

# *Math into L<sup>A</sup>T<sub>E</sub>X*

Third Edition

George Grätzer

*Math into L<sup>A</sup>T<sub>E</sub>X*

Third Edition



BIRKHÄUSER  
BOSTON



• SPRINGER  
NEW YORK

George Grätzer  
Department of Mathematics  
University of Manitoba  
Winnipeg, MB R3T 2N2  
Canada

**Library of Congress Cataloging-in-Publication Data**

Grätzer, George A.

Math into LaTeX / George Grätzer.—3rd ed.

p. cm.

Includes bibliographical references and index.

ISBN-13: 978-0-8176-4131-3

e-ISBN-13: 978-1-4612-2134-0

DOI: 10.1007/978-1-4612-2134-0

1. LaTeX (Computer file) 2. AMS-LaTeX. 3. Mathematics printing—Computer programs. 4. Computerized typesetting. I. Title

Z253.4.L38 G745 2000

686.2'2544536—dc21

00-036088

CIP

ISBN-13: 978-0-8176-4131-3 Printed on acid-free paper.

©2000 Birkhäuser Boston

©2004 Birkhäuser Boston, 2nd printing

©2004 Birkhäuser Boston, 3rd printing

*Birkhäuser* 

All rights reserved. This work may not be translated or copied in whole or in part without the written permission of the publisher (Birkhäuser Boston, c/o Springer Science+Business Media Inc., Rights and Permissions, 233 Spring Street, New York, NY 10013, USA), except for brief excerpts in connection with reviews or scholarly analysis. Use in connection with any form of information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed is forbidden.

The use in this publication of trade names, trademarks, service marks and similar terms, even if they are not identified as such, is not to be taken as an expression of opinion as to whether or not they are subject to proprietary rights.

Adobe, Adobe Acrobat, Adobe Acrobat Distiller, Adobe Acrobat Reader, Adobe Illustrator, ATM, Portable Document Format, PostScript are trademarks of Adobe Systems Inc.

Apple and Macintosh are trademarks of Apple Computer Inc.

Microsoft and Windows are trademarks of Microsoft Corporation.

Microspell is a trademark of Trigram Systems.

UNIX is a registered trademark of Open Group.

9 8 7 6 5 4 3

SPIN 11318521

Birkhäuser is part of *Springer Science+Business Media*

[www.birkhauser.com](http://www.birkhauser.com)

---

# *Short contents*

<b>Quick Finder</b>	xxi
<b>Preface to the third edition</b>	xxiii
<b>Introduction</b>	xxvii
<b>I A short course</b>	<b>1</b>
1 Typing your first article	3
<b>II Text and math</b>	<b>65</b>
2 Typing text	67
3 Text environments	121
4 Typing math	155
5 Multiline math displays	203
<b>III Document structure</b>	<b>237</b>
6 L <sup>A</sup> T <sub>E</sub> X documents	239
7 Standard L <sup>A</sup> T <sub>E</sub> X document classes	263
8 AMS documents	273

<b>IV Customization</b>	<b>309</b>
9 Customizing L <sup>A</sup> T <sub>E</sub> X	311
<b>V Long documents</b>	<b>365</b>
10 BIBT <sub>E</sub> X	367
11 <i>MakeIndex</i>	393
12 Books in L <sup>A</sup> T <sub>E</sub> X	409
<b>VI Math and the Web</b>	<b>431</b>
13 T <sub>E</sub> X, L <sup>A</sup> T <sub>E</sub> X, and the Internet	433
14 Putting L <sup>A</sup> T <sub>E</sub> X on the Web	439
<b>A Math symbol tables</b>	<b>455</b>
<b>B Text symbol tables</b>	<b>469</b>
<b>C Background</b>	<b>475</b>
<b>D PostScript fonts</b>	<b>485</b>
<b>E L<sup>A</sup>T<sub>E</sub>X localized</b>	<b>491</b>
<b>F A book document class</b>	<b>493</b>
<b>G Conversions</b>	<b>507</b>
<b>H Final word</b>	<b>517</b>
<b>Bibliography</b>	<b>521</b>
<b>Index</b>	<b>525</b>

---

# Contents

<b>Quick Finder</b>	xxi
<b>Preface to the third edition</b>	xxiii
<b>Introduction</b>	xxvii
<b>I A short course</b>	<b>1</b>
<b>1 Typing your first article</b>	<b>3</b>
1.1 Typing text . . . . .	4
1.1.1 The keyboard . . . . .	4
1.1.2 Your first note . . . . .	6
1.1.3 Lines too wide . . . . .	7
1.1.4 More text features . . . . .	9
1.2 Typing math . . . . .	11
1.2.1 A note with math . . . . .	11
1.2.2 Errors in math . . . . .	13
1.3 Building blocks of a formula . . . . .	15
1.4 Building a formula step-by-step . . . . .	22
1.5 Formula gallery . . . . .	25
1.6 Displayed formulas . . . . .	32
1.6.1 Equations . . . . .	32
1.6.2 Aligned formulas . . . . .	34
1.6.3 Cases . . . . .	37
1.7 The anatomy of an article . . . . .	38
1.7.1 The typeset sample article . . . . .	43
1.8 L <sup>A</sup> T <sub>E</sub> X article templates . . . . .	46
1.9 Your first article . . . . .	47

1.9.1	Editing the top matter . . . . .	47
1.9.2	Sectioning . . . . .	48
1.9.3	Invoking proclamations . . . . .	49
1.9.4	Inserting references . . . . .	49
1.10	L <sup>A</sup> T <sub>E</sub> X error messages . . . . .	50
1.11	Logical and visual design . . . . .	55
1.12	A brief overview . . . . .	57
1.13	Using L <sup>A</sup> T <sub>E</sub> X . . . . .	58
1.13.1	AMS packages revisited . . . . .	58
1.13.2	Interactive L <sup>A</sup> T <sub>E</sub> X . . . . .	60
1.13.3	Versions . . . . .	61
1.13.4	Spelling checkers and text editors . . . . .	62

## II Text and math 65

2	Typing text . . . . .	67
2.1	The keyboard . . . . .	68
2.1.1	Basic keys . . . . .	68
2.1.2	Special keys . . . . .	69
2.1.3	Prohibited keys . . . . .	69
2.2	Words, sentences, and paragraphs . . . . .	70
2.2.1	Spacing rules . . . . .	70
2.2.2	Periods . . . . .	71
2.3	Commanding L <sup>A</sup> T <sub>E</sub> X . . . . .	73
2.3.1	Commands and environments . . . . .	73
2.3.2	Scope . . . . .	76
2.3.3	Types of commands . . . . .	78
2.4	Symbols not on the keyboard . . . . .	79
2.4.1	Quotation marks . . . . .	80
2.4.2	Dashes . . . . .	80
2.4.3	Ties or nonbreakable spaces . . . . .	81
2.4.4	Special characters . . . . .	81
2.4.5	Ellipses . . . . .	83
2.4.6	Ligatures . . . . .	83
2.4.7	Accents and symbols in text . . . . .	83
2.4.8	Logos and numbers . . . . .	84
2.4.9	Hyphenation . . . . .	86
2.5	Comments and footnotes . . . . .	89
2.5.1	Comments . . . . .	89
2.5.2	Footnotes . . . . .	92
2.6	Changing font characteristics . . . . .	93
2.6.1	Basic font characteristics . . . . .	93
2.6.2	Document font families . . . . .	94

2.6.3	Command pairs . . . . .	94
2.6.4	Shape commands . . . . .	95
2.6.5	Italic corrections . . . . .	97
2.6.6	Series . . . . .	98
2.6.7	Size changes . . . . .	98
2.6.8	Orthogonality . . . . .	99
2.6.9	Two-letter commands . . . . .	100
2.6.10	Low-level commands . . . . .	100
2.6.11	Boxed text . . . . .	101
2.7	Lines, paragraphs, and pages . . . . .	101
2.7.1	Lines . . . . .	101
2.7.2	Paragraphs . . . . .	105
2.7.3	Pages . . . . .	106
2.7.4	Multicolumn printing . . . . .	107
2.8	Spaces . . . . .	108
2.8.1	Horizontal spaces . . . . .	108
2.8.2	Vertical spaces . . . . .	110
2.8.3	Relative spaces . . . . .	111
2.8.4	Expanding spaces . . . . .	111
2.9	Boxes . . . . .	112
2.9.1	Line boxes . . . . .	112
2.9.2	Paragraph boxes . . . . .	115
2.9.3	Marginal comments . . . . .	116
2.9.4	Solid boxes . . . . .	117
2.9.5	Fine-tuning boxes . . . . .	119
<b>3</b>	<b>Text environments</b> . . . . .	<b>121</b>
3.1	List environments . . . . .	122
3.1.1	Numbered lists . . . . .	122
3.1.2	Bulleted lists . . . . .	122
3.1.3	Captioned lists . . . . .	123
3.1.4	Rule and combinations . . . . .	124
3.2	Tabbing environments . . . . .	127
3.3	Miscellaneous displayed text environments . . . . .	129
3.4	Proclamations . . . . .	135
3.4.1	The full syntax . . . . .	138
3.4.2	Proclamations with style . . . . .	139
3.5	Proof environments . . . . .	143
3.6	Some general rules for displayed text environments . . . . .	145
3.7	Tabular environments . . . . .	146
3.7.1	Table styles . . . . .	152
3.8	Style and size environments . . . . .	153



