

CONTENTS

Abstract (Chinese)		i
Abstract (English)		ii
Acknowledgements		iv
Contents		v
List of Tables		vii
List of Figures		viii
Symbols		xi
CHAPTER 1.	INTRODUCTION	1
1.1	Motivations	1
1.2	Scope and description of the study	2
CHAPTER 2.	TUNABLE EXTERNAL-CAVITY DIODE LASERS	4
2.1	External-cavity diode lasers	4
2.2	Wavelength tuning mechanisms	6
2.2.1	Mechanical tuning	6
2.2.2	Electronically tuning	10
CHAPTER 3.	TUNABLE LIQUID CRYSTAL FILTERS	15
3.1	Birefringent filters	15
3.2	Fabry-Perot étalon filters	17
3.3	Spatial light modulators	18
CHAPTER 4.	OPERATION PRINCIPLES OF TUNABLE EXTERNAL-CAVITY DIODE LASERS	21
4.1	Tunable ECDL	21
4.1.1	Diffraction gratings	22
4.1.2	Mode hopping	24
4.2	Nematic liquid crystals	26
4.3	Planar-aligned NLC cell	27
4.3.1	Structures and basic principles	27
4.3.2	The NLC cell in the laser cavity	31
4.3.3	Mode-hop-free tuning	32
4.4	Liquid crystal pixel mirror	32
4.4.1	Structures and operation principles	32
4.4.2	LCPM based ECDL	38
CHAPTER 5.	FINE-TUNING OF AN ECDL WITH AN INTRACAVITY LIQUID CRYSTAL ELEMENT	40
5.1	Mode-hop-free wavelength fine-tuning	40
5.1.1	Tuning by the NLC cell	42
5.1.2	Synchronous tuning	46
5.2	Properties of the NLC cell in the laser cavity	50
5.2.1	Tilt angle of the NLC cell	50
5.2.2	Hysterisis and tuning repeatability	51
5.2.3	Response time	53
5.2.4	Proportional constant β of the laser	53

CHAPTER 6.	APPLICATIONS	55
6.1	Sub-Doppler resonances of the rubidium D ₂ -line	55
6.1.1	Doppler-free saturated spectroscopy	55
6.1.2	Rubidium D ₂ -line	56
6.1.3	Experimental setup	57
6.2	Wavelength stabilization	59
6.2.1	Wavelength locked to an étalon	59
6.2.2	Frequency locking to femtosecond optical frequency combs	62
6.3	Fine-tuning of a digitally channel-selectable laser	65
6.4	Liquid crystal cell gap measurements	68
6.4.1	Liquid crystal cell gap of 9.6 μm	71
6.4.2	Liquid crystal cell gap of 4.25 μm	73
6.4.3	Error analysis	74
CHAPTER 7.	CONCLUSIONS AND RECOMMENDATIONS	78
7.1	A summary of the present work	78
7.2	Recommendations for further work	80
7.2.1	Channel selectable laser with LC enabled functionalities	80
7.2.2	Terahertz frequency standards	82
7.2.3	Cell gap measurements	82
Publication List		84
REFERENCES		86
APPENDIX A.	Birefringence of liquid crystals	94
APPENDIX B.	Dual-wavelengths external-cavity diode lasers	99
BIOGRAPHY		116

