

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Star formation . . . . .	4
1.1.1	Low-mass star formation . . . . .	4
1.1.2	High-mass star formation . . . . .	5
1.1.3	Ultraluminous infrared galaxies . . . . .	6
1.2	Infrared spectroscopic data . . . . .	7
1.3	Infrared space instruments . . . . .	8
1.4	Physicochemical properties . . . . .	9
1.4.1	Hot dense regions . . . . .	10
1.4.2	High temperature chemistry . . . . .	11
1.5	Outline of this thesis . . . . .	11
<b>2</b>	<b>ISO–SWS Signal Capture</b>	<b>13</b>
2.1	Introduction . . . . .	14
2.2	SWS detectors and detector read-out . . . . .	14
2.2.1	Detectors artifacts . . . . .	14
2.2.2	Reset of 24 Hz read-out signal . . . . .	16
2.2.3	Read-out electronics . . . . .	16
2.2.4	System noise . . . . .	17
2.3	Calibration and data reduction . . . . .	17
2.4	Deglitching of SWS low resolution data . . . . .	19
2.5	Requirements . . . . .	21
2.5.1	SWS glitch detection . . . . .	22
2.5.2	Correcting the ramp derivative . . . . .	22
2.5.3	Slope fitting . . . . .	23
2.5.4	Deglitching results . . . . .	23
2.6	Conclusions . . . . .	24
<b>3</b>	<b>From Molecular Cores to Planet Forming Disks – a c2d data legacy –</b>	<b>25</b>
3.1	Introduction . . . . .	26
3.2	Reduction of IRS pointed observations . . . . .	29
3.2.1	Bad/hot pixels . . . . .	29
3.2.2	Spectral extraction . . . . .	31
3.2.3	The IRS cross dispersion PSF . . . . .	33
3.2.4	Spectral Response Function (SRF) . . . . .	34
3.2.5	Error propagation . . . . .	35
3.2.6	Defringing . . . . .	36
3.2.7	Order matching . . . . .	37

3.3	Data products of IRS pointed observations . . . . .	38
3.3.1	IRS c2d products . . . . .	38
3.3.2	Source parameters . . . . .	39
3.3.3	Extended emission . . . . .	40
3.3.4	Final source spectrum . . . . .	41
3.3.5	IRS artifacts . . . . .	44
3.3.6	Spikes . . . . .	44
3.3.7	Edge effects . . . . .	45
3.3.8	Module mismatches . . . . .	46
3.3.9	Spectral features . . . . .	46
3.4	Summary . . . . .	50
<b>4</b>	<b>ISO-SWS Spectroscopy of Gas-Phase C<sub>2</sub>H<sub>2</sub> and HCN Toward Massive Young Stellar Objects</b>	<b>53</b>
4.1	Introduction . . . . .	54
4.2	Observations and data reduction . . . . .	56
4.2.1	Observations and sources . . . . .	56
4.2.2	Data reduction . . . . .	56
4.3	Model spectra and fits . . . . .	58
4.3.1	Synthetic spectra . . . . .	59
4.3.2	Hot bands . . . . .	61
4.3.3	Model fits . . . . .	62
4.4	Results . . . . .	63
4.4.1	AFGL 2591 . . . . .	67
4.4.2	AFGL 2136 . . . . .	67
4.4.3	AFGL 4176 . . . . .	67
4.4.4	W 33 A . . . . .	68
4.4.5	W 3 IRS 5 . . . . .	68
4.4.6	NGC 7538 IRS 1 and IRS 9 . . . . .	68
4.4.7	Other sources . . . . .	68
4.5	Discussion . . . . .	69
4.5.1	Excitation temperature . . . . .	69
4.5.2	Column densities and abundances . . . . .	71
4.5.3	Chemistry . . . . .	73
4.6	Conclusions . . . . .	74
<b>5</b>	<b>c2d <i>Spitzer</i> IRS Spectra of Disks around T Tauri Stars</b>	
	<b>III. [Ne II] and H<sub>2</sub> gas-phase lines</b>	<b>75</b>
5.1	Introduction . . . . .	76
5.2	Observations . . . . .	79
5.2.1	Source selection . . . . .	79
5.2.2	SH mini maps . . . . .	79
5.3	Data reduction . . . . .	80
5.3.1	Separating disk and cloud emission – optimal extraction . . . . .	80
5.3.2	1-D spectra . . . . .	81
5.3.3	Spectral analysis . . . . .	82

5.4	Results . . . . .	82
5.4.1	Atomic fine-structure lines: Neon . . . . .	82
5.4.2	Atomic fine-structure lines: Other species . . . . .	84
5.4.3	Molecular hydrogen . . . . .	84
5.4.4	Correlations . . . . .	87
5.5	Discussion . . . . .	88
5.5.1	[Ne II] . . . . .	88
5.5.2	[Fe I] and [S I] . . . . .	91
5.5.3	Molecular hydrogen . . . . .	91
5.6	Conclusions . . . . .	93
<b>6</b>	<b>c2d <i>Spitzer</i> IRS Spectra of Embedded Protostars: Gas-phase Lines</b>	<b>103</b>
6.1	Introduction . . . . .	104
6.2	Observations and data reduction . . . . .	105
6.3	Results . . . . .	107
6.3.1	Atomic fine-structure lines . . . . .	107
6.3.2	Molecular hydrogen . . . . .	107
6.3.3	Correlations . . . . .	110
6.4	Discussion . . . . .	110
6.4.1	Extended emission . . . . .	112
6.4.2	Spatially unresolved emission . . . . .	112
6.4.3	Hot H <sub>2</sub> . . . . .	114
6.5	Conclusions . . . . .	115
<b>7</b>	<b>Hot Organic Molecules Toward a Young Low-mass Star: a Look at Inner Disk Chemistry</b>	<b>125</b>
7.1	Introduction . . . . .	126
7.2	Observations . . . . .	127
7.3	Analysis . . . . .	128
7.4	Discussion . . . . .	130
<b>8</b>	<b>Infrared Molecular Starburst Fingerprints in Deeply Obscured (Ultra)Luminous Infrared Galaxy Nuclei</b>	<b>133</b>
8.1	Introduction . . . . .	134
8.2	Observations . . . . .	135
8.3	Analysis . . . . .	137
8.3.1	Molecular analysis . . . . .	137
8.3.2	Fit results . . . . .	138
8.3.3	Abundances . . . . .	139
8.3.4	Gas temperature . . . . .	140
8.4	Discussion . . . . .	142
8.4.1	Warm molecular gas in (U)LIRGs . . . . .	142
8.4.2	AGN activity and X-ray-driven chemistry . . . . .	142
8.4.3	Static hot-core chemistry . . . . .	144
8.4.4	Pressure confined starburst chemistry . . . . .	144
8.5	Summary . . . . .	145

Contents	iv
<hr/>	
<b>Bibliography</b>	<b>147</b>
<b>Nederlandse Samenvatting</b>	<b>155</b>
<b>Curriculum Vitae</b>	<b>161</b>
<b>Papers in Refereed Journals</b>	<b>162</b>
<b>Nawoord</b>	<b>163</b>