

# Contents

|  |           |
|--|-----------|
| <b>Introduction</b>  | <b>1</b>  |
| 0.1 Objectives . . . . .   | 2         |
| 0.2 Figure notation and abbreviations . . . . .  | 2         |
| <b>1 Framework</b>   | <b>3</b>  |
| 1.1 Liquid crystals . . . . .  | 3         |
| 1.2 Free Energy . . . . .  | 5         |
| 1.3 Fréedericksz Voltage . . . . .   | 8         |
| 1.4 Vortices in liquid crystal . . . . .   | 9         |
| 1.5 Topological transitions . . . . .  | 10        |
| <b>2 Umbilical defect dynamics in an inhomogeneous nematic liquid crystal layer</b>                    | <b>15</b> |
| 2.1 Experimental Setup . . . . .   | 16        |
| 2.2 Results . . . . .  | 17        |
| 2.3 Defects dynamics in presence of a glass beads . . . . .  | 20        |
| <b>3 Topological transitions at room temperature in nematic liquid crystal cell out of equilibrium</b> | <b>27</b> |
| 3.1 Experimental Setup . . . . .   | 28        |
| 3.2 Results . . . . .  | 28        |
| <b>4 Magnetic ring induced vortex triplet in a liquid crystal layer</b>                                | <b>36</b> |
| 4.1 Experimental Setup . . . . .   | 36        |
| 4.2 Results . . . . .  | 38        |
| 4.3 Intuitive description . . . . .  | 43        |
| 4.4 Theoretical description . . . . .  | 44        |
| 4.5 A new phenomenon . . . . .   | 48        |
| <b>5 Vortex nucleation by inherent fluctuations in nematic liquid crystal layers</b>                   | <b>51</b> |
| 5.1 Experimental Setup . . . . .   | 51        |
| 5.2 Theoretical description . . . . .  | 53        |
| 5.3 Numerical Simulations . . . . .  | 54        |
| 5.4 Results . . . . .  | 55        |
| 5.4.1 Number of vortices as a function of bifurcation parameter . . . . .                              | 55        |
| 5.4.2 Number of vortices as a function of anisotropy . . . . .   | 56        |
| 5.4.3 Number of vortices as a function of noise . . . . .  | 57        |

|          |   |            |
|----------|---|------------|
| 5.4.4    | Number of vortices as a function of temperature . . . . . | 58         |
| 5.4.5    | Number of vortices as a function of time . . . . .        | 59         |
| <b>6</b> | <b>Conclusions</b>  | <b>63</b>  |
|          | <b>Bibliography</b>                                       | <b>64</b>  |
|          | <b>Appendix A</b>   | <b>83</b>  |
|          | <b>Appendix B</b>   | <b>95</b>  |
|          | <b>Appendix C</b>   | <b>107</b> |
|          | <b>Appendix D</b>   | <b>117</b> |
|          | <b>Appendix E</b>   | <b>123</b> |
|          | <b>Appendix F</b>   | <b>123</b> |