_e) at different temperatures of sample 10CPS
by Vuks method.**

Temp. in °C	$\lambda = 6907 \text{ \AA}$		$\lambda = 5780 \text{ \AA}$		$\lambda = 5461 \text{ \AA}$		$\lambda = 4358 \text{ \AA}$	
	α_o	α_e	α_o	α_e	α_o	α_e	α_o	α_e
35	43.03	55.92	43.58	56.47	44.13	57.01	44.85	57.72
37	43.21	55.62	43.76	56.16	44.31	56.70	45.04	57.42
39	43.41	55.32	43.96	55.87	44.50	56.41	45.23	57.13
42	43.72	55.11	44.27	55.66	44.81	56.20	45.54	56.93
44	43.91	54.80	44.47	55.35	45.02	55.89	45.75	56.62
46	44.14	54.39	44.71	54.94	45.26	55.49	45.99	56.21
48	44.59	53.92	45.15	54.47	45.70	55.01	46.44	55.74
49	44.82	53.56	45.37	54.10	45.93	54.65	46.67	55.38
50	45.14	53.18	45.70	53.74	46.25	54.28	46.99	55.01

α_o & α_e are in 10^{-24} cm^3 unit.

Table 4.4

**Polarisability (α_o, α_e) at different temperatures of sample 10 CPS
by Neugebauer method.**

Temp in °C	$\lambda = 6907 \text{ \AA}$		$\lambda = 5780 \text{ \AA}$		$\lambda = 5461 \text{ \AA}$		$\lambda = 4358 \text{ \AA}$	
	α_o	α_e	α_o	α_e	α_o	α_e	α_o	α_e
35	43.82	54.35	44.37	54.88	44.93	55.40	45.67	56.09
37	43.97	54.11	44.52	54.63	45.08	55.15	45.82	55.85
39	44.13	53.88	44.69	54.40	45.24	54.93	45.98	55.63
42	44.41	53.73	44.97	54.26	45.52	54.79	46.26	55.49
44	44.57	53.49	45.14	54.01	45.69	54.54	46.44	55.25
46	44.76	53.15	45.34	53.69	45.89	54.22	46.64	54.93
48	45.15	52.79	45.72	53.33	46.28	53.86	47.02	54.57
49	45.34	52.50	45.91	53.03	46.47	53.57	47.22	54.28
50	45.62	52.21	46.19	52.75	46.75	53.29	47.49	54.00

α_o & α_e are in 10^{-24} cm^3 unit.

Table 4.5

**Polarisability (α_o, α_e) at different temperatures of sample 12CPS
by Vuks method.**

Temp. in ° C	$\lambda = 6907 \text{ \AA}$		$\lambda = 5780 \text{ \AA}$		$\lambda = 5461 \text{ \AA}$		$\lambda = 4358 \text{ \AA}$	
	α_o	α_e	α_o	α_e	α_o	α_e	α_o	α_e
48	46.15	60.48	46.99	61.34	47.85	62.17	48.97	63.28
49	46.29	60.33	47.14	61.18	47.99	62.01	49.11	63.11
50	46.43	60.17	47.28	61.01	48.13	61.85	49.25	62.96
51	46.64	59.89	47.50	60.73	48.34	61.57	49.47	62.69
52	46.84	59.35	47.70	60.19	48.54	61.06	49.67	62.17

α_o & α_e are in 10^{-24} cm^3 unit.

Table 4.6

**Polarisability (α_o, α_e) at different temperatures of sample 12CPS
by Neugebauer method.**

Temp. in ° C	$\lambda = 6907 \text{ \AA}$		$\lambda = 5780 \text{ \AA}$		$\lambda = 5461 \text{ \AA}$		$\lambda = 4358 \text{ \AA}$	
	α_o	α_e	α_o	α_e	α_o	α_e	α_o	α_e
48	46.96	58.85	47.82	59.68	48.70	60.48	49.83	61.55
49	47.09	58.73	47.95	59.55	48.81	60.35	49.95	61.42
50	47.21	58.61	48.08	59.42	48.94	60.23	50.08	61.31
51	47.39	58.38	48.27	59.19	49.12	60.01	50.26	61.10
52	47.55	57.93	48.42	58.75	49.28	59.59	50.42	60.66

α_o & α_e are in 10^{-24} cm^3 unit.

