

## LETTERS TO THE EDITOR

### A PROPERTY OF THE SCHILD-KERR METRIC

THE Schild-Kerr metric is given by

$$g_{ij} = \eta_{ij} + 2H\Psi_i\Psi_j \quad (i, j \dots = 1, 2, 3, 4; \quad a, \beta, \dots = 1, 2, 3) \quad (1)$$

where  $\eta_{ij}$  is the Minkowskian metric in rectangular cartesian coordinates, i.e.,  $\eta_{ij} = \text{diag} (-1, -1, -1, +1)$ ,  $H$  is a scalar field and the vector field  $\Psi_i$  is null with respect to the Minkowskian metric. Besides the congruence  $\Psi_i$  is geodesic and we take  $\Psi_4 = 1$ .

If we consider solutions for which the congruence  $\Psi_i$  is shear-free we get

$$(\Psi_{i;j} + \Psi_{j;i})\Psi_i = \theta^2, \quad (2)$$

where a semicolon indicates covariant differentiation and  $\theta = \psi^i_{;i} = \psi^i_{;i}$ , a comma indicating partial differentiation.

Equation (2) can be put in the form

$$\eta^{km}\eta^{\alpha\beta}\Psi_{\alpha,k}\Psi_{\beta,m} + \Psi^{\alpha}_{;\beta}\Psi^{\beta}_{;\alpha} = \theta^2; \quad (3)$$

and since<sup>1</sup>

$$\eta^{km}\eta^{\alpha\beta}\Psi_{\alpha,k}\Psi_{\beta,m} = \frac{b\theta}{H}, \quad (4)$$

and

$$\Psi^{\alpha}_{;\beta}\Psi^{\beta}_{;\alpha} = -\dot{\theta}, \quad (5)$$

where

$$\dot{\theta} = \theta_{;i}\Psi^i, \quad (6)$$

and

$$b = \dot{H} + H\theta, \quad (7)$$

we get

$$H\dot{\theta} - \dot{H}\theta = 0. \quad (8)$$

If  $\theta \neq 0$ , since  $H$  cannot be zero, we get

$$H = g\theta \quad (9)$$

where  $g$  is a function such that

$$\dot{g} = 0. \quad (10)$$

The relation (9) between  $H$  and  $\theta$  can be verified for the Kerr and Vaidya solutions.

For Kerr solution

$$H = \frac{m\rho^2}{(\rho^4 + a^2z^2)} \quad \theta = -\frac{2\rho^3}{(\rho^4 + a^2z^2)}$$

so that  $g = -m/2$ ,  $m$  being a constant, so that (10) is satisfied.

For Vaidya solution

$$H = \frac{m}{r}, \quad \theta = \frac{2}{r}$$

so that  $g = m/2$  and although  $m$  is a function of  $(r-t)$ , one can easily see that (10) is satisfied.

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### LIQUID CRYSTALLINE BEHAVIOUR OF SOME NAPHTHALENE DERIVATIVES

LIQUID crystalline behaviour of Schiff bases containing naphthalene moiety has been reported before<sup>1-4</sup>. The liquid crystallinity of such compounds is influenced by the position of the substituents in the naphthalene nucleus. Recently, Dewar *et al.*<sup>5</sup> studied a number of liquid crystalline esters of *p*-*n*-alkoxybenzoic acids with hydroquinone (III), 1,4-dihydroxybicyclo (2,2,2) octane (IV) and 1,4-dihydroxy *trans*-cyclohexane (V). The present investigation was undertaken with a view to studying the effect of a central naphthalene nucleus on the mesomorphic properties of such molecules. In this note we present the liquid crystalline behaviour of the esters of 1,4- and 1,5-naphthalene bis(*p*-*n*-alkoxybenzoates). Table I compiles the molecular geometry and the transition temperatures of different homologous series.

