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Coherent Optical Sources using Micromolecular Ordered Structures

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Modelling of Liquid Crystal Lasers

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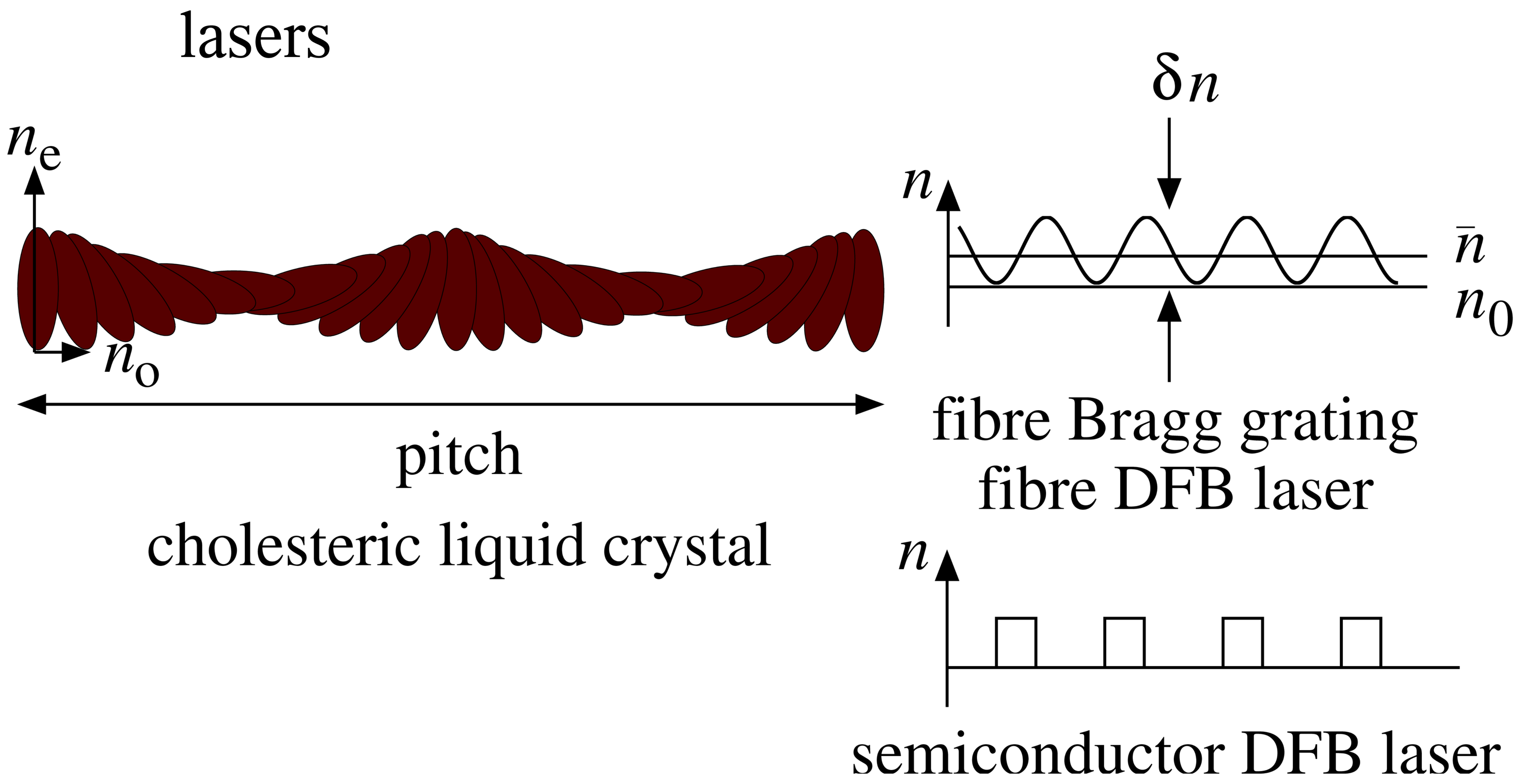
Liquid Crystal lasers are distributed feedback (DFB) lasers

- Chiral birefringent structure similar to index modulation in semiconductor and fibre DFB lasers