<b>4</b>	<b>Typing math</b>	155
4.1	Math environments	156
4.2	Spacing rules	158
4.3	Equations	160
4.4	Basic constructs	162
4.4.1	Arithmetic operations	162
4.4.2	Binomial coefficients	164
4.4.3	Ellipses	165
4.4.4	Integrals	166
4.4.5	Roots	166
4.5	Text in math	167
4.6	Delimiters	168
4.6.1	Delimiter tables	169
4.6.2	Delimiters of fixed size	170
4.6.3	Delimiters of variable size	171
4.6.4	Delimiters as binary relations	172
4.7	Operators	173
4.7.1	Operator tables	173
4.7.2	Declaring operators	175
4.7.3	Congruences	176
4.8	Large operators	176
4.8.1	Multiline subscripts and superscripts	178
4.9	Math accents	179
4.10	Stretchable horizontal lines	180
4.10.1	Horizontal braces	180
4.10.2	Overlines and underlines	181
4.10.3	Stretchable arrow math symbols	182
4.11	Spacing of symbols	182
4.11.1	Classification	183
4.11.2	Three exceptions	183
4.11.3	Spacing commands	185
4.11.4	Examples	186
4.11.5	The <code>\phantom</code> command	187
4.12	Building new symbols	187
4.12.1	Stacking symbols	188
4.12.2	Negating and side-setting symbols	189
4.12.3	Changing a symbol's type	190
4.13	Math alphabets and symbols	190
4.13.1	Math alphabets	191
4.13.2	Math symbol alphabets	192
4.13.3	Bold math symbols	193
4.13.4	Size changes	195

4.13.5	Continued fractions . . . . .	195
4.14	Vertical spacing . . . . .	196
4.15	Tagging and grouping . . . . .	197
4.16	Generalized fractions . . . . .	199
4.16.1	Examples . . . . .	200
4.17	Boxed formulas . . . . .	200
<b>5</b>	<b>Multiline math displays</b>	<b>203</b>
5.1	A visual guide . . . . .	204
5.2	Gathering formulas . . . . .	206
5.3	Splitting long formulas . . . . .	206
5.4	Some general rules . . . . .	209
5.4.1	Subformula rules . . . . .	209
5.4.2	Breaking and aligning formulas . . . . .	211
5.4.3	Numbering groups of formulas . . . . .	212
5.5	Aligned columns . . . . .	213
5.5.1	An <code>align</code> variant . . . . .	215
5.5.2	<code>eqnarray</code> , the ancestor of <code>align</code> . . . . .	215
5.5.3	The subformula rule revisited . . . . .	216
5.5.4	The <code>alignat</code> environment . . . . .	217
5.5.5	Inserting text . . . . .	219
5.6	Aligned subsidiary math environments . . . . .	220
5.6.1	Subsidiary variants . . . . .	221
5.6.2	<code>Split</code> . . . . .	223
5.7	Adjusted columns . . . . .	225
5.7.1	Matrices . . . . .	226
5.7.2	Arrays . . . . .	229
5.7.3	Cases . . . . .	231
5.8	Commutative diagrams . . . . .	232
5.9	Page breaks . . . . .	234
<b>III</b>	<b>Document structure</b>	<b>237</b>
<b>6</b>	<b>L<sup>A</sup>T<sub>E</sub>X documents</b>	<b>239</b>
6.1	The structure of a document . . . . .	240
6.2	The preamble . . . . .	241
6.3	Front matter . . . . .	242
6.3.1	Abstract . . . . .	243
6.4	Main matter . . . . .	243
6.4.1	Sectioning . . . . .	243
6.4.2	Cross-referencing . . . . .	246
6.4.3	Tables and figures . . . . .	250

6.5	Back matter . . . . .	252
6.5.1	Bibliographies in articles . . . . .	252
6.5.2	Simple indexes . . . . .	258
6.6	Visual design . . . . .	259
<b>7</b>	<b>Standard L<sup>A</sup>T<sub>E</sub>X document classes</b>	<b>263</b>
7.1	Articles and reports . . . . .	263
7.1.1	Options . . . . .	264
7.2	Letters . . . . .	266
7.3	The L <sup>A</sup> T <sub>E</sub> X distribution . . . . .	268
7.3.1	Tools . . . . .	269
<b>8</b>	<b>AMS documents</b>	<b>273</b>
8.1	Two AMS document classes for articles . . . . .	274
8.1.1	Font-size commands . . . . .	274
8.2	The top matter . . . . .	275
8.2.1	Article information . . . . .	275
8.2.2	Author information . . . . .	277
8.2.3	AMS information . . . . .	279
8.2.4	Multiple authors . . . . .	281
8.2.5	Examples . . . . .	281
8.2.6	Abstract . . . . .	285
8.3	The AMS sample article . . . . .	285
8.4	AMS article templates . . . . .	298
8.5	Options . . . . .	301
8.5.1	Math options . . . . .	304
8.6	The AMS packages . . . . .	305
<b>IV</b>	<b>Customization</b>	<b>309</b>
<b>9</b>	<b>Customizing L<sup>A</sup>T<sub>E</sub>X</b>	<b>311</b>
9.1	User-defined commands . . . . .	312
9.1.1	Examples and rules . . . . .	312
9.1.2	Arguments . . . . .	318
9.1.3	Short arguments . . . . .	320
9.1.4	Optional arguments . . . . .	321
9.1.5	Redefining commands . . . . .	322
9.1.6	Redefining names . . . . .	323
9.1.7	Showing the definitions of commands . . . . .	323
9.1.8	Delimited commands . . . . .	325
9.2	User-defined environments . . . . .	328
9.2.1	Modifying existing environments . . . . .	328
9.2.2	Arguments . . . . .	331

9.2.3	Optional arguments with default values . . . . .	331
9.2.4	Short arguments . . . . .	332
9.2.5	Brand-new environments . . . . .	332
9.3	A custom command file . . . . .	333
9.4	The sample article with user-defined commands . . . . .	338
9.5	Numbering and measuring . . . . .	344
9.5.1	Counters . . . . .	345
9.5.2	Length commands . . . . .	349
9.6	Custom lists . . . . .	352
9.6.1	Length commands for the <code>list</code> environment . . . . .	352
9.6.2	The <code>list</code> environment . . . . .	354
9.6.3	Two complete examples . . . . .	357
9.6.4	The <code>trivlist</code> environment . . . . .	360
9.7	Custom formats . . . . .	360
<b>V</b>	<b>Long documents</b>	<b>365</b>
<b>10</b>	<b>BIBTEX</b>	<b>367</b>
10.1	The database . . . . .	370
10.1.1	Entry types . . . . .	370
10.1.2	Typing fields . . . . .	372
10.1.3	Articles . . . . .	374
10.1.4	Books . . . . .	375
10.1.5	Conference proceedings and collections . . . . .	376
10.1.6	Theses . . . . .	379
10.1.7	Technical reports . . . . .	380
10.1.8	Manuscripts and other entry types . . . . .	381
10.1.9	Abbreviations . . . . .	382
10.2	Using BIBTEX . . . . .	383
10.2.1	Sample files . . . . .	383
10.2.2	Setup . . . . .	385
10.2.3	Four steps of BIBTEXing . . . . .	386
10.2.4	BIBTEX files . . . . .	386
10.2.5	BIBTEX rules and messages . . . . .	389
10.2.6	Concluding comments . . . . .	392
<b>11</b>	<b>MakeIndex</b>	<b>393</b>
11.1	Preparing the document . . . . .	393
11.2	Index commands . . . . .	397
11.3	Processing the index entries . . . . .	402
11.4	Rules . . . . .	405
11.5	Glossary . . . . .	407

