

DIAGNOSIS AND MODELLING OF OPTICALLY THICK
STRUCTURES IN THE LOWER SOLAR ATMOSPHERE

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Abstract

This thesis presents a study of escape probability and absorption factor techniques for describing the effects of opacity on atomic population structure and emergent spectral line intensities in the context of solar atmospheric plasmas. These techniques are presented and used in conjunction with data from the SUMER spectrometer onboard the SOHO spacecraft from which values of optical depth are directly extracted. From these, spectral lines of C II and C III are classified according to their disk centre and limb optical depths and also according to the influence of opacity on the upper level population density of each line.

Escape probability quantities are then used with the SUMER data to assess the applicability of simple stratified atmosphere models in describing spectral emission from the highly inhomogeneous solar transition region.

Following this, the assumptions underpinning the escape probability and absorption factor methods are comprehensively addressed to test the validity of the escape probability expressions and to develop them for use within non-stratified models which include plasma flow and line blending. It is found that for moderate optical depths ($\tau_0 < \sim 10$) the escape probability is an effective tool for accurately describing the effect of opacity on emergent spectral line intensities. Furthermore it is found that they may be used to extract optical depths directly from observational data *independently* of preconceived atmosphere model ideas. The analysis enables the detection of *unresolved* spicule-like structures at the solar limb.

Stratified models are re-addressed with the inclusion of line blending and instrumentally scattered light and it is found that they can be effective in predicting observed spectral emission at the solar limb.

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To my Esther,

for your smile and the joy you've brought to my life.

*Remembering mine affliction and my misery,
the wormwood and the gall.
My soul hath them still in remembrance,
and is humbled in me.
This I recall to my mind,
therefore have I hope.*

*It is of the LORD's mercies that we are
not consumed,
because his compassions fail not.
They are new every morning:
great is thy faithfulness.
The LORD is my portion,
saith my soul;
therefore will I hope in him.*

Lamentations 3:19-24 (KJV)

Contents

List of Figures	viii
List of Tables	xiii
1 Introduction	1
1.1 The solar chromosphere and transition region	3
1.1.1 Solar spicules	8
1.1.2 Solar prominences	14
1.2 Spectral emission from plasmas	15
1.3 The problem of opacity	20
1.3.1 The radiative transfer equation	20
1.3.2 Solving the radiative transfer problem	23
1.4 Thesis overview	27
2 The escape probability approach to opacity	29
2.1 The effect of opacity on emergent intensities	31
2.1.1 Deduction of opacity from observations	37
2.2 The effect of opacity on the population structure	39
2.2.1 Extrapolation to all transitions of an ion	42
2.3 Opacity deduction at the limb of the sun	43
2.4 Atmosphere Modelling	46
2.4.1 Modelling flux ratios on disk	54
2.4.2 Modelling flux ratios beyond the limb	55
2.5 Spectral line classification	61

2.6	The use of $g\{\tau_0\}$ versus $\bar{g}\{\tau_0\}$	63
2.7	Concluding remarks	66
3	The extended escape probability approach: the effect of a variable source function	69
3.1	The source function	70
3.2	The spatially resolved absorption factor	74
3.2.1	$\bar{g}\{\tau_0\}$ as a function of space	74
3.2.2	Inclusion of variable density in the absorption factor expression	75
3.2.3	Verification of the Λ result	78
3.3	The assumption of constant source function	78
3.4	The spatially resolved population calculation	81
3.5	The effect of an opacity modified source function upon the absorption factor	82
3.6	The validity of $\mathcal{G}(\tau_0, x)$	86
3.7	The effect upon the density distributions	88
3.8	The exponential density case	91
3.9	Modelling emergent intensities	92
3.9.1	The modified $\bar{g}\{\tau_0\}$	92
3.9.2	The perspective of scattering into the line-of-sight	96
3.10	The implications of a spatially varying source function upon escape probability techniques	98
3.11	Concluding remarks	99
4	The effects of spectral line blending on photo-absorption	102
4.1	Blended escape probabilities	103
4.2	The blended absorption factor	105
4.3	Modelling emergent intensities with blending included	111
4.4	The effect of a variable source function on absorption	115
4.5	The validity of $\mathcal{G}^{(i)}(\tau_0, x)$ in the blended case	120
4.6	The effect of blending upon the density distributions	123
4.7	The effect of line blending on emergent fluxes	125