- Bandgap for light of one circular polarisation

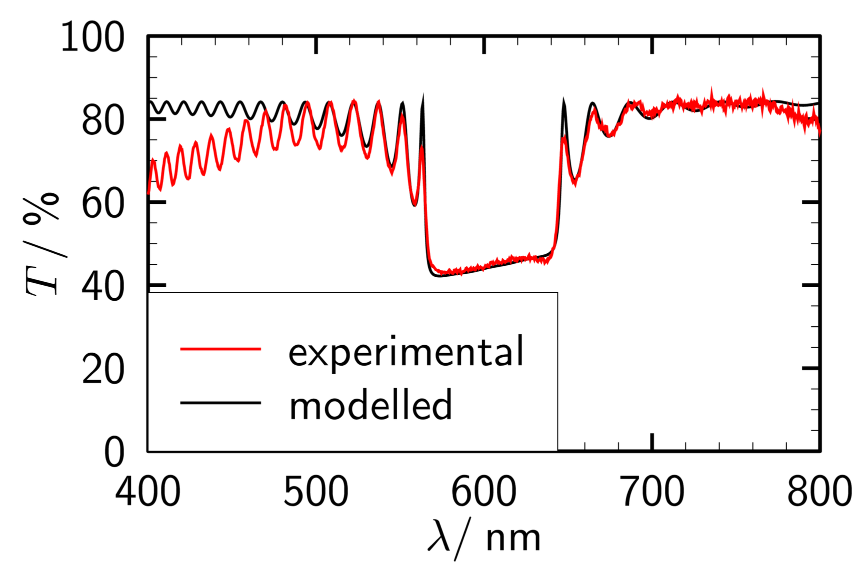


Fig. 1 Transmission spectrum of chiral LC measured with linear polarised light. Modelled spectrum calculated with transfer matrix approach.

- Access to a vast amount of theory and device designs from semiconductor and fibre DFB lasers
  - Coupled mode theory
  - Analytic solutions or transfer matrices
- ⇒ identify possible routes to improve LC lasers and achieve cw operation through different laser designs and gain materials

Coupled mode theory and transfer matrices applied to liquid crystal lasers

- Two counter propagating waves R and S coupled by scattering from chiral LC structure

$$\frac{dR}{dz} = (\alpha + i\delta)R + i\kappa S$$

$$\frac{dS}{dz} = -(\alpha + i\delta)S - i\kappa^* R$$

α = amplitude gain, δ = wavelength detuning, κ = coupling coefficient

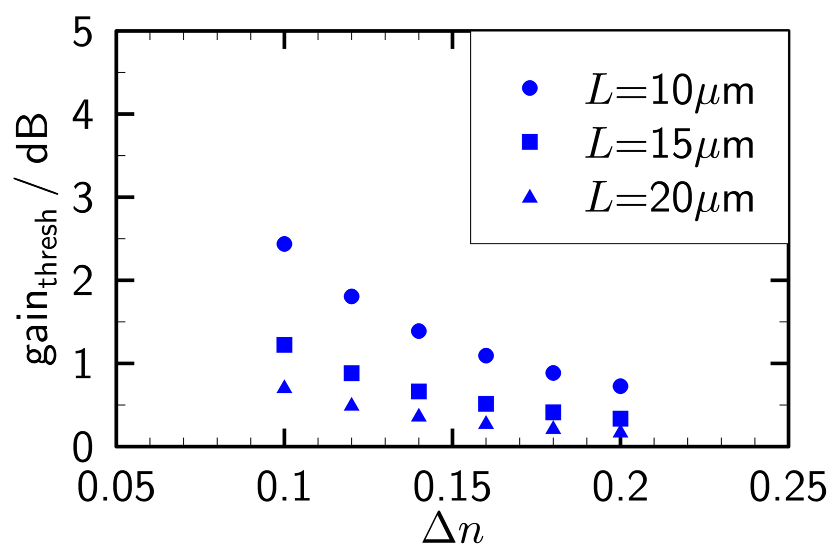


Fig. 2 Required threshold gain for LC with different birefringence and length. This gain has to be obtained over a few µm!

