

# Contents

<b>Nomenclature</b>	ii
<b>Summary</b>	vi
<b>Résumé</b>	viii
<b>Samenvatting</b>	x
<b>Sommario</b>	xii
<b>1 Introduction</b>	1
<b>2 Liquid crystals and solitons</b>	5
2.1 Thermotropic liquid crystals . . . . .	5
2.2 Nematics . . . . .	6
2.2.1 Dielectric tensor . . . . .	6
2.2.2 Free energy in the continuum theory . . . . .	7
2.2.3 Electric field responses . . . . .	8
2.3 Chiral nematic LCs . . . . .	10
2.3.1 Optical band-gap . . . . .	10
2.3.2 Free energy in the continuum theory . . . . .	12
2.3.3 Electric field responses . . . . .	12
2.4 Liquid crystal cells . . . . .	14
2.4.1 Fréedericksz threshold . . . . .	14
2.4.2 Cell fabrication . . . . .	15
2.5 Optical solitons . . . . .	15
2.5.1 Light propagation in dielectric media . . . . .	16
2.5.2 Linear propagation . . . . .	17
2.5.3 Optical Kerr soliton . . . . .	18
2.6 Nematicons . . . . .	20
2.6.1 Constitutive equations . . . . .	21
<b>3 Spatial fluctuations of solitons in LCs</b>	25
3.1 Soliton propagation in LCs without noise . . . . .	25
3.1.1 Propagation equation . . . . .	26
3.1.2 Reorientation equation . . . . .	29
3.2 Numerical results . . . . .	31
3.2.1 Importance of the frame of reference . . . . .	32
3.2.2 LC reorientation, beam profile and walk-off . . . . .	32
3.3 Correlated thermal noise in LCs . . . . .	34
3.3.1 Director correlation . . . . .	34
3.3.2 Director correlation on the discretization grid . . . . .	36
3.3.3 Generate a correlated noise . . . . .	37
3.4 Light propagation in LCs . . . . .	38
3.4.1 Linear propagation and speckle formation . . . . .	39
3.4.2 Nematicon propagation, numerical and experimental . . . . .	39
3.5 Conclusions . . . . .	43

<b>4 Optical gain in liquid crystals</b>	45
4.1 Organic semiconductors . . . . .	46
4.1.1 Excited species in organics . . . . .	49
4.2 Pump-probe technique . . . . .	50
4.2.1 The experimental setup . . . . .	50
4.2.2 The pump-probe signal . . . . .	51
4.3 Dyes in LCs . . . . .	52
4.3.1 Photophysical characterization . . . . .	53
4.3.2 Amplified spontaneous emission . . . . .	55
4.4 Polymers in LCs: PFO . . . . .	56
4.4.1 Preparation of the sample . . . . .	57
4.4.2 Morphology, absorption and photoluminescence of the samples . . . . .	57
4.4.3 Photophysical characterization . . . . .	60
4.5 Conclusion . . . . .	64
<b>5 Chiral nematic liquid crystals for tuning and feedback</b>	65
5.1 Uniform lying helix . . . . .	65
5.2 Sample preparation . . . . .	66
5.2.1 Shear-flow technique . . . . .	67
5.2.2 Solvent evaporation technique . . . . .	68
5.3 Contrast ratio . . . . .	71
5.4 Flexoelectro-optic effect . . . . .	72
5.4.1 Measurement of the tilt angle . . . . .	72
5.4.2 Flexoelectro-optic characterization . . . . .	73
5.5 Spatial instabilities . . . . .	74
5.6 In-plane characterization . . . . .	75
5.7 Conclusion . . . . .	76
<b>6 Interplay between gain, nonlinearities and feedback</b>	79
6.1 ASE and nematicon . . . . .	79
6.1.1 The optical setup . . . . .	79
6.1.2 Results and discussion . . . . .	81
6.2 Investigation of lasing from dye-doped solvent-induced polymerized ULH . . . . .	84
6.2.1 Sample preparation via two-photon photopolymerization . . . . .	85
6.2.2 Investigation of laser emission . . . . .	88
6.3 Conclusion . . . . .	90
<b>7 Conclusions</b>	91
7.1 Outlook . . . . .	91
<b>A Notation for the permittivity</b>	93
<b>B Matlab code</b>	94
B.1 Main section . . . . .	94
B.2 Propagation equation . . . . .	101
B.3 Optimization of the molecular orientation . . . . .	103
B.4 Correlation matrix . . . . .	104
B.5 Auxiliary functions . . . . .	105
<b>Bibliography</b>	124