Appendix A
Coxeter and Artin–Like Presentations

This appendix is written after the work which can be found in various successive papers : [BrMaRo], [BeMi], [Bes3], [MaMi].

A.1 Meaning of the Diagrams

A.1.1 Diagrams for the Reflection Groups

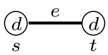
Here are some definitions, notation, conventions, which will allow the reader to understand the diagrams.

The groups have presentations given by diagrams $\mathcal{D}$ such that

- the nodes correspond to pseudo-reflections in G, the order of which is given inside the circle representing the node,
- two distinct nodes which do not commute are related by "homogeneous" relations with the same "support" (of cardinality 2 or 3), which are represented by links between two or three nodes, or circles between three nodes, weighted with a number representing the degree of the relation (as in Coxeter diagrams, 3 is omitted, 4 is represented by a double line, 6 is represented by a triple line). These homogeneous relations are called the *braid relations* of $\mathcal{D}$.

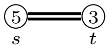
More details are provided below.

This paragraph provides a list of examples which illustrate the way in which diagrams provide presentations for the attached groups.

- The diagram 

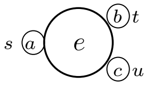
corresponds to the presentation

$$s^d = t^d = 1 \text{ and } \underbrace{ststs\cdots}_{e \text{ factors}} = \underbrace{tstst\cdots}_{e \text{ factors}}$$

- The diagram 

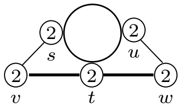
corresponds to the presentation

$$s^5 = t^3 = 1 \text{ and } stst = tsts.$$

- The diagram 

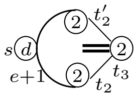
corresponds to the presentation

$$s^a = t^b = u^c = 1 \text{ and } \underbrace{stustu\cdots}_{e \text{ factors}} = \underbrace{tustus\cdots}_{e \text{ factors}} = \underbrace{ustust\cdots}_{e \text{ factors}} .$$

- The diagram 

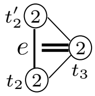
corresponds to the presentation

$$\begin{aligned} &s^2 = t^2 = u^2 = v^2 = w^2 = 1\,, \\ &uv = vu\,,\ sw = ws\,,\ vw = wv\,, \\ &sut = uts = tsu\,, \\ &svs = vsv\,,\ tvt = vtv\,,\ twt = wtw\,, wuw = uwu\,. \end{aligned}$$

- The diagram 

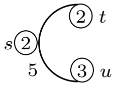
corresponds to the presentation

$$\begin{aligned} &s^d = {t'_2}^2 = t_2^2 = t_3^2 = 1\,,\ st_3 = t_3 s\,, \\ &st'_2t_2 = t'_2t_2s\,, \\ &t'_2t_3t'_2 = t_3t'_2t_3\,,\ t_2t_3t_2 = t_3t_2t_3\,,\ t_3t'_2t_2t_3t'_2t_2 = t'_2t_2t_3t'_2t_2t_3\,, \\ &\underbrace{t_2st'_2t_2t'_2t_2t'_2\cdots}_{e+1 \text{ factors}} = \underbrace{st'_2t_2t'_2t_2t'_2t_2\cdots}_{e+1 \text{ factors}} . \end{aligned}$$

- The diagram 

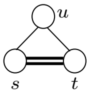
corresponds to the presentation

$$\begin{aligned} &{t'_2}^2 = t_2^2 = t_3^2 = 1\,, \\ &t'_2t_3t'_2 = t_3t'_2t_3\,,\ t_2t_3t_2 = t_3t_2t_3\,,\ t_3t'_2t_2t_3t'_2t_2 = t'_2t_2t_3t'_2t_2t_3\,, \\ &\underbrace{t_2t'_2t_2t'_2t_2t'_2\cdots}_{e \text{ factors}} = \underbrace{t'_2t_2t'_2t_2t'_2t_2\cdots}_{e \text{ factors}} . \end{aligned}$$

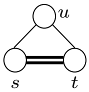
- The diagram 

corresponds to the presentation

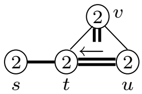
$$s^2 = t^2 = u^3 = 1\,,\ stu = tus\,,\ ustut = stutu\,.$$

- The diagram  corresponds to the presentation

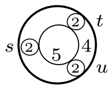
$$s^2 = t^2 = u^2 = 1,\ stst = tsts, tutu = utuu, sus = usu, tu(stu)^2 s = utu(stu)^2.$$

- The diagram  corresponds to the presentation

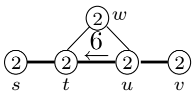
$$s^2 = t^2 = u^2 =,\ stst = tsts,\ tut- = utu,\ sus =,\ tu(stu)^3 t = utu(stu)^3\,.$$

- The diagram  corresponds to the presentation

$$s^2 = t^2 = u^2 = v^2 = 1,\ sv = vs\,,\ su = us\,,$$
$$sts = tst,\ vtv = tvt,\ uvu = vuv,\ tutu = utut,\ vtuvtu = tuvtuv\,.$$

- The diagram  corresponds to the presentation

$$s^2 = t^2 = u^2 = 1\,,\ ustus = stust\,,\ tust = ustu\,.$$

- The diagram  corresponds to the presentation

$$s^2 = t^2 = u^2 = v^2 = w^2 = 1\,,\ vt = tv\,,\ uv = vu\,,\ tu = ut\,,\ wu = uw\,,$$
$$sts = tst\,,\ tut = utu\,,\ uvu = vuv\,,\ twt = wtw\,,\ uwu = wuw\,,$$
$$utwutw = twutwu = wutwut\,.$$

In the following tables, we denote by $H \rtimes K$ a group which is a non-trivial split extension of K by H. We denote by $H \cdot K$ a group which is a non-split extension of K by H. We denote by p^n an elementary abelian group of order p^n.