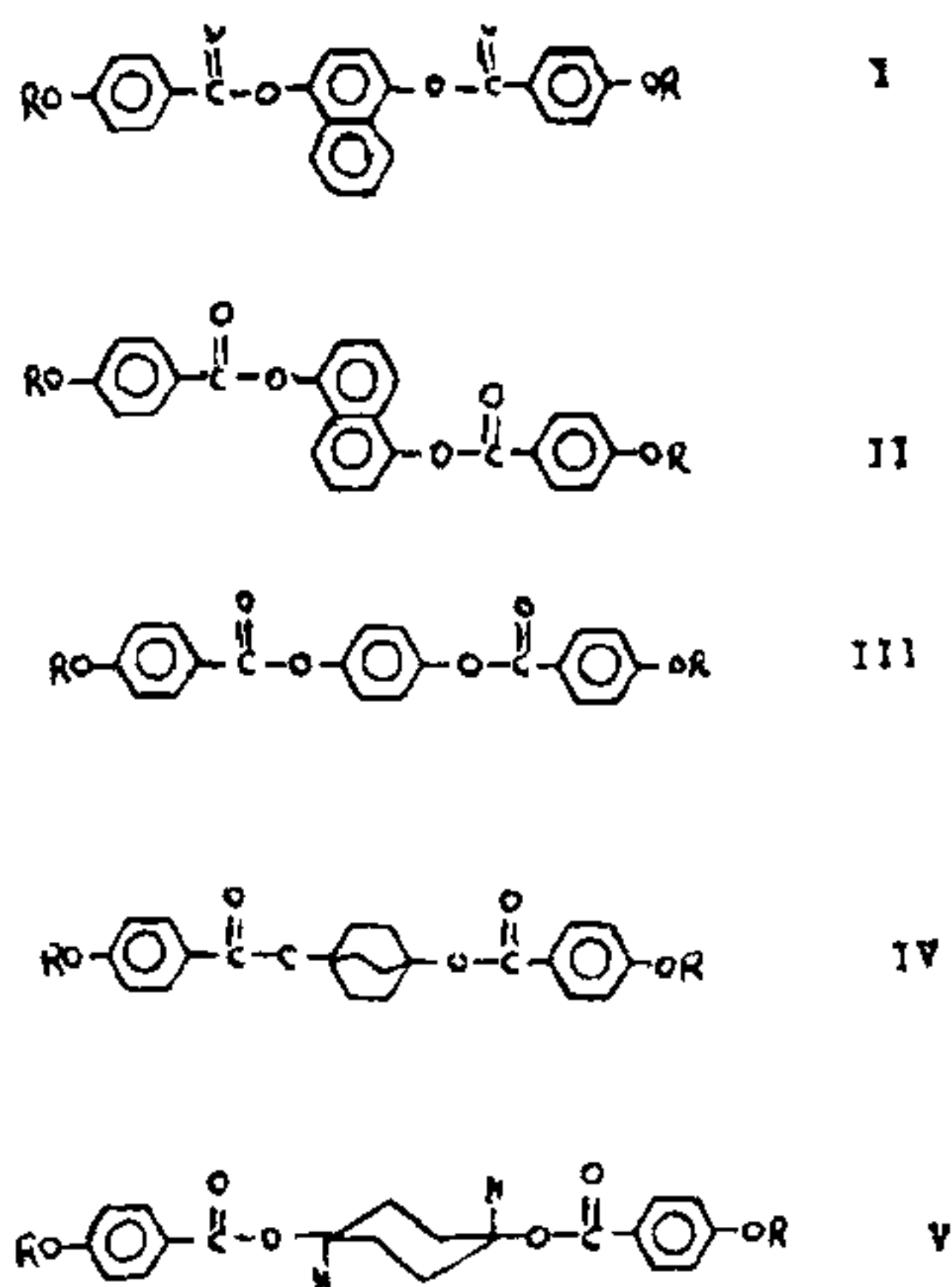
TABLE I

Compound	Transition temperature in °C.	
	Solid-Nematic	Nematic-Isotropic or Solid-Isotropic
I (a)	180	229
I (b)	196	236
II (a)	216	235
II (b)	227	257
III (a)	213	297
III (b)	226	287
IV (a)	185	269
IV (b)	171	273
V (a)	(195)	197

Figure in parenthesis indicates monotropy.  
(a) = CH<sub>3</sub>; (b) = C<sub>2</sub>H<sub>5</sub>.