<b>12 Books in L<sup>A</sup>T<sub>E</sub>X</b>	<b>409</b>
12.1 Book document classes . . . . .	410
12.1.1 Sectioning . . . . .	410
12.1.2 Division of the body . . . . .	411
12.1.3 Document class options . . . . .	412
12.1.4 Title pages . . . . .	413
12.2 Tables of contents, lists of tables and figures . . . . .	413
12.2.1 Tables of contents . . . . .	413
12.2.2 Lists of tables and figures . . . . .	415
12.3 Splitting and combining files . . . . .	416
12.3.1 <code>\input</code> and <code>\include</code> . . . . .	416
12.3.2 Organizing your files . . . . .	418
12.3.3 Combining files . . . . .	421
12.4 Logical design . . . . .	422
12.5 Final preparations for the publisher . . . . .	424
12.6 Final preparations for printing . . . . .	426
<b>VI Math and the Web</b>	<b>431</b>
<b>13 T<sub>E</sub>X, L<sup>A</sup>T<sub>E</sub>X, and the Internet</b>	<b>433</b>
13.1 Obtaining files from the Internet . . . . .	434
13.2 Commercial T <sub>E</sub> X implementations . . . . .	435
13.3 Free and shareware implementations . . . . .	436
13.4 T <sub>E</sub> X user groups and the AMS . . . . .	436
13.5 Some useful sources of L <sup>A</sup> T <sub>E</sub> X information . . . . .	437
<b>14 Putting L<sup>A</sup>T<sub>E</sub>X on the Web</b>	<b>439</b>
14.1 File formats . . . . .	440
14.1.1 HTML . . . . .	440
14.1.2 PostScript . . . . .	444
14.1.3 PDF . . . . .	444
14.1.4 Graphics file formats . . . . .	446
14.2 Choosing a file format . . . . .	447
14.2.1 Downloading only . . . . .	447
14.2.2 Viewing only . . . . .	449
14.2.3 Viewing and downloading . . . . .	450
14.3 Hyperlinks and PDF files . . . . .	450
14.3.1 Using <code>hyperref</code> . . . . .	450
14.3.2 <code>backref</code> and <code>colorlinks</code> . . . . .	451
14.3.3 Bookmarks . . . . .	452
14.3.4 Additional commands . . . . .	452

<b>A</b>	<b>Math symbol tables</b>	455
A.1	Hebrew and Greek letters . . . . .	455
A.1.1	Hebrew letters . . . . .	455
A.1.2	Greek letters . . . . .	456
A.2	Binary relations . . . . .	457
A.2.1	L <sup>A</sup> T <sub>E</sub> X binary relations . . . . .	457
A.2.2	AMS binary relations . . . . .	458
A.2.3	Negated binary relations . . . . .	459
A.3	Binary operations . . . . .	460
A.4	Arrows . . . . .	461
A.4.1	L <sup>A</sup> T <sub>E</sub> X arrows . . . . .	461
A.4.2	AMS arrows . . . . .	462
A.5	Miscellaneous symbols . . . . .	463
A.6	Delimiters . . . . .	464
A.7	Operators . . . . .	465
A.7.1	“Pure” operators, with no limits . . . . .	465
A.7.2	Operators with limits . . . . .	465
A.7.3	Large operators . . . . .	466
A.8	Math accents and fonts . . . . .	467
A.8.1	Math accents . . . . .	467
A.8.2	Math fonts . . . . .	468
A.9	Math spacing commands . . . . .	468
<b>B</b>	<b>Text symbol tables</b>	469
B.1	Some European characters . . . . .	469
B.2	Text accents . . . . .	470
B.3	Text font commands . . . . .	470
B.3.1	Text font family commands . . . . .	470
B.3.2	Text font size changes (L <sup>A</sup> T <sub>E</sub> X and AMS) . . . . .	471
B.4	Additional text symbols . . . . .	472
B.5	Additional text symbols with T1 encoding . . . . .	473
B.5.1	Accents . . . . .	473
B.5.2	European characters . . . . .	473
B.5.3	Quotation marks . . . . .	473
B.6	Text spacing commands . . . . .	474
<b>C</b>	<b>Background</b>	475
C.1	A short history . . . . .	475
C.1.1	L <sup>A</sup> T <sub>E</sub> X3 . . . . .	476
C.1.2	Recent developments . . . . .	478
C.2	How does L <sup>A</sup> T <sub>E</sub> X work? . . . . .	479
C.2.1	The layers . . . . .	479
C.2.2	Typesetting . . . . .	480

C.2.3	Viewing and printing . . . . .	481
C.2.4	L <sup>A</sup> T <sub>E</sub> X's files . . . . .	481
<b>D</b>	<b>PostScript fonts</b> . . . . .	<b>485</b>
D.1	CM, AMS, and EM PostScript Fonts . . . . .	486
D.2	The Times font and MathTime . . . . .	487
D.3	Lucida Bright fonts . . . . .	489
D.4	More PostScript fonts . . . . .	489
<b>E</b>	<b>L<sup>A</sup>T<sub>E</sub>X localized</b> . . . . .	<b>491</b>
<b>F</b>	<b>A book document class</b> . . . . .	<b>493</b>
<b>G</b>	<b>Conversions</b> . . . . .	<b>507</b>
G.1	Converting to L <sup>A</sup> T <sub>E</sub> X . . . . .	508
G.1.1	Converting Plain T <sub>E</sub> X to L <sup>A</sup> T <sub>E</sub> X . . . . .	508
G.1.2	Converting L <sup>A</sup> T <sub>E</sub> X 2.09 to L <sup>A</sup> T <sub>E</sub> X . . . . .	509
G.2	Converting to L <sup>A</sup> T <sub>E</sub> X with the AMS packages . . . . .	510
G.2.1	Using the AMS packages in a L <sup>A</sup> T <sub>E</sub> X document . . . . .	510
G.2.2	Converting from $\mathcal{A}\mathcal{M}\mathcal{S}$ -T <sub>E</sub> X . . . . .	510
G.2.3	Converting from version 1.2 of the AMS packages . . . . .	511
G.3	Converting to an AMS document class . . . . .	512
G.3.1	Converting from L <sup>A</sup> T <sub>E</sub> X . . . . .	512
G.3.2	Converting from $\mathcal{A}\mathcal{M}\mathcal{S}$ -L <sup>A</sup> T <sub>E</sub> X, version 1.1 . . . . .	514
<b>H</b>	<b>Final word</b> . . . . .	<b>517</b>
H.1	What was left out? . . . . .	517
H.1.1	L <sup>A</sup> T <sub>E</sub> X omissions . . . . .	517
H.1.2	T <sub>E</sub> X omissions . . . . .	518
H.2	Further reading . . . . .	518
	<b>Bibliography</b> . . . . .	<b>521</b>
	<b>Index</b> . . . . .	<b>525</b>

---

# *List of tables*

2.1	Nine special characters . . . . .	81
2.2	Font table for the Computer Modern typewriter-style font . . . . .	83
2.3	European accents . . . . .	84
2.4	European characters . . . . .	84
2.5	Extra text symbols . . . . .	85
2.6	Font family switching commands . . . . .	95
3.1	Tabular table . . . . .	147
3.2	Table with <code>\multicolumn</code> . . . . .	150
3.3	Table with <code>\multicolumn</code> and <code>\cline</code> . . . . .	151
3.4	Smokers and Nonsmokers, by Sex . . . . .	152
4.1	Standard delimiters . . . . .	169
4.2	Operators without limits . . . . .	174
4.3	Operators with limits . . . . .	174
4.4	Congruences . . . . .	176
4.5	Large operators . . . . .	177
4.6	Math accents . . . . .	180
4.7	Math spacing commands . . . . .	185
8.1	L <sup>A</sup> T <sub>E</sub> X and AMS font size commands . . . . .	275
9.1	Redefinable name commands in L <sup>A</sup> T <sub>E</sub> X . . . . .	324
9.2	Standard L <sup>A</sup> T <sub>E</sub> X counters . . . . .	345
9.3	Counter styles . . . . .	347
14.1	hyperref <code>\autoref</code> names . . . . .	453
D.1	Some type foundries on the World Wide Web . . . . .	490



G.1	$\text{\TeX}$ commands to avoid using in $\text{\LaTeX}$ documents . . . . .	509
G.2	AMS package equivalents of $\mathcal{A}\mathcal{M}\mathcal{S}$ - $\text{\TeX}$ style commands . . . . .	512
G.3	$\mathcal{A}\mathcal{M}\mathcal{S}$ - $\text{\TeX}$ commands to avoid using with the AMS packages . . .	513

