

## Far Infrared Spectra of Nematic 4-Cyano-4'-n-heptylbiphenyl Aligned with Electric Fields

By GARETH EVANS and MYRON EVANS\*

(University College of Wales, Aberystwyth SY23 1NE)

*Summary* The far i.r. absorption spectrum of 4-cyano-4'-n-heptyl-biphenyl (HCB) in the field-aligned nematic phase consists of a large number of sharp peaks, most of

which are unresolved in the unaligned nematic; the overall spectral intensity being considerably reduced by polarisation effects as field strength increases.

We present far i.r.<sup>1</sup> spectra of the nematogen<sup>2,3</sup> 4-cyano-4'-n-heptyl-biphenyl (HCB) in the unaligned condition, and also aligned parallel to the window surface of the containing cell with electric fields. The effect of the field is to split the broad absorption observed in the unaligned phase into many more and sharper components: more, indeed, than are observed in the crystalline solid. This might be of interest in the analysis of display device mesophases.

The accuracy of the data obtainable with our Grubb-Parsons interferometer is discussed fully elsewhere.<sup>4</sup> It is estimated at *ca.*  $\pm 2\%$  of the power absorption coefficient  $\alpha(\bar{\nu})$  at each frequency. The spectra were obtained in a specially built variable path length cell made of TPX polymer,<sup>4</sup> so that the windows and framework of this cell

tion substantiate this. The field splitting effect plus loss of intensity seems characteristic of the HCB nematic phase, since little difference in absorption *intensity* with increasing field has been discerned in the room temperature smectic phase of 4-cyano-4'-n-octyl-biphenyl, and the cholesteric phases of cholesteryl oleyl carbonate and cholesteryl linoleate. The effect on the spectral bandshapes and positions of these is to be investigated.

The change in alignment of the nematic director with the application of an external d.c. field is relevant to the development of a theoretical model treating the appearance of so many extra peaks, especially when it is borne in mind that the field apparently has little effect on the smectic phase. It will be established in our detailed report on this

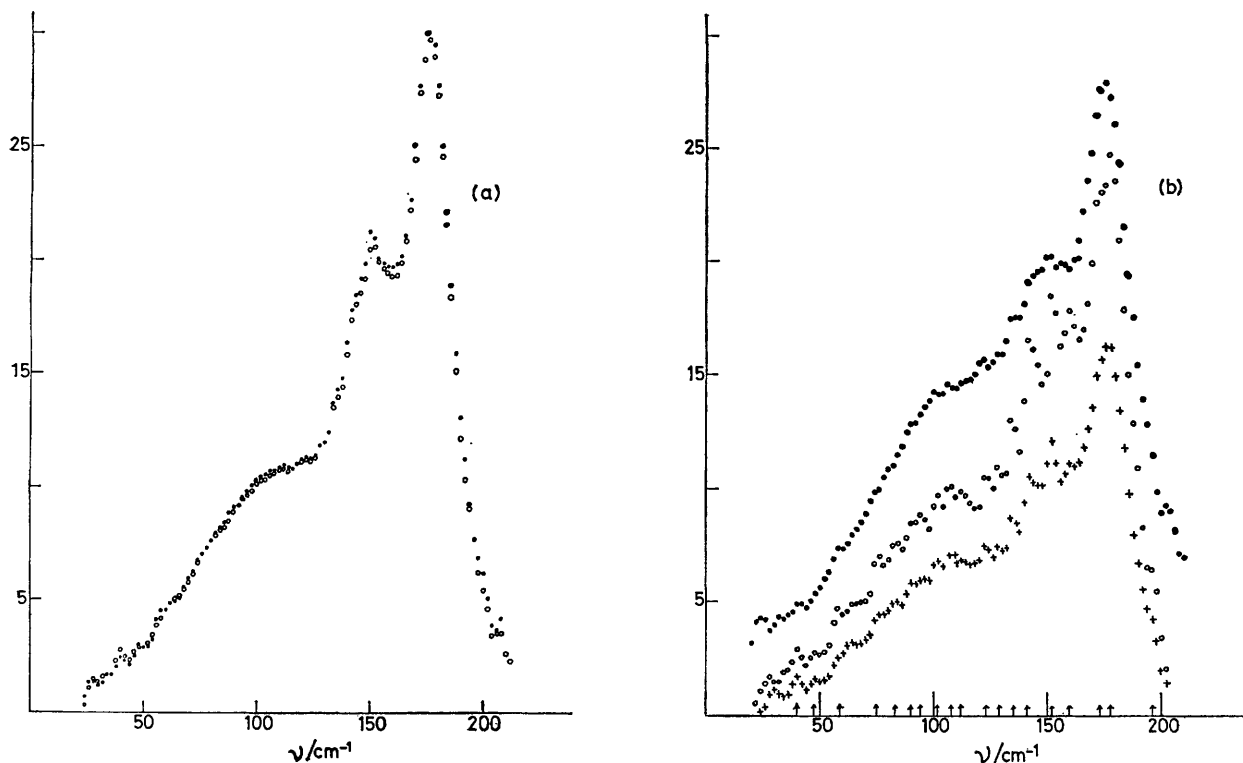


FIGURE. (a) Nematic phase of HCB at 299 K, unaligned (no applied field, no treatment of the window surfaces): far i.r. absorption. ○ Applied field of  $1 \text{ kV cm}^{-1}$ . (b) ● Aligned nematic phase of HCB at 299 K, applied field of  $2.0 \text{ kV cm}^{-1}$ . ○ Applied field of  $3.0 \text{ kV cm}^{-1}$ . + Applied field of  $7.1 \text{ kV cm}^{-1}$ .

consist of the same material, and it is possible at all times to observe the nematogen visually. Fields of up to  $7 \text{ kV cm}^{-1}$  were applied, and their effect is illustrated in the Figure. There are no traces of water absorption in the spectrum of the unaligned nematogen. This is important because the field-applied spectra were taken consecutively with the same sample under the same background and temperature conditions. The random noise level of each spectrum is small (Figure, a).

With a resolution of  $4 \text{ cm}^{-1}$ , some of the peaks in the Figure are incompletely resolved, which testifies to their narrow half-widths. Preliminary runs at a higher resolu-

work whether or not these peaks are torsional modes of the Poley type, which may be linked<sup>5</sup> to the lower frequency Debye process in aligned HCB, which ought to be broadened from the single Debye were this the case.

It is difficult to see why interference fringes can account for the observed peaks, especially as these do not appear in the solid.

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