Table 4.7

Order parameter $\langle P_2 \rangle$ of sample 10CPS at different temperatures by Vuks method.

$$(\alpha_{\parallel} - \alpha_{\perp}) = 22.3 \text{ in } 10^{-24} \text{ cm}^3 \text{ unit.}$$

Temp. in °C	$\lambda = 6907 \text{ \AA}$	$\lambda = 5780 \text{ \AA}$	$\lambda = 5461 \text{ \AA}$	$\lambda = 4358 \text{ \AA}$	Average
	$\langle P_2 \rangle$	$\langle P_2 \rangle$	$\langle P_2 \rangle$	$\langle P_2 \rangle$	$\langle P_2 \rangle$
35	0.578	0.578	0.578	0.577	0.578
37	0.556	0.556	0.555	0.555	0.555
39	0.534	0.534	0.534	0.534	0.534
42	0.511	0.511	0.511	0.511	0.511
44	0.488	0.488	0.487	0.487	0.487
46	0.460	0.459	0.459	0.458	0.459
48	0.418	0.418	0.417	0.417	0.417
49	0.392	0.390	0.391	0.391	0.391
50	0.361	0.360	0.360	0.360	0.360

Table 4.8

Order parameter $\langle P_2 \rangle$ of sample 10CPS at different temperatures by Neugebauer method.

$$(\alpha_{\parallel} - \alpha_{\perp}) = 18.25 \text{ in } 10^{-24} \text{ cm}^3 \text{ unit.}$$

Temp. in °C	$\lambda = 6907 \text{ \AA}$	$\lambda = 5780 \text{ \AA}$	$\lambda = 5461 \text{ \AA}$	$\lambda = 4358 \text{ \AA}$	Average
	$\langle P_2 \rangle$	$\langle P_2 \rangle$	$\langle P_2 \rangle$	$\langle P_2 \rangle$	$\langle P_2 \rangle$
35	0.577	0.576	0.573	0.571	0.574
37	0.556	0.554	0.552	0.550	0.553
39	0.534	0.532	0.531	0.529	0.532
42	0.511	0.510	0.507	0.506	0.509
44	0.489	0.487	0.485	0.483	0.486
46	0.460	0.458	0.456	0.454	0.457
48	0.419	0.417	0.415	0.414	0.416
49	0.382	0.391	0.389	0.387	0.387
50	0.361	0.360	0.358	0.357	0.359

Table 4.9

Order parameter $\langle P_2 \rangle$ of sample 12CPS at different temperatures by Vuks method.

$$(\alpha_{\parallel} - \alpha_{\perp}) = 28.7 \text{ in } 10^{-24} \text{ cm}^3 \text{ unit.}$$

Temp. in °C	$\lambda = 6907 \text{ \AA}$	$\lambda = 5780 \text{ \AA}$	$\lambda = 5461 \text{ \AA}$	$\lambda = 4358 \text{ \AA}$	Average
	$\langle P_2 \rangle$	$\langle P_2 \rangle$	$\langle P_2 \rangle$	$\langle P_2 \rangle$	$\langle P_2 \rangle$
48	0.500	0.500	0.499	0.498	0.499
49	0.489	0.489	0.488	0.488	0.488
50	0.479	0.478	0.478	0.478	0.478
51	0.461	0.460	0.461	0.461	0.461
52	0.436	0.435	0.436	0.435	0.435

Table 4.10

Order parameter $\langle P_2 \rangle$ of sample 12CPS at different temperatures by Neugebauer method.

$$(\alpha_{\parallel} - \alpha_{\perp}) = 23.9 \text{ in } 10^{-24} \text{ cm}^3 \text{ unit.}$$

Temp. in °C	$\lambda = 6907 \text{ \AA}$	$\lambda = 5780 \text{ \AA}$	$\lambda = 5461 \text{ \AA}$	$\lambda = 4358 \text{ \AA}$	Average
	$\langle P_2 \rangle$	$\langle P_2 \rangle$	$\langle P_2 \rangle$	$\langle P_2 \rangle$	$\langle P_2 \rangle$
48	0.497	0.496	0.493	0.490	0.494
49	0.487	0.485	0.483	0.480	0.484
50	0.477	0.474	0.472	0.469	0.473
51	0.460	0.457	0.456	0.454	0.457
52	0.434	0.432	0.431	0.428	0.431