---

# *List of figures*

1.1	Simple alignment: source and typeset . . . . .	35
1.2	Annotated alignment: source and typeset . . . . .	37
1.3	A schematic view of an article . . . . .	38
1.4	The structure of L <sup>A</sup> T <sub>E</sub> X . . . . .	57
1.5	Using L <sup>A</sup> T <sub>E</sub> X . . . . .	59
5.1	The AMS multiline formulas . . . . .	205
5.2	Two aligned columns: source and typeset . . . . .	214
6.1	The structure of a L <sup>A</sup> T <sub>E</sub> X document . . . . .	240
6.2	Sectioning commands in the <code>article</code> document class . . . . .	246
6.3	Sectioning commands in the <code>amsart</code> document class . . . . .	246
6.4	The most important bibliographic entry types . . . . .	254
6.5	Page layout for the <code>article</code> document class . . . . .	260
7.1	The <code>openbib</code> option . . . . .	267
9.1	The measurements of a box . . . . .	351
9.2	The layout of a custom list . . . . .	353
10.1	Using BIB <sub>T</sub> E <sub>X</sub> , step 2 . . . . .	387
10.2	Using BIB <sub>T</sub> E <sub>X</sub> , step 3 . . . . .	387
11.1	Simple index entries . . . . .	394
11.2	Using <i>MakeIndex</i> , step 1 . . . . .	403
11.3	Using <i>MakeIndex</i> , step 2 . . . . .	403
12.1	A page break . . . . .	427

14.1 A simple Web page and its title . . . . .	441
14.2 The hyperref package with the \autoref command . . . . .	451
14.3 The hyperref package with the backref option . . . . .	451
E.1 German test for Babel . . . . .	492

---

# Quick Finder

## **A**bbreviations, 71

accented characters, 10, 83; Sec. B.2

addresses, 277

aligned formulas, Secs. 1.6.2, 5.5, 5.6

AMS (American Mathematical Society), 437

articles, Secs. 8.1–8.5

packages, xxxii; Secs. 1.13.1, 8.6

subject classifications, 280

arithmetic, 162

arrows, Sec. A.4

articles, Secs. 1.7–1.9, 7.1, 8.1–8.5

authors, 39, 48, 277

## **B**ibliographies, 10, 49; Ch. 10

binary operations, 182; Sec. A.3

binary relations, 457; Sec. A.2

binomials, 17, 164

blank spaces, 7, 70

body of an article, 39

bold math, 30,

bold text, 10, 93 60, 191

## **C**alligraphic font, 31, 192

cases, 37, 231

centering text, 10, 153

characters, special, 5, 69

citations, 49; Ch. 10

commands, 10; Secs. 2.3, 9.1

with arguments, 10; Sec. 9.1.2

with optional arguments, 10; Sec. 9.1.4

commenting out, 6; Sec. 2.5

congruences, 18; Sec. 4.7.3

cross-referencing, 33, 160; Secs. 6.4.2, 8.5

CTAN, 434

## **D**ates, 39, 48, 268

dedications, 276

delimiters, 18; Secs. 4.6, A.6

displayed math, 12, 156; Sec. 1.6; Ch. 5

document classes, 7, 241; Chs. 7–12

options, 9; Secs. 7.1.1, 8.5, 12.1.3

double spacing, 104

## **E**llipses, 19; Secs. 2.4.5, 4.4.3

em dashes, 10, 80

e-mail, 278

emphasize text, 10

en dashes, 10, 80

environments, 4; Secs. 2.3.1, 9.2

equations, Secs. 1.6.1, 4.3

error messages, Secs. 1.1.3, 1.2.2, 1.10

European characters, 10, 84; Secs. B.1, B.5.2

## **F**ont size, Secs. 2.6.7, B.3.2

fonts; Secs. 2.6, B.3

Fraktur, 26, 193

## **G**raphics, 250, 449

Greek letters, 27, 182; Sec. A.1.2

## **H**ebrew letters, Sec. A.1.1

hyphenation, 9; Sec. 2.4.9

## **I**ndex, Sec. 6.5.2, Ch. 11

multiple, 407

inline math, 12, 156

instructions to L<sup>A</sup>T<sub>E</sub>X, 3; Secs. 2.3, 9.1, 9.2

integrals, 19; Sec. 4.4.4

intersentence spacing, 7, 71

interword spacing, 7, 71

invalid characters, 5, 69

italics, 10, 95, 153

**J**ustification, 4, 7, 10, 153

**K**eyboard, 4; Sec. 2.1  
keywords, 280

**L**A<sub>T</sub>E<sub>X</sub>, xxxi; App. C  
  articles, Sec. 1.7; Chs. 6, 8  
  commands, 10; Secs. 2.3, 9.1  
  error messages, Secs. 1.1.3, 1.2.2, 1.10  
left justifying text, 4, 7, 10, 153  
line breaks, 10, 102  
lines too wide, 7, 101  
log files, 8, 58, 482

**M**acros, 312  
math, 3; Secs. 1.2–1.6; Chs 4, 5  
  accents, 19; Secs. 4.9, A.8.1  
  fonts, Sec. 4.13  
  symbols, Sec. 4.13; App. A  
matrices, 19; Sec. 5.7.1

**N**onbreakable spaces (ties), Sec. 2.4.3  
numbering  
  consecutively, 138  
  equations, 32, 160  
  renumbering, 33  
  within a section, 138  
  theorems, 49  
 $n$ -th roots, 21; Sec. 4.4.5

**O**perators, 21; Secs. 4.7, A.7

**P**ackages, 57  
  AMS, xxxii; Secs. 1.13.1, 8.6  
page breaks, 10; Sec. 2.7.3  
paragraphs, 7; Sec. 2.7.2  
parentheses, 18; Secs. 4.6, A.6  
pictures, 250, 449  
points (pt), 8; Sec. 9.5.2  
Portable Document Format (PDF), 444  
PostScript, 444  
preamble of an article, 38  
printing, 58  
products, 21; Sec. 4.8  
prohibited keys, 5; Sec. 2.1.3  
prompts, 60  
proofs, Sec. 3.5  
punctuation marks, 5, 68

**Q**otation marks, 7, 68

**R**eferencing, *see* cross-referencing  
renumbering, 33  
research support, 279

Return key, 5, 69  
right justifying text, 4, 7, 10, 153

**S**ample articles, 44–45, 286–297; Sec. 1.7  
sample files, 4, 435  
sectioning, Secs. 1.9.2, 6.4.1, 12.1.1  
sentences, 7, 70  
sine function, 21; Secs. 4.7.1, A.6  
spacing in text and math, 12; Secs. 2.2.1, A.9  
special keys, 5, 69  
spelling checkers, 62  
square roots, 21; Sec. 4.4.5  
subscripts, 17, 163  
sums, 21; Sec. 4.8  
superscripts, 17, 163

**T**ab key, 5, 69  
tables, Sec. 3.7  
templates, 46; Sec. 8.4  
**T**E<sub>X</sub>, xxxi; Sec. C.1  
  implementation, Secs. 13.2, 13.3  
text, 3; Ch. 2  
  accents, 10; Secs. 2.4.7, B.2  
  in a formula, 22; Sec. 4.5  
  symbols, Sec. B.4  
text editors, xxvii  
theorems, 39, 49; Sec. 3.4  
ties (unbreakable spaces), 7; Sec. 2.4.3  
titles, 39, 48, 275  
translators, 276  
TUG (T<sub>E</sub>X Users Group), 437

**U**ser-defined commands, Sec. 9.1  
URLs, 279

**W**eb-page addresses, 279  
white space, 12, 69; Sec. A.9

---

# *Preface to the third edition*

## *Why a new edition?*

### *The Internet*

Just a few years ago, the Internet consisted of little more than e-mail, USENET, and FTP sites. The state-of-the-art in information technology was Gopher, a text-based system using hierarchical menus to organize documents. Today the World Wide Web dominates the headlines in major magazines and newspapers. Many journals now have electronic editions, and new journals published solely on the Internet are beginning to appear. E-books and e-learning have started to establish themselves. The popularity and ease of use of the World Wide Web make it one of the best ways to share L<sup>A</sup>T<sub>E</sub>X articles, reports, and books with a wider audience.

Part VI discusses the interaction between L<sup>A</sup>T<sub>E</sub>X and the Internet:

- Chapter 13 examines the role of the Internet as the main source for information about using and customizing L<sup>A</sup>T<sub>E</sub>X.
- Chapter 14 explains how to publish your own L<sup>A</sup>T<sub>E</sub>X articles, reports, and books on the World Wide Web.