The length and geometry of the molecules in the series compared are almost the same but thermal stabilities of their mesophases differ. Series III is the thermally most stable of the series discussed. This of course is expected because the molecule is having a rigid linear geometry which is ideal for the mesophase formation.

Series I is essentially series III with a fused benzene ring at the 2,3 position of the central unit. This substitution on the side increases the breadth of the molecule and so reduces the thermal stabilities of the mesophases as reported by Dave *et al.* in 4-*n*-alkoxy-1-naphthylidene Schiff bases<sup>2-4</sup>. Compared to series I the mesophases of the molecules of series II are thermally more stable. The molecules of series I and II are geometrically similar except for the attachment of the benzyloxy groups at those (1,5) positions in series II where the breadth increasing effect is not so manifest, as is the case in (1,4) positions in series I. It has been shown by Wiegand<sup>1</sup> that dianisal 1,5-naphthalenediamine is thermally more stable than the corresponding 1,4-naphthalenediamine Schiff base.



Molecular geometry of series I to V.

Series IV is thermally more stable than series I and II. This can also be attributed to the increased breadth of the molecules of series I and II. Series V is the thermally least stable. The methoxy derivative is even monotropic. This behaviour of this series could be assigned to the central cyclohexane ring which lacks the rigidity of the molecule which is essential for the liquid crystallinity<sup>5</sup>.

The authors express their thanks to Professor S. M. Sethna for his interest in the work. One of

us (B. C. J.) is thankful to the Gujarat Government Scientific and Industrial Research Committee for the award of an assistantship and a research grant.

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Baroda-2, February 12, 1973. GEORGE KURIAN.

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### ZINC (II) COMPLEXES WITH SUBSTITUTED PYRIDINES AND QUINOLINE

IN continuation of our earlier work<sup>1,2</sup> on zinc(II) complexes with nitrogen donor ligands, we report here some more complexes of substituted (3-amino, and 2-amino-4-methyl) pyridines and 2-methyl quinoline. Ethanolic solution of zinc halides were treated with the ligand in ethanol in 1:2 mole ratio with brisk shaking. Immediately the compounds precipitated which were filtered, washed with ethanol followed by ether, and dried *in vacuo*. Metal and halogen were estimated by standard methods, conductance was measured in acetone using a conductance bridge, and infrared spectra were recorded in Nujol mull using a Unicam Sp-200 spectrophotometer. The analytical data are given in Table I.

The compounds are fairly soluble in acetone. The molar conductance ( $\Lambda_m$ ) values in acetone ( $10 \text{ ohm}^{-1} \text{ cm}^2 \text{ mole}^{-1}$ ) indicate the non-electrolytic nature of the compounds since the value for 1:1 electrolytes is about  $150 \text{ ohm}^{-1} \text{ cm}^2 \text{ mole}^{-1}$ . Infrared spectra show that most of the ligand absorption bands are split or shifted due to change in bond order consequent to metal ligand bonding. Direct metal ligand stretching frequencies could not be recorded since they are beyond the range of spectrophotometer used.

Divalent zinc ion has a completely filled  $3d^{10}$  shell. Generally, four coordinated tetrahedral complexes can be formed. Several such compounds were reported earlier<sup>3,4</sup>. Compounds of the composition  $\text{ZnL}_2\text{X}_2$  where L is 3-amino, and 2-amino-4-methyl pyridine may be four coordinated complexes having presumably a tetrahedral environment around the metal ion as reported earlier<sup>3,4</sup>. The compounds having the formula  $\text{ZnLX}_2$  where L is 2-methyl-quinoline are apparently three coordinated. They are sparingly soluble in common organic solvents. Hence, the  $\text{ZnLX}_2$  complexes may be dimer or a