Table 4.11

**Mean experimental intensity values $I(\psi)$, in arbitrary units, of 10
CPS after background correction.**

ψ (deg.)	$I(\psi)$ values at different temperatures in degrees					
	34	37	42	46	49	50
0	1.83	1.60	1.55	1.80	0.75	2.80
5	1.80	1.55	1.55	1.75	0.75	2.75
10	1.55	1.45	1.40	1.65	0.70	2.65
15	1.20	1.30	1.10	1.50	0.55	2.40
20	0.85	1.00	0.80	1.40	0.45	2.10
25	0.65	0.75	0.60	1.30	0.35	2.00
30	0.50	0.60	0.50	1.10	0.25	1.70
35	0.35	0.50	0.40	0.85	0.20	1.40
40	0.35	0.35	0.35	0.70	0.20	1.15
45	0.25	0.30	0.30	0.55	0.18	0.95
50	0.22	0.25	0.25	0.45	0.15	0.80
55	0.20	0.23	0.20	0.35	0.15	0.70
60	0.18	0.20	0.20	0.25	0.12	0.60
65	0.17	0.18	0.18	0.20	0.11	0.40
70	0.14	0.13	0.15	0.15	0.10	0.25
75	0.13	0.08	0.15	0.10	0.10	0.20
80	0.10	0.00	0.10	0.08	0.10	0.10
85	0.05	0.00	0.10	0.00	0.05	0.05
90	0.00	0.00	0.00	0.00	0.00	0.00

Table 4.12**Normalised distribution function values $f(\beta)$ of 10 CPS.**

β (deg.)	$f(\beta)$ values at different temperatures in degrees					
	34	37	42	46	49	50
0	9.88	6.90	8.18	4.57	6.49	4.51
5	9.75	6.74	8.22	4.50	6.62	4.41
10	8.80	6.24	7.74	4.22	6.55	4.08
15	6.53	5.41	6.02	3.72	5.52	3.59
20	4.03	4.33	3.82	3.19	3.80	3.08
25	2.42	3.18	2.31	2.82	2.39	2.68
30	1.64	2.19	1.59	2.57	1.59	2.37
35	1.27	1.47	1.29	2.26	1.21	2.02
40	1.00	1.04	1.09	1.73	0.99	1.57
45	0.71	0.80	0.85	1.17	0.81	1.56
50	0.50	0.66	0.62	0.79	0.66	0.88
55	0.40	0.55	0.48	0.62	0.57	0.75
60	0.39	0.47	0.44	0.55	0.55	0.69
65	0.40	0.40	0.43	0.47	0.54	0.59
70	0.37	0.32	0.40	0.32	0.49	0.38
75	0.25	0.22	0.30	0.15	0.37	0.18
80	0.14	0.10	0.19	0.06	0.24	0.08
85	0.08	0.04	0.13	0.03	0.17	0.04
90	0.06	0.03	0.11	0.02	0.15	0.03

Table 4.13

Mean experimental intensity values $I(\psi)$, in arbitrary units, after background correction and Normalised distribution function values $f(\beta)$ of 12CPS.

ψ in degrees	$I(\psi)$ values at 51.5° C	β in degrees	$f(\beta)$ values at 51.5°C
0	1.35	0	3.60
5	1.33	5	3.68
10	1.25	10	3.82
15	1.20	15	3.82
20	1.15	20	3.55
25	1.00	25	3.07
30	0.80	30	2.52
35	0.60	35	1.99
40	0.50	40	1.50
45	0.45	45	1.10
50	0.35	50	0.81
55	0.25	55	0.62
60	0.20	60	0.51
65	0.18	65	0.42
70	0.15	70	0.32
75	0.13	75	0.23
80	0.10	80	0.15
85	0.10	85	0.11
90	0.00	90	0.10

Table 4.14**Sample : 10CPS****Variation of $\langle P_2 \rangle$ and $\langle P_4 \rangle$ with temperature.**

Temperature in $^{\circ}$ C	$\langle P_2 \rangle$	$\langle P_4 \rangle$
34	0.569	0.293
37	0.554	0.214
42	0.519	0.245
46	0.484	0.089
49	0.465	0.212
50	0.451	0.077

Table 4.15**Sample : 12CPS****Variation of $\langle P_2 \rangle$ and $\langle P_4 \rangle$ with temperature.**

Temperature in $^{\circ}$ C	$\langle P_2 \rangle$	$\langle P_4 \rangle$
51.5	0.465	0.102

Table 4.16**Apparent molecular length (l_{ap}) at different temperature.**Sample to film distance = 7.86 cm., $\lambda = 1.54051 \text{ \AA}$,