### *New focus*

This edition focuses on the “standard L<sup>A</sup>T<sub>E</sub>X.” The first edition of this book (published in 1993) described  $\mathcal{A}\mathcal{M}\mathcal{S}$ -L<sup>A</sup>T<sub>E</sub>X, version 1.1, and the `amsart` document style.  $\mathcal{A}\mathcal{M}\mathcal{S}$ -L<sup>A</sup>T<sub>E</sub>X, version 1.1, was a stand-alone product that was incompatible with the standard L<sup>A</sup>T<sub>E</sub>X of the time, L<sup>A</sup>T<sub>E</sub>X 2.09. The second edition (in 1996) reported on the new L<sup>A</sup>T<sub>E</sub>X (then called L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub>) and the new L<sup>A</sup>T<sub>E</sub>X-compatible

AMS packages that replaced  $\mathcal{A}\mathcal{M}\mathcal{S}\text{-L}\text{\AA}\text{T}\text{E}\text{X}$ , version 1.1, but the book still had an  $\mathcal{A}\mathcal{M}\mathcal{S}\text{-L}\text{\AA}\text{T}\text{E}\text{X}$ -centric view.

This third edition is about  $\text{L}\text{\AA}\text{T}\text{E}\text{X}$ . Where necessary, I recommend that you use packages to extend  $\text{L}\text{\AA}\text{T}\text{E}\text{X}$ 's capabilities. For typesetting mathematics, I strongly recommend that you use the AMS packages.

### *AMS packages, version 2.0*

The American Mathematical Society released version 2.0 of the AMS packages in 1999. This third edition covers the changes made in this release.

### *Books*

The first and second editions of this book dealt primarily with the tasks involved in writing articles. In Part V, the third edition addresses the issues that arise when creating longer documents. In addition to chapters on  $\text{B}\text{I}\text{B}\text{T}\text{E}\text{X}$  and *MakeIndex*, I have added a new chapter on writing books. Appendix F illustrates the importance of choosing a well-designed book document class.

### *Other changes*

$\text{L}\text{\AA}\text{T}\text{E}\text{X}$   $\text{L}\text{\AA}\text{T}\text{E}\text{X} 2_{\epsilon}$  has been remarkably stable since its release in 1996, becoming the standard  $\text{L}\text{\AA}\text{T}\text{E}\text{X}$  (see Section C.1.2). Changes have been minor except for advances in using  $\text{L}\text{\AA}\text{T}\text{E}\text{X}$  with non-English languages (see the new Appendix E) and the widespread use of the PostScript CM and AMS fonts (see the new Section D.1).

**Reorganization and additions** Due to the new emphasis on writing books, a number of sections and subsections have moved from Chapter 2 and Chapters 6–8 to the new Chapter 12.

I have carefully revised the content to cover the changes made in  $\text{L}\text{\AA}\text{T}\text{E}\text{X}$  and the AMS packages. I have added new material based on my own experiences (since 1996, I have typeset roughly 1500 pages—including two books—using  $\text{L}\text{\AA}\text{T}\text{E}\text{X}$ ) and in response to e-mail queries from readers of previous editions (as an example, see the revised Section 5.6.2 on the `split` subsidiary math environment). Most of the text has been rewritten and there are many minor corrections.

In 1999, my introductory book, *First Steps in  $\text{L}\text{\AA}\text{T}\text{E}\text{X}$* , [30] was published; it is based on Part I of the second edition of this book. Part I of this third edition takes into account the rewriting and editing that was done for *First Steps*.

**Illustrations** I believe that a visual illustration of a complicated construct substantially cuts the learning curve. So I have almost doubled the number of illustrations. See, for example, the illustrations of aligned formulas in Section 1.6.2;

the new Section 5.1, a visual guide to multiline math formulas; and the two-page spread of bibliographic styles in Chapter 10.

**Web enhanced** In the introduction, I explain how I plan to keep you, the reader, up-to-date on changes to come via the Web.

### *Two recurring questions*

When I hear from readers, there are two questions that come up again and again:

1. I do not have much time to spend learning the technical aspects of writing articles. Do I really need a book as large as this one?
2. Can you help me to get started from scratch, covering everything from installing a working L<sup>A</sup>T<sub>E</sub>X system to the rudiments of text editing?

My answer to the first question is no. You do not need to read the entire book to get started. If you only read Part I (the short course), the few pages discussing the top matter of an AMS document (Section 8.1), and those parts of the book that cover the types of mathematical expressions your work uses, you will be able to write a basic article. *Math into L<sup>A</sup>T<sub>E</sub>X* is as large as it is because it addresses the use of L<sup>A</sup>T<sub>E</sub>X for a wide range of users. You can be very selective about what you choose to read at first, and come back later for more detail as needed.

The second question is addressed in a very small way by a section in the introduction, *Setting the stage*. There are dozens of different L<sup>A</sup>T<sub>E</sub>X implementations and hundreds of text editors. Your environment will be based on the kind of computer you have (or have access to), what you need your L<sup>A</sup>T<sub>E</sub>X system to do, how much work you are willing to do to maintain the system, and how much money you are willing to spend. Sections 13.2 and 13.3 will help you select a L<sup>A</sup>T<sub>E</sub>X system that meets your needs.

Because of the complex choices involved, no one book can possibly cover all of the possible combinations. I assume that you have a working and up-to-date L<sup>A</sup>T<sub>E</sub>X system, that you know how to use some text-editing application (even Word will do), and that you know the basics of working with your computer's operating system.

George Grätzer



---

# Introduction

## *Is this book for you?*

This book is for the mathematician, physicist, engineer, scientist, or technical typist who has to learn how to typeset articles containing mathematical formulas.

Part I provides a quick introduction to L<sup>A</sup>T<sub>E</sub>X, so that you will be ready to type your first article (such as the sample article on pages 44–45) in a very short time. That is followed, in Parts II–IV, by a detailed exposition that provides you with a solid foundation in L<sup>A</sup>T<sub>E</sub>X, so that typing mathematical documents will become second nature.

You can find specific topics in the short table of contents, in the detailed table of contents, in the Quick Finder, or in the index. While the index is L<sup>A</sup>T<sub>E</sub>X-oriented, the Quick Finder lists the main topics mainly using the terminology utilized by word processing applications. For example, to find out how to italicize text, look under “italics” in the Quick Finder, and under `\emph` in the index.

## *Setting the stage*

Watch someone type a mathematical article in L<sup>A</sup>T<sub>E</sub>X. You will see that

- *A text editor* is used to create a L<sup>A</sup>T<sub>E</sub>X *source file*. A source file (we will call it `first.tex`) might look like the following:

```
\documentclass{article}
\begin{document}
The hypotenuse:  $\sqrt{a^2 + b^2}$ $. I can type math!
\end{document}
```

Note that the source file `first.tex` is different from a typical word-processor file: All characters are displayed at the same size and in the same font.

- *Typeset the source file and view the result on their monitor* (the two corners indicate material that is shown as typeset by L<sup>A</sup>T<sub>E</sub>X):



The hypotenuse:  $\sqrt{a^2 + b^2}$ . I can type math!

- *Continue the editing cycle.* You will go back and forth between the source file and the typeset version, making changes and observing the results of those changes.
- *Print the file.* Once you are satisfied with the typeset version, you can print the document, creating a paper version of the typeset article.

Unfortunately, I cannot tell you exactly how your particular text editor works, or how typesetting and printing is done on your system. Just as there are many text editors (ranging from the ancient `vi` to modern editors with graphical user interfaces), there are many L<sup>A</sup>T<sub>E</sub>X setups, each with its own unique installation and a different way of typesetting and printing. However, the following two examples should give you some idea of the process.

### ***Example 1: UNIX***

UNIX commands are typed at a *shell prompt* (such as `unix$`). The following command starts a text editor:

```
unix$ vi first.tex
```

Once the editor starts, you type the text of your article. When you are ready to typeset the article, save the file and quit the editor. Back at the shell prompt, typing

```
unix$ latex first
```

results in a series of messages scrolling up the screen as the file is typeset.