4.8	Concluding remarks	127
5	Comments on the effects of structure and flow	130
5.1	Non-stratified models	131
5.2	Models with flow	136
5.3	Concluding remarks	138
6	Plasma diagnostics and models using the improved escape probability	139
6.1	The geometric extension of the line-of-sight	142
6.2	Instrumentally scattered light	145
6.3	Model predictions	146
6.3.1	Fluxes	147
6.3.2	Ratios	149
6.3.3	Discussion	151
6.4	Comments on the effectiveness of stratified models	153
6.5	Extraction of optical depth from observations and the validity of the escape probability approach	155
6.6	Removing the discrepancy between model and observed spectral data	157
6.7	Implications for transition region structure	164
6.8	Concluding remarks	168
7	Thesis summary	171
	Bibliography	176
A	The assumption of constant source function: results for the expo- nential density case	181
B	The effect of line blending: results for the exponential density case	188

List of Figures

1.1	The variation of temperature with height in the solar atmosphere . . .	3
1.2	Image of the solar disk in hydrogen H α at 6563 Å	4
1.3	Image of the solar disk in He II 304 Å	6
1.4	Image of the solar disk in Fe IX 171 Å	7
1.5	Eleven images of spicules at the limb obtained from different regions of the H α line	8
1.6	A region of the disk seen in H α showing dark mottle features	10
1.7	Model of the variation of electron temperature and electron density with height	11
1.8	Two examples of spectral lines originating in the solar chromosphere.	12
2.1	Plot of $g\{\tau_0\}$ vs τ_0	34
2.2	Plot of $\bar{g}\{\tau_0\}$ and $g\{\tau_0/2\}$ vs τ_0	35
2.3	Plot of $A_{2-2}\bar{g}\{\tau_0\}/A_{2-1}\bar{g}\{\tau_0/3.35\}$ vs τ_0	38
2.4	Plot of $\bar{g}\{\tau_0/2\}$ vs τ_0	41
2.5	Plot of $g\{\tau_0\}$, $\bar{g}\{\tau_0\}$ and $\bar{g}\{\tau_0/2\}$ vs τ_0	42
2.6	Plot of C III $2p^{23}P_2/2p^{23}P_1$ population density ratio vs τ_0	43
2.7	Plot of C III $2p^{23}P_2/2s2p^3P_2$ population density ratio vs τ_0	44
2.8	Surface plots of total flux in the slit/raster plane for the C II 904 Å and C III 1175 Å multiplets.	45
2.9	Observed spectrum of the C II 1036 Å multiplet and observed branching line ratios.	47
2.10	Observed spectrum of the C III 1175 Å multiplet and observed branch- ing line ratios.	48