Magnetic field = 5 K. Gauss

Sample: 10CPS Model length $L = 25.7 \text{ \AA}$				Sample: 12CPS Model length $L = 28.1 \text{ \AA}$		
Temp. in $^{\circ}\text{C}$	l_{ap} in \AA	Mean length l_{ap} in \AA	l_{ap}/L	Temp. in $^{\circ}\text{C}$	l_{ap} in \AA	l_{ap}/L
34	31.6	31.7	1.23	51	33.9	1.21
42	31.7					
46	31.9					
50	31.9					

Table 4.17

Experimental values of the density (ρ), magnetic susceptibility (χ), susceptibility anisotropy ($\Delta\chi$), and the order parameter $\langle P_2 \rangle$

Sample 10CPS

Temp. in °C	Density (ρ)* in gm/cc	$-\chi_{\parallel} \times 10^{-7}$ c.g.s.unit	$\Delta\chi \times 10^{-8}$ c.g.s.unit	order parameter $\langle P_2 \rangle$
36.0	0.971	7.1i	3.5	0.566
38.5	0.969	7.11	3.5	0.551
40.5	0.967	7.12	3.4	0.537
43.0	0.964	7.13	3.2	0.516
46.0	0.962	7.15	3.0	0.475
48.0	0.960	7.16	2.7	0.439
50.5	0.955	7.18	2.5	0.395
52.0	0.952	$7.35 = \bar{\chi}_{iso}$		

$$\Delta\chi_o = 6.265 \times 10^{-8} \text{ c.g.s.unit ;}$$

* Interpolated values from Table 4.1a.

Table 4.18

Experimental values of the density (ρ), magnetic susceptibility (χ), susceptibility anisotropy ($\Delta\chi$), and the order parameter $\langle P_2 \rangle$

Sample 12CPS

Temp. in °C	Density (ρ)* in gm/cc	$-\chi_{\parallel} \times 10^{-7}$ c.g.s.unit	$\Delta\chi \times 10^{-8}$ c.g.s.unit	order parameter $\langle P_2 \rangle$
51	0.913	7.626	2.905	0.445
53	0.910	$7.820 = \bar{\chi}_{iso}$		

$$\Delta\chi_o = 6.528 \times 10^{-8} \text{ c.g.s.unit ;}$$

* Interpolated values from Table 4.2a.

Table 4.19

Experimental values of splay elastic constant (K_{11}) for various ($T_c - T$) values.

Sample 10CPS

$T_c = 50.7^\circ \text{C}$, Sample thickness = 162 μm , H_c = Threshold magnetic field.

$T_c - T$	H_c in Gauss	$\Delta\chi \times 10^{-8}$ cgs unit	$K_{11} \times 10^{-6}$ dyne
1.7	710	2.6	0.35
3.7	746	2.9	0.42
5.7	780	3.1	0.50
7.7	819	3.2	0.58
9.7	860	3.3	0.66

Table 4.20

Experimental values of splay elastic constant (K_{33}) for various ($T_c - T$) values.

Sample 10CPS

$T_c = 50.7^\circ \text{C}$, Sample thickness = 162 μm , H_c = Threshold magnetic field

$T_c - T$	H_c in Gauss	$\Delta\chi \times 10^{-8}$ cgs unit	$K_{33} \times 10^{-6}$ dyne
1.7	700	2.6	0.34
3.7	726	2.9	0.40
5.7	750	3.1	0.46
7.7	775	3.2	0.52
9.7	800	3.3	0.57

Table 4.21

Experimental values of splay elastic constant (K_{11}) for various ($T_c - T$) values.

Sample 12CPS

$T_c = 52.5^\circ \text{C}$, Sample thickness = 162 μm , H_c = Threshold magnetic field

$T_c - T$	H_c in Gauss	$\Delta\chi \times 10^{-8}$ cgs unit	$K_{11} \times 10^{-6}$ dyne
1.5	725	2.9	0.41

Table 4.22

Experimental values of splay elastic constant (K_{33}) for various ($T_c - T$) values.

Sample 12CPS

$T_c = 52.5^\circ \text{C}$, Sample thickness = 162 μm , H_c = Threshold magnetic field

$T_c - T$	H_c in Gauss	$\Delta\chi \times 10^{-8}$ cgs unit	$K_{33} \times 10^{-6}$ dyne
1.5	720	2.9	0.4

Table 4.23

Experimental values of the Frank elastic constant ratio (K_{33} / K_{11}) at different relative temperatures ($T_c - T$).

Sample: 10CPS		Sample: 12CPS	
$T_c - T$	K_{33} / K_{11}	$T_c - T$	K_{33} / K_{11}
1.7	0.89	1.5	.99
3.7	0.90		
5.7	0.92		
7.7	0.95		
9.7	0.97		

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