When this process is complete, you will have a DVI file, `first.dvi`, that may be viewed (in an X Window environment) by typing

```
unix$ xdvi first
```

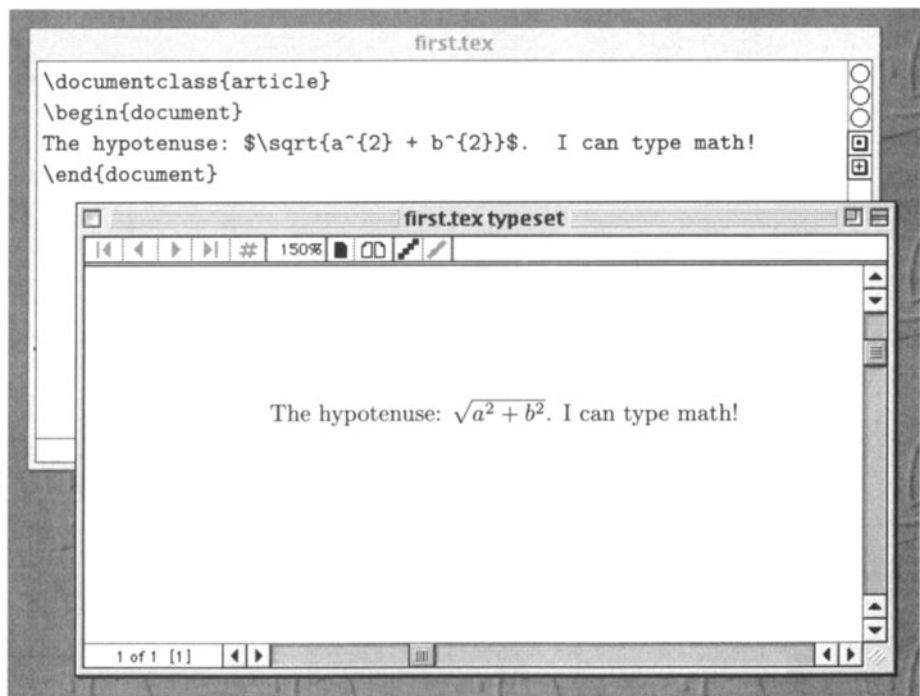
If changes must be made, you can return to the editor and make them, save and quit, then typeset and preview the file again. To print the DVI file, type a command such as the following at the shell prompt:

```
unix$ dvips first | lpr
```

### ***Example 2: TEXTURES on a Macintosh***

When you start the TEXTURES application on a Macintosh computer, a blank text-editing window appears. Type the text of your document in the window and save it as `first.tex`. When you are ready to typeset the document, make sure that the LaTeX format is selected in the Typeset menu, and then choose Typeset from the same menu.

A second window (titled `first.tex typeset`) appears, displaying the typeset version of your document:



To print your document, choose `Print...` from the `File` menu. To continue editing your document, simply click the mouse in the text-editing window to bring it to the front, and type. Depending on how you have set the options, the changes in the LaTeX source file may automatically appear in the window displaying the typeset version.

### ***Choosing a LaTeX setup***

In Sections 13.2 and 13.3, I briefly review a few of the most popular LaTeX setups. My best advice is to get the same LaTeX setup as that of a friend or colleague so they can help you get started. Many LaTeX implementations come on a CD-ROM or are downloadable from the Internet, and installation is often no more complicated

## TEX

The TEX composition language was designed for typesetting mathematical and scientific articles and books, and can handle complex mathematical formulas as well as text: To get the formula  $\int_0^\pi \sqrt{\alpha^2 + x^2} dx$ , type

```
\int_{0}^{\pi} \sqrt{\alpha^{2} + x^{2}}\,dx
```

You do not have to worry about determining the size of the integral symbol or how to construct the square root symbol that covers  $\alpha^2 + x^2$  because TEX does this for you!

A tremendous part of the appeal of the TEX language is that a source file is *plain text* (ASCII text), which is easy to transmit *electronically* to colleagues, coauthors, journals, editors, and publishers.

TEX is also *platform independent*. You may type the first version of a source file on a Macintosh computer; your coauthor may make improvements to the same file on a PC (a computer running Microsoft Windows); and the journal publishing the article may use a UNIX machine (a computer running a UNIX variant such as Solaris or Linux) to prepare the manuscript for printing.<sup>2</sup>

## L<sup>A</sup>TEX

L<sup>A</sup>TEX was built on TEX's foundation, and has commands that are easier to use, a set of structural elements, and a larger set of diagnostic messages.

L<sup>A</sup>TEX provides the following additional features:

- A document is divided into *logical units*, including an abstract, various sections and subsections, theorems, and a bibliography. The logical units are typed independently of one another. Once all the units have been typed, L<sup>A</sup>TEX controls the *placement* and *formatting* of these elements.
- Line 4 of the sample article `intrart.tex` (on page 39) reads

```
\documentclass{article}
```

This line tells L<sup>A</sup>TEX to load the *document class* `article`, which causes L<sup>A</sup>TEX to format the document as a generic article. When submitting your article to a journal that is equipped to handle L<sup>A</sup>TEX manuscripts (the number of such journals is increasing rapidly), the editor can simply substitute the name of the journal's document class to make the body of your article conform to the journal's design. (Depending on the journal, you may need to use the AMS article document class, `amsart`, in order to ensure that the front matter of your article also adapts.) Many journals make their own document classes available to prospective authors to use while preparing their articles.

---

<sup>2</sup>You may take this sentence as a definition of the three major computing platforms. We will only discuss tools that are available in some form on all three platforms.

- L<sup>A</sup>T<sub>E</sub>X's automatic numbering relieves you of tedious bookkeeping chores. Imagine that you have finished writing an article, with all of your theorems and equations numbered and properly cross-referenced. After a final reading, you must make some changes: Section 4 needs to be moved after Section 7, and some new theorems have to be inserted somewhere in the middle. Such minor changes used to be a major headache! But with L<sup>A</sup>T<sub>E</sub>X, it almost becomes a pleasure to make such changes: L<sup>A</sup>T<sub>E</sub>X automatically renumbers the sections, theorems, and equations in your article, and rebuilds the cross-references.
- With L<sup>A</sup>T<sub>E</sub>X you may use BIB<sub>T</sub>E<sub>X</sub>, an application that helps you create and maintain bibliographic databases, so references do not have to be retyped for each article. BIB<sub>T</sub>E<sub>X</sub> will select and format the needed references from your database.
- Compiling a large index is a big job. L<sup>A</sup>T<sub>E</sub>X users are assisted by *MakeIndex*, an application which makes this job easier.

## The AMS packages

The AMS packages distill the American Mathematical Society's (AMS) years of experience in publishing mathematical journals and books; they add a host of features related to mathematical typesetting, especially the typesetting of multiline formulas and the production of finely tuned printed output. The AMS packages enhance L<sup>A</sup>T<sub>E</sub>X's capabilities in three different areas:

1. **Math.** The `amsmath` package adds a wide variety of tools for typesetting math, including

- Powerful tools to deal with multiline math formulas. For instance, in the following formula, the equal signs (=) and the explanatory comments are vertically aligned:

$$\begin{aligned} x &= (x + y)(x + z) && \text{(by distributivity)} \\ &= x + yz && \text{(by Condition (M))} \\ &= yz. \end{aligned}$$

- Numerous constructs for typesetting mathematical formulas, exemplified by the following:

$$f(x) = \begin{cases} -x^2, & \text{if } x < 0; \\ \alpha + x, & \text{if } 0 \leq x \leq 1; \\ x^2, & \text{otherwise.} \end{cases}$$

- Special spacing rules for dozens of formula types; for example,

$$a \equiv b \pmod{\Theta}$$

typed inline becomes  $a \equiv b \pmod{\Theta}$ .

- Multiline subscripts, as in

$$\sum_{\substack{i^2+j^2=50 \\ i, j \leq 10}} \frac{x^i + y^j}{(i+j)!}$$

- User-defined symbols for typesetting math, such as

$$\text{Trunc } f(x), \quad \hat{A}, \quad \sum^*$$

- Formulas numbered in a variety of ways:
  - Automatically (with numbers)
  - Manually (with tags)
  - By groups, with a group number such as (2) and individual formulas numbered as (2a), (2b), and so on

**2. Document classes.** The AMS packages provide a number of document classes; the most important of which is the AMS article document class, `amsart`; it allows the input of title page information (e.g., author, address, e-mail address) as separate entities. As a result, a journal can typeset even the title page of an article according to its own specifications without having to retype any information.

The AMS document classes provide the proof environment and three theorem styles: plain, definition, and remark. (See the `sampart.tex` sample article on pages 286–288: Theorem 1 uses the plain style, Definition 1 uses the definition style, and the Notation uses the remark style.)

Many users also prefer the visual design of the `amsart` document class to the simpler design of the classic L<sup>A</sup>T<sub>E</sub>X `article` document class.