2.11	Observed spectral line fluxes vs position for the C III $2s2p^3P_2 - 2p^2^3P_2$ line at 1175.711 Å.	53
2.12	Observed spectrum of the C III 1175 Å multiplet and observed branching line ratios.	54
2.13	Observed C III branching line ratios vs raster position with calculated values overlaid for positions on the disk	56
2.14	Observed C II branching line ratios vs raster position with calculated values overlaid for positions on the disk	57
2.15	Observed branching line intensity ratios vs raster position for C II and C III with VAL based model ratios overlaid.	58
2.16	Observed branching line intensity ratios vs raster position for C II and C III with VAL based, constant density based, and exponential density based model ratios overlaid.	60
2.17	Observed and model fluxes for the C III $2s2p^3P_2 - 2p^2^3P_2$ line (1175.711 Å)	67
3.1	C II and C III $G(T_e)$ functions.	71
3.2	C II and C III optically thin contribution functions versus electron density.	72
3.3	Examples of C II and C III optically thin source functions versus electron density.	73
3.4	$\mathcal{G}(\tau_0, x)$ vs τ_0 for $x = 0$ and $x = D/2$	76
3.5	$\Lambda(\tau_0, x)$ vs x for a selection of spectral lines of C II.	83
3.6	$\Lambda(\tau_0, x)$ vs x for a selection of spectral lines of C II.	84
3.7	$\Lambda(\tau_0, x)$ and $\mathcal{G}(\tau_0, x)$ vs τ_0 for $x = D/2$ and $x = 0$	87
3.8	Upper level population densities vs spatial position for selected lines of C II	88
3.9	Upper level population densities vs spatial position for selected lines of C II	89
3.10	Upper level population densities vs spatial position for selected lines of C II	90
3.11	Upper level population densities vs spatial position for selected lines of C II	91

3.12	Predicted limb brightening curves for the C II 904.143 Å line including an opacity modified upper level	93
3.13	Predicted limb brightening curves for the C II 903.620 Å line including an opacity modified upper level	94
3.14	$\bar{g}\{\tau_0\}$ and $\bar{g}_r\{\tau_0\}$ vs τ_0 at disk centre and the limb.	95
4.1	$\bar{g}\{\tau_0\}$ and $\bar{g}^{(i)}\{\tau_0\}$ vs τ_0 for a selection of spectral lines of C II	104
4.2	Plots of C II $2s2p^2D_{5/2}/2s^22p^2P_{1/2}$ and $2s2p^2D_{3/2}/2s2p^2D_{5/2}$ population density ratios vs τ_0	109
4.3	$\bar{g}^{(i)}\{\tau_0/2\}$ vs <i>degree of overlap</i> for a selection of spectral lines of C II	110
4.4	Predicted limb brightening curves for the C II 904.143 Å and 903.958 Å lines including line blending	112
4.5	Predicted spectral line profiles of the C II 904 Å multiplet	113
4.6	Predicted spectral line profiles of the C II lines at 903.958 Å and 904.143 Å	114
4.7	$\Lambda^{(i)}(\tau_0, x)$ vs x for a selection of spectral lines of C II.	116
4.8	$\Lambda^{(i)}(\tau_0, x)$ vs x for a selection of spectral lines of C II.	117
4.9	$\Lambda^{(i)}(\tau_0, x)$ and $\mathcal{G}(\tau_0, x)$ vs τ_0 for $x = D/2$ and $x = 0$	119
4.10	Upper level population densities vs spatial position for selected lines of C II with blending effects included	121
4.11	Upper level population densities vs spatial position for selected lines of C II with blending effects included	122
4.12	Upper level population densities vs spatial position for selected lines of C II with blending effects included	124
4.13	Upper level population densities vs spatial position for selected lines of C II with blending effects included	125
4.14	Predicted limb brightening curves for the C II 904.143 Å line including line blending	126
4.15	Predicted limb brightening curves for the C II 904.143 Å line with and without line blending	128
6.1	Observed line profiles for selected lines of C II and C III	141

