grams have been calculated for model systems with various values of the amphiphile length-to-width ratio r and the interaction energies ϵ_{AA}, ϵ_{AB}, *etc.* in an effort to elucidate more fully the molecular factors which govern the formation and stability of lipid bilayers. This basic model has been modified by allowing the amphiphilic 'r-*mers*' to form bilayer vesicles which can be packed on the lattice together with water molecules and individual amphiphile molecules. It is hoped that this modified model will be useful for studying the phase transition between the bilayer smectic phase and a solution of bilayer vesicles.

Unusual Mesogenic Compounds; Molecular Geometry and Stability of Ordered Fluid Mixtures

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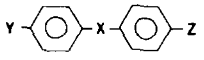
The most known mesogenic molecules have the following structure



(calamitic molecules) conducting to nematic and smectic mesophases.

With this general scheme and particular terminal groups pure compounds exhibiting stable nematic or smectic mesophases and particular physical properties can be obtained. For example with stable free radicals we obtain mesomorphic spin labels for the structural studies by ESR technique. With a side group incorporating an appropriate heavy metal atom we obtain derivatives suitable for Mössbauer measurements.

Other mesophases can be obtained with non extended molecules: plastic crystals with globular molecules and discotic mesophases with disk-like molecules.

A simple way to study the respective stabilities of the mesomorphic and isotropic binary mixtures *versus* temperature and concentration is the selting of isobaric phase diagrams.

Generally two mesogenic molecules having a similar geometrical form are totally miscible in the mesomorphic states. Contrarily, two mesogenic molecules exhibiting dissimilar forms (calamitic and globular, calamitic and disk-like, globular and discotic) are totally miscible in the liquid phase, but the common miscibilities in the partially ordered states are very small.

Relaxation Effects and Molecular Interactions

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The molecular rotational motion is one of the most important mechanisms determining relaxation of macroscopic physical properties and spectral profiles in liquid crystals. Under these circumstances, the relaxation effects are interpreted in terms of a conditional probability $P(\Omega_0; \Omega, t)$ for the change of orientation from Ω_0 to Ω. When this is assumed to occur through small angular steps, $P(\Omega_0; \Omega, t)$ is the solution of a generalized diffusion equation in which the anisotropic pseudo-potential $V(\Omega)$ responsible for the liquid crystalline ordering is introduced [1]:

$$(\partial/\partial t) P(\Omega_0; \Omega, t) =$$
$$-L \cdot D \cdot [L + (LV)/kT] P(\Omega_0; \Omega, t)$$

where L is the operator generating infinitesimal rotations and D the diffusion tensor.

In this way, information on the long-range interactions which give rise to the orientational ordering can be obtained from relaxation experiments. As an example, it is examined the effect of a 'diffuse cone' or 'tilted' rotation [2, 3] in smectic-A mesophases on a variety of spectroscopical techniques, including NMR relaxation, ESR lineshapes, dielectric dispersion and neutron scattering. To describe the tilted rotation, the orientational potential is written as a sum of second and fourth-rank legendre polynormals:

$$V(\beta) = \alpha[P_2(\cos\beta) + \lambda P_4(\cos\beta)]$$

the parameters α and λ being adjusted to give selected order parameters $\bar{P}_2$ and tilt angle. With this choice $V(\beta) = V(\pi - \beta)$, as it is the case for uniaxial, non-polar mesophases. The orientational distribution function generated from this potential can give negative values for $\bar{P}_4$.

The validity of the diffusional model is theoretically supported by a general memory-function approach, which also provides additional information on the short-range frictional forces. The method is based on the three-variable expansion of the Mori equations [4, 5], adapted to anisotropic systems, where the generalized spherical harmonics are no longer independent variables.

The Fourier transforms $J_{MN}(\omega)$ of the correlation functions $G_{MN}(t) = (\delta D^M(t), \delta D^N(o)^*)$ are found to be:

$$J_{MN}(\omega) = \sum_{Ki}\sum X_{Mi}X^{-1}_{iK}\, G_{KN}(o) \times$$
$$\times\ \{i\omega + \lambda_i K_0[i\omega + K_1/(i\omega + \gamma)]^{-1}\}^{-1}$$

where X and $\{\lambda\}$ are eigenfunctions and eigenvalues of the anisotropic diffusion operator. The expansion parameters K_0, K_1 are related to mean-square angular velocity and (total) torque N, and $1/\gamma$ to the torque relaxation time. The diffusion equation results are recovered under 'strong anisotropic interaction limit' (SAIL) conditions [6], $K_1/K_0 = N/kT >> 1$.

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The Effect of Solute Structure on the Nematic–Isotropic Transition in Binary Mixtures

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Systematic thermodynamic and statistical-mechanical studies of nematic–isotropic (NI) phase equilibria in binary mixtures have provided significant information on the effects of molecular size, shape and flexibility on the orientational order and stability of nematic mesophases [1–3].

The addition of solute to a nematogenic solvent either depresses or elevates the NI transition temperature (T_{NI}) of the pure solvent and gives a two-phase region. The phase diagram in the T^*–x_2 plane $T^* = T/T_{NI}$; x_2 = solute mole fraction) yields coexistence curves that are virtually linear for $x_2 < \sim 0.10$. Of interest is the negative of the slope of the lower phase-boundary line (nematic/nematic + isotropic), $\beta_N = -(dT^*/dx_2)_N$, which is a measure of the order-destroying (positive β_N) or order-enhancing (negative β_N) ability of a solute.

Experimental β_N results are presented for mixtures of quasispherical (tetra-n-alkyl tins), chain-like (n-alkanes) and rodlike (*p*-polyphenyls) solutes dissolved in nematogenic solvents (MBBA and 5CB). These results are compared with the predictions of lattice models, which stress the predominant role of repulsive interactions.

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Properties of Amphiphilic Nematic Systems†

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Nematic liquid crystalline states formed in mixtures of surfactant and water correspond to anisotropic micelle solutions with anisometric surfactant aggregates of a finite size. Addition of salts and co-surfactants stabilize in general the nematic state. An addition of chiral compounds leads to the formation of cholesteric states.

There are two different nematic states and direct transitions between the states are possible. The transition is weakly first order. The temperature dependence of the nematic order parameter can be positive or negative. It differs in general significantly from that found in thermotropic nematics. Curvature elastic and viscous properties seems to be qualitatively the same as in thermotropic nematics. Results on curvature elasticity coefficients obtained on the decylammoniumchloride/NH_4Cl/water system will be discussed and the methods of measurements described.

Incorporation and Transport of Solutes in Lipid Bilayers

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Lipid bilayers are excellent solvents for amphiphatic, hydrophobic and even charged molecules. This property is essential for the role of the lipid bilayer as fundamental building unit of biological membranes where a large class of molecules ranging from small substrates to large enzyme complexes must be organized in well defined structures. This property is closely related to the liquid-crystalline structure and the two-dimensionality of the bilayer. The molecular organization of bilayers and mono-

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