**3. Fonts.** The AMS packages provide hundreds of symbols for binary operations, binary relations, negated binary relations, arrows, extensible arrows, and so on (see the tables in Appendix A); there are also additional math alphabets such as blackboard bold, Euler Fraktur, Euler Script, and math bold and math bold italic. Here are just a few examples:

$$\Leftarrow, \blacktriangle, \nabla, \supsetneq, \mathbb{A}, \mathfrak{p}, \mathcal{E}$$

The AMS calls these enhancements  $\mathcal{A}\mathcal{M}\mathcal{S}$ -L<sup>A</sup>T<sub>E</sub>X (consisting of the math packages and the document classes) and AMSFonts (consisting of the font-related packages and the fonts themselves). In this book, to simplify the terminology, I refer to all these enhancements collectively as AMS *packages*; I use AMS *distribution* and AMS *enhancements* as synonyms.

I will point out in the text which commands are L<sup>A</sup>T<sub>E</sub>X commands and which are defined by AMS packages. References to AMS commands will also be indicated by the use of a symbol in the margin (such as the one shown here). A smaller version,  $\textcircled{A}$ , is used in the tables of Appendixes A and B and in the index.

$\textcircled{A}$

## What's in the book?

Just before this introduction is the **Quick Finder**, a brief index using mainly non-L<sup>A</sup>T<sub>E</sub>X terms.

**Part I (Chapter 1)** will help you get started quickly with L<sup>A</sup>T<sub>E</sub>X; if you read it carefully, you will be ready to type your own first article and to tackle L<sup>A</sup>T<sub>E</sub>X in more depth.

Part I guides you through

- Text markup, which is quite easy
- Math markup, which is not so straightforward; several sections ease you into mathematical typesetting, including
  - The basic building blocks of math formulas
  - How to build up a complex formula in simple steps
  - A formula gallery
  - Equations and multiline formulas
- The anatomy of an article
- How to set up an article template
- Typing your first article

**Part II** introduces the two most basic skills for writing with L<sup>A</sup>T<sub>E</sub>X in depth: *typing text* and *typing math*.

**Chapters 2 and 3** introduce *text* and *displayed text*. Chapter 2 is especially important because when you type a L<sup>A</sup>T<sub>E</sub>X document, most of your time is spent typing text. The topics covered include special characters and accents, hyphenation, fonts, and spacing. Chapter 3 covers displayed text, including *lists* and *tables*, and for the mathematician, proclamations (theorem-like structures) and proofs.

**Chapters 4 and 5** discuss *inline* and *displayed math*. Typing math is the heart of any mathematical typesetting system. Chapter 4 discusses this topic in detail, including basic constructs, operators, delimiters, building new symbols, fonts, and grouping equations. Chapter 5 presents one of the major contributions of the AMS packages: aligned multiline formulas. This chapter also discusses other forms of multiline formulas.

**Part III** discusses the parts of a L<sup>A</sup>T<sub>E</sub>X document. In **Chapter 6**, you learn about the structure of a L<sup>A</sup>T<sub>E</sub>X document. The most important topics are sectioning and cross-referencing. In **Chapter 7**, the most commonly used standard L<sup>A</sup>T<sub>E</sub>X document classes are presented: `article`, `report`, and `letter` (the book class is discussed in Chapter 12), along with a description of the standard L<sup>A</sup>T<sub>E</sub>X distribution.

In **Chapter 8**, we discuss the AMS document classes. In particular, I present the title page information for the AMS article document class and provide a description of the standard AMS distribution.

Chapter 8 also features the AMS sample article, `sampart.tex`, first in typeset form (pages 286–288), then in mixed form, juxtaposing the source file and the typeset article (pages 290–297). You can learn a lot about L<sup>A</sup>T<sub>E</sub>X and the AMS packages just by reading the source file one paragraph at a time and seeing how that paragraph is typeset by L<sup>A</sup>T<sub>E</sub>X.

**Part IV (Chapter 9)** introduces techniques to *customize* L<sup>A</sup>T<sub>E</sub>X to speed up the typing of source files and the typesetting of documents: user-defined commands, user-defined environments, and custom formats. You will learn how parameters that affect L<sup>A</sup>T<sub>E</sub>X's behavior are stored in *counters* and *length commands*, how to change them, and how to design your own custom lists.

Chapter 9 also contains a version of the AMS sample article utilizing the user-defined commands collected in `lattice.sty`.

In **Part V (Chapters 10 and 11)**, we will discuss longer documents, which have special needs. Two applications, contained in the standard L<sup>A</sup>T<sub>E</sub>X distribution, `BIBTEX` and `MakeIndex` make compiling large bibliographies and indexes much easier.

I present the L<sup>A</sup>T<sub>E</sub>X and the AMS book document classes in **Chapter 12** along with the *dos and don'ts* of book writing in L<sup>A</sup>T<sub>E</sub>X.

**Part VI** deals with L<sup>A</sup>T<sub>E</sub>X and the Internet. **Chapter 13** discusses where to find useful L<sup>A</sup>T<sub>E</sub>X-related information on the Internet. The main topics are:

- Obtaining files from the Internet
- CTAN, the Comprehensive T<sub>E</sub>X Archive Network
- Obtaining the L<sup>A</sup>T<sub>E</sub>X distribution and the AMS packages
- Getting the sample files for this book
- Some commercial T<sub>E</sub>X implementations
- Freeware and shareware T<sub>E</sub>X implementations
- T<sub>E</sub>X user groups and the AMS
- Important L<sup>A</sup>T<sub>E</sub>X-related FTP and Web sites

You can share your L<sup>A</sup>T<sub>E</sub>X articles, reports, and books by putting them on the Web so that others can view, read, download, and print them. **Chapter 14** tells you how.

You will probably find yourself referring to **Appendices A** and **B** time and again: They contain the math and text symbol tables.

**Appendix C** relates some historical background material on L<sup>A</sup>T<sub>E</sub>X: how it developed and how it works. **Appendix D** is a brief introduction to the use of PostScript fonts in a L<sup>A</sup>T<sub>E</sub>X document.

**Appendix E** briefly describes the use of L<sup>A</sup>T<sub>E</sub>X for languages other than American English. **Appendix F** shows a few pages from a book typeset with a Springer-Verlag book document class along with excerpts from the source document.

**Appendix G** will help orient those people who have previously worked with



(Plain)  $\TeX$ ,  $\LaTeX$ , version 2.09,  $\mathcal{A}\mathcal{M}\mathcal{S}\text{-}\TeX$ , or  $\mathcal{A}\mathcal{M}\mathcal{S}\text{-}\LaTeX$ , version 1.x. Some tips are given to smooth your transition to using the current standard  $\LaTeX$  and the AMS packages. Finally, **Appendix H** points you towards some areas for further study.

## *Mission statement*

This book is a guide for typesetting mathematical documents within the constraints imposed by  $\LaTeX$ , an elaborate system with hundreds of rules.  $\LaTeX$  allows you to perform almost any mathematical typesetting task through the appropriate application of its rules. You can customize  $\LaTeX$  (as it was designed to be modified) by introducing user-defined commands and environments and by changing  $\LaTeX$  parameters.

You can also extend  $\LaTeX$  by invoking packages that accomplish special tasks: One such set of packages from the AMS plays an important role in this book—as it should in any book dealing with mathematical typesetting.

It is not my goal to teach you

- How to modify  $\LaTeX$  code to change  $\LaTeX$ 's behavior
- How to write  $\TeX$  code to create your own packages ( $\LaTeX$  extensions)
- How to design beautiful documents (writing document classes)

The definitive book on the first topic is Michel Goossens, Frank Mittelbach, and Alexander Samarin's *The  $\LaTeX$  Companion* [17]. The second and third topics still await authoritative books.

## *A recommendation*

I strongly recommend that you use the `amsart` document class for all your articles. Begin each article with the lines

```
\documentclass{amsart}
\usepackage{amssymb,latexsym}
\begin{document}
```

and you can ignore all of the discussions in this book about  $\LaTeX$  commands versus AMS commands, and  $\LaTeX$  fonts and the `latexsym` package versus AMS fonts and the `amssymb` package.

Some of you may not be able to follow this recommendation, including those who work with older installations whose system managers cannot or will not install a newer version of  $\LaTeX$  or the AMS packages, and those who are forced to use a publisher's document class file that is not compatible with the AMS packages. But most users of  $\LaTeX$  who typeset documents with significant amounts of math will find that using the `amsart` document class and loading `amssymb` and `latexsym` make their work easier.