6.2	Observed and model limb-brightening curves and branching line intensity ratios vs raster position for C III	144
6.3	The SUMER pre-launch point spread function	146
6.4	Observed and model fluxes for the C II 1037.020 Å line and the C III 1175.711 Å line.	148
6.5	Observed and model branching ratios of the C II 1037.020 Å line and the C III 1175.711 Å line.	150
6.6	Predicted intensity ratio of C III (2-2)/(1-2) vs optical depth	151
6.7	Observed fluxes for the C III line at 1175.711 Å with predicted values overlaid which are based on extracted optical depths.	158
6.8	Observed C III 1775 Å multiplet component fluxes with $f_{los}\{\tau_0\}\tau_0\bar{g}^{(i)}\{\tau_0\}$ overlaid	161
6.9	Observed C II 904 Å multiplet component fluxes with $f_{los}\{\tau_0\}\tau_0\bar{g}^{(i)}\{\tau_0\}$ overlaid	163
6.10	Observed C II 1036 Å multiplet component fluxes compared with $f_{los}\{\tau_0\}\tau_0\bar{g}^{(i)}\{\tau_0\}$ overlaid	164
6.11	C II 904 Å and 1036 Å multiplet filling factors vs pointing position	165
6.12	C III 1775 Å multiplet filling factors vs pointing position	166
6.13	Observed fluxes of the C III $2s2p\ ^3P_2 - 2p^2\ ^3P_2$ line at 1175.711 Å for regions associated with and regions not associated with structures, with predicted values overlaid.	167
6.14	Observed fluxes of the C III $2s2p\ ^3P_2 - 2p^2\ ^3P_2$ line at 1175.711 Å for regions associated with and regions not associated with structures, with predicted values overlaid.	169
A.1	$\Lambda(\tau_0, x)$ vs x for a selection of spectral lines of C II based on an exponential density model	182
A.2	$\Lambda(\tau_0, x)$ vs x for a selection of spectral lines of C II based on an exponential density model	183
A.3	Upper level population densities vs spatial position for selected lines of C II based on an exponential density model	184

A.4	Upper level population densities vs spatial position for selected lines of C II based on an exponential density model	185
A.5	Upper level population densities vs spatial position for selected lines of C II based on an exponential density model	186
A.6	Upper level population densities vs spatial position for selected lines of C II	187
B.1	$\Lambda^{(i)}(\tau_0, x)$ vs x for a selection of spectral lines of C II based on an exponential density model.	189
B.2	$\Lambda^{(i)}(\tau_0, x)$ vs x for a selection of spectral lines of C II based on an exponential density model.	190
B.3	Upper level population densities vs spatial position for selected lines of C II based on an exponential density model, with blending effects included.	191
B.4	Upper level population densities vs spatial position for selected lines of C II based on an exponential density model, with blending effects included.	192
B.5	Upper level population densities vs spatial position for selected lines of C II based on an exponential density model, with blending effects included.	193
B.6	Upper level population densities vs spatial position for selected lines of C II based on an exponential density model, with blending effects included.	194

List of Tables

2.1	Summary of data for the C III $2s2p\ ^3P_2 - 2p^2\ ^3P_2$ transition for each raster scan position.	46
2.2	Summary of data for the C III $2s2p\ ^3P_0 - 2p^2\ ^3P_1$ transition for each raster scan position.	49
2.3	Summary of data for the C II $2s^22p\ ^2P_{3/2} - 2s2p^2\ ^2S_{1/2}$ transition for each raster scan position.	50
2.4	Summary of data for the C II $2s^22p\ ^2P_{3/2} - 2s2p^2\ ^2P_{1/2}$ transition for each raster scan position.	51
2.5	Summary of data for the C II $2s^22p\ ^2P_{3/2} - 2s2p^2\ ^2P_{3/2}$ transition for each raster scan position.	52
2.6	Characterisation and classification of some spectral lines of C II at disk centre.	64
2.7	Characterisation and classification of some spectral lines of C III at disk centre.	65
6.1	Summary of data for the C III $2s2p\ ^3P_2 - 2p^2\ ^3P_2$ transition for each raster scan position.	155
6.2	Summary of data for the C II $2s^22p\ ^2P_{3/2} - 2s2p^2\ ^2S_{1/2}$ transition for each raster scan position.	156
6.3	Summary of data for the C II $2s^22p\ ^2P_{3/2} - 2s2p^2\ ^2P_{3/2}$ transition for each raster scan position.	156