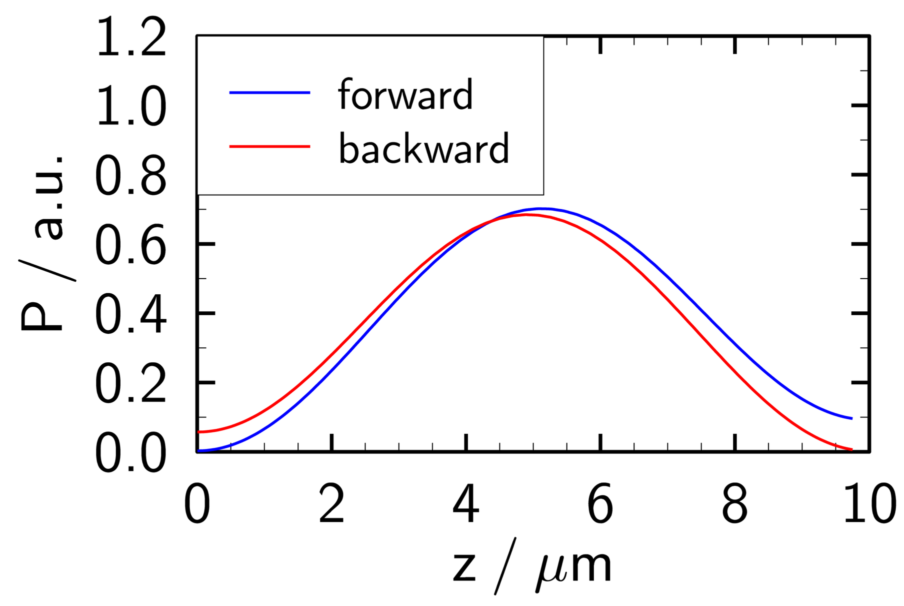


Fig. 3 Internal power along CLC laser just above threshold. L = 9.75µm. Calculated using transfer matrices. Large concentration of lasing power at centre of device ⇒ internal heating.

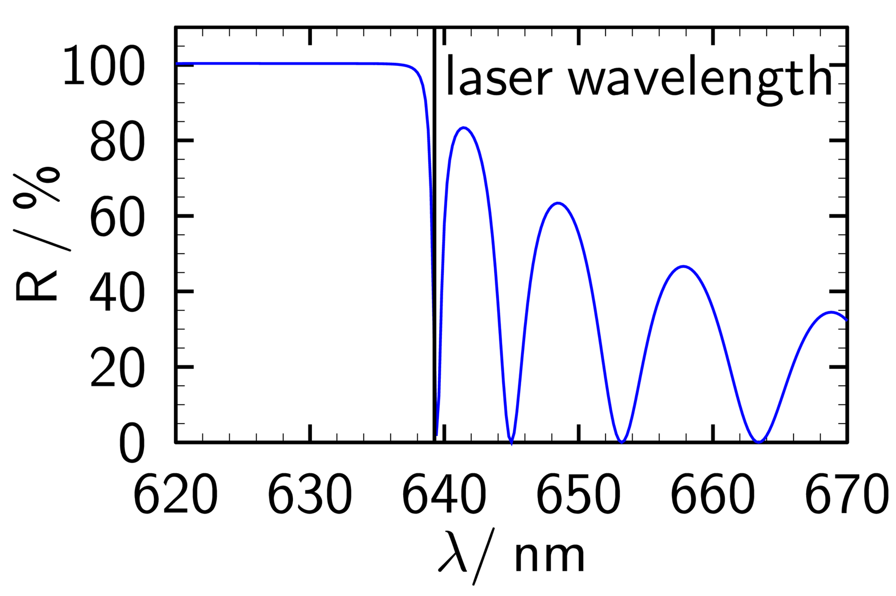
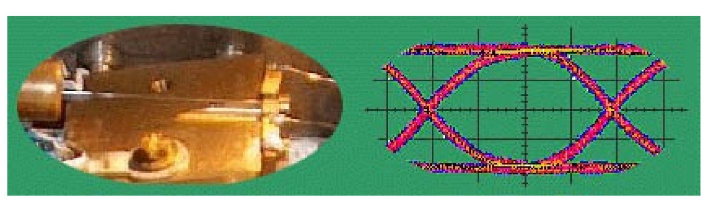


Fig. 4 Lasing wavelength in relation to reflection spectrum. Lasing occurs near the null in the spectrum.

Further reading: O. Hadeler et al., 33rd Topical Meeting of Liquid Crystals, Paderborn, Germany, P35 (2005)
D.-K. Yang and X.-D. Mi, J. Phys. D **33** pp. 672 (2000)
H. Kogelnik and C.V. Shank, J. Appl. Phys. 43 pp. 2327 (1972)



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