## Keeping up-to-date

Like most computer-related subjects, the material in this book is subject to change over time. While L<sup>A</sup>T<sub>E</sub>X itself may not change much until the advent of L<sup>A</sup>T<sub>E</sub>X3, there is a new version of the `amsmath` package on the horizon, introducing a variant of the `equation` environment that will automatically break long formulas into shorter lines. Chapter 13 deals with the Internet, which is in a state of constant flux. To keep you up-to-date, I am maintaining a Web page to track these changes for you. To find this page, go to my home page,

<http://www.maths.umanitoba.ca/homepages/gratzer/>

and follow the links `LaTeX books` and `MiL Update`. Or go directly to

<http://www.maths.umanitoba.ca/homepages/gratzer/LaTeXBooks/milupdate.html>

## Conventions

To make this book easy to read, I use some simple conventions:

- Explanatory text is set in this typeface: Galliard.
- Computer Modern typewriter is used to show what you should type (as well as messages from LaTeX). All the characters in this typeface have the same width, making it easy to recognize.
- I also use Computer Modern typewriter to indicate
  - Commands (`\parbox`)
  - Environments (`align`)
  - Documents (`intrart.tex`)
  - Document classes (`article`)
  - Document class options (`draft`)
  - Directories or folders (`work`)
- The names of *packages*, which are extensions of L<sup>A</sup>T<sub>E</sub>X, are set in a sans-serif typeface (`amsmath`).
- When I show you how something looks when typeset, I use Computer Modern, T<sub>E</sub>X's standard typeface:

┌

I think you will find this typeface sufficiently different from the other typefaces I have used (the strokes are much lighter) so that you should not have much difficulty recognizing typeset L<sup>A</sup>T<sub>E</sub>X material. When the typeset material is a separate paragraph (or paragraphs), corner brackets in the margin set it off from the rest of the text—unless it is a single displayed formula.

└

- For explanations in the text, such as

Compare `iff` with `iff`, typed as `iff` and `if{f}`, respectively.

the same typefaces are used. Because they are not set off spatially, it may be a little more difficult to see that `iff` is set in Computer Modern roman, whereas `iff` is set in the Computer Modern typewriter typeface.

- I usually introduce commands with examples, such as

```
\\[22pt]
```

However, it is sometimes necessary to define the syntax of a command more formally. For instance,

```
\\[length]
```

where *length* is a *placeholder* representing the value you have to supply. I use the Computer Modern typewriter italic font for placeholders.

- I use the term *directory* to mean both directory and folder.

## Acknowledgments

This book is based, of course, on its previous editions. I would like to thank the many people, too numerous to list here again, who read and reread those earlier manuscripts.

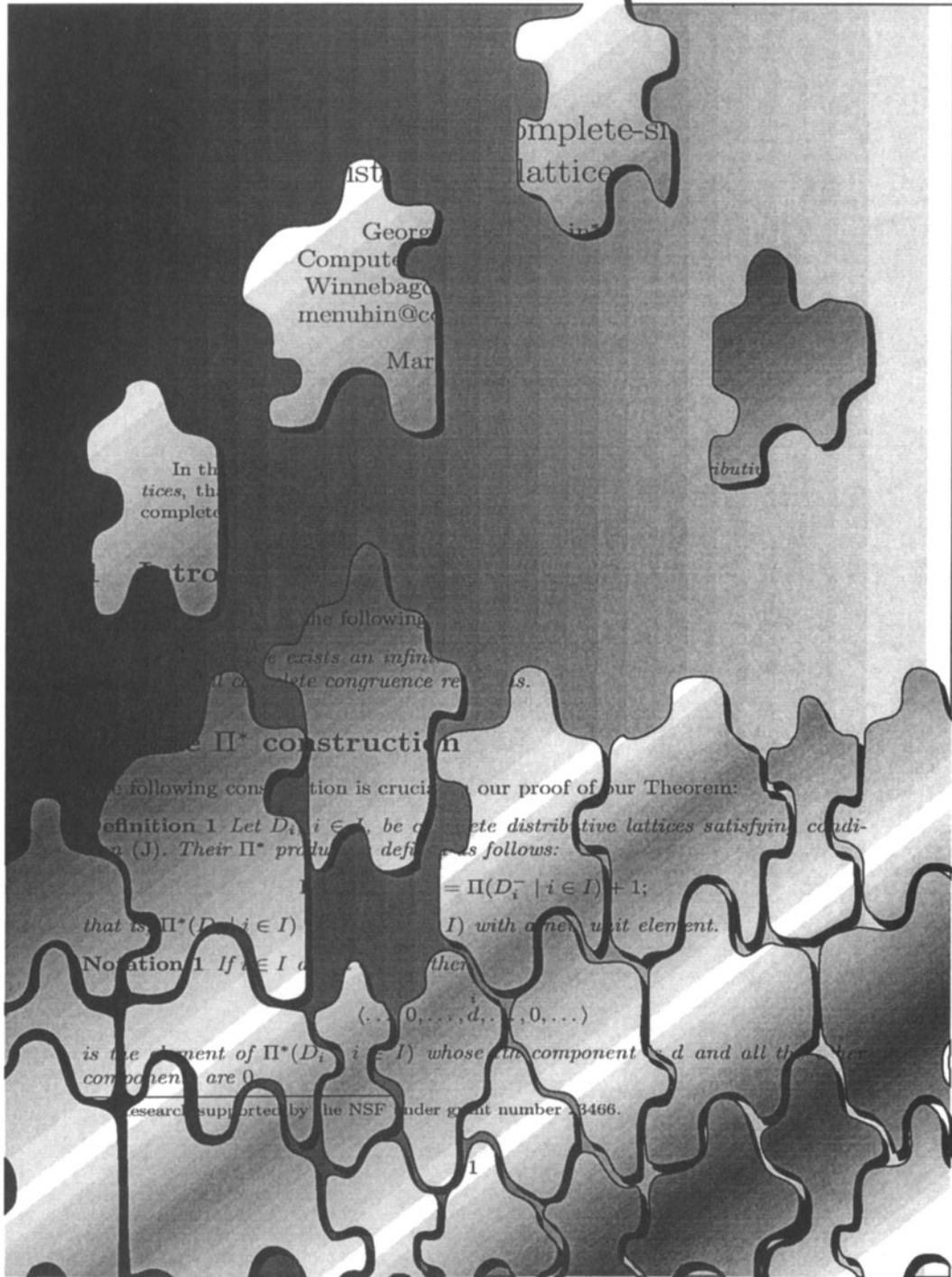
I received professional reports on the manuscript from Barbara Beeton, Nandor Sieben, and Ferenc Wettl. Arthur Ogawa commented on Part I. The chapter on `BIBTEX` has been carefully reviewed—again—by Oren Patashnik (the author of `BIBTEX`); the chapter on the Web was read by Sebastian Raetz (the author of the `hyperref` package and coauthor of the *The L<sup>A</sup>T<sub>E</sub>X Web Companion* [19]); the chapter on books was read by Fred Bartlett (Electronic Publishing, Springer-Verlag New York).

Claire M. Connelly did an outstanding job editing the manuscript, far and beyond the call of duty; in addition to editing the text and making suggestions for improvements, she redesigned the tables and updated the index. Melissa O’Neill provided two ingenious Perl scripts for cleaning up the index. Ann Kostant demonstrated that publishers care; this complex project greatly benefited from her guidance and editorial advice. Elizabeth Loew carefully guided the manuscript to publication.

George Grätzer

E-mail: [gratzer@cc.umanitoba.ca](mailto:gratzer@cc.umanitoba.ca)

Home page: <http://www.maths.umanitoba.ca/homepages/gratzer/>



complete-distributive lattice

George  
Comput  
Winnebago  
menuhin@cc

Mar

In the  
tices, the  
complete

tributin

Intro

the following

exists an infinite  
congruence re

### the $\Pi^*$ construction

the following construction is crucial to our proof of our Theorem:

**Definition 1** Let  $D_i, i \in I$ , be complete distributive lattices satisfying condition (J). Their  $\Pi^*$  product is defined as follows:

$$\Pi^*(D_i | i \in I) = \Pi(D_i | i \in I) + 1;$$

that is,  $\Pi^*(D_i | i \in I)$  is a complete distributive lattice with a new unit element.

**Notation 1** If  $i \in I$  and  $d \in D_i$ , then

$$\langle \dots, 0, \dots, d, \dots, 0, \dots \rangle$$

is the element of  $\Pi^*(D_i | i \in I)$  whose  $i$ -th component is  $d$  and all the other components are 0.

research supported by the NSF under grant number 3466.