A.1.2 Braid Diagrams

A diagram where the orders of the nodes are "forgotten" and where only the braid relations are kept is called a *braid diagram* for the corresponding group.

All braid diagrams define presentation by braid reflections of the corresponding braid groups.

The groups have been ordered by their diagrams, by collecting groups with the same braid diagram. Thus, for example,

- G_{15} has the same braid diagram as the groups $G(4d, 4, 2)$ for all $d \geq 2$,
- G_4, G_8, G_{16}, G_{25}, G_{32} all have the same braid diagrams as groups $\mathfrak{S}_3$, $\mathfrak{S}_4$ and $\mathfrak{S}_5$,
- G_5, G_{10}, G_{18} have the same braid diagram as the groups $G(d, 1, 2)$ for all $d \geq 2$,
- G_7, G_{11}, G_{19} have the same braid diagram as the groups $G(2d, 2, 2)$ for all $d \geq 2$,
- G_{26} has the same braid diagram as $G(d, 1, 3)$ for $d \geq 2$.

The element β (generator of $Z(G)$) is given in the last column of our tables. Notice that the knowledge of degrees and codegrees allows then to find the order of $Z(G)$, which is not explicitly provided in the tables.

The tables provide diagrams and data for all irreducible reflection groups.

- Tables 1 and 2 collect groups corresponding to infinite families of braid diagrams,
- Table 3 collects groups corresponding to exceptional braid diagrams but G_{24}, G_{27}, G_{29}, G_{33}, G_{34}.
- The last table (table 4) provides diagrams for the remaining cases (G_{24}, G_{27}, G_{29}, G_{33}, G_{34}).

Degrees and Codegrees of a Braid Diagram

The following property has been first noticed on the tables. It generalizes a property already noticed by Orlik and Solomon for the case of Coxeter–Shephard groups (see [OrSo3], (3.7)).

It has been proven by Couwenberg–Heckman–Looijenga [CoHeLo] who also proved that, given any braid diagram, there is a complex reflection group generated by reflections of order 2 with that braid diagram.

Proposition A.1. *Let $\mathcal{D}$ be a braid diagram of rank r. There exist two families*

$$(\mathbf{d}_1, \mathbf{d}_2, \ldots, \mathbf{d}_r) \quad \textit{and} \quad (\mathbf{d}_1^\vee, \mathbf{d}_2^\vee, \ldots, \mathbf{d}_r^\vee)$$

of r integers, depending only on $\mathcal{D}$, and called respectively the degrees and the codegrees of $\mathcal{D}$, with the following property: whenever G is a complex reflection group with $\mathcal{D}$ as a braid diagram, its degrees and codegrees are given by the formulae

$$d_j = |Z(G)|\mathbf{d}_j \quad \textit{and} \quad d_j^\vee = |Z(G)|\mathbf{d}_j^\vee \quad (j = 1, 2, \ldots, r)\,.$$

The Zeta Function of a Braid Diagram

In [DeLo], Denef and Loeser compute the *zeta function of local monodromy of the discriminant* of a complex reflection group G, which is the element of $\mathbb{Q}[q]$ defined by the formula

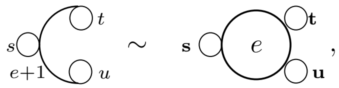
$$Z(q,G) := \prod_j \det(1 - q\mu, H^j(F_0, \mathbb{C}))^{(-1)^{j+1}} ,$$

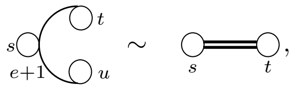
where F_0 denotes the Milnor fiber of the discriminant at 0 and μ denotes the monodromy automorphism (see [DeLo]).

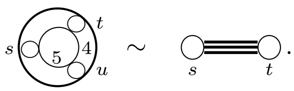
Putting together the tables of *loc.cit.* and our braid diagrams, one may notice the following fact.

Proposition A.2. *The zeta function of local monodromy of the discriminant of a complex reflection group G depends only on the braid diagram of G.*

Remark A.3. Two different braid diagrams may be associated to isomorphic braid groups. For example, this is the case for the following rank 2 diagrams (where the sign "$\sim$" means that the corresponding groups are isomorphic) :

For e even, 

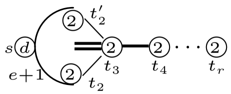
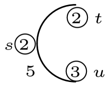
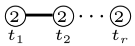
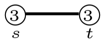
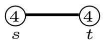
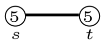
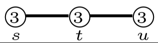
for e odd, 

and 

It should be noticed, however, that the above pairs of diagrams do not have the same degrees and codegrees, nor do they have the same zeta function. Thus, degrees, codegrees and zeta functions are indeed attached to the braid diagrams, not to the braid groups.

A.2 Tables

Table A.1

name	diagram	degrees	codegrees	β	field	$G/Z(G)$
$G(de,e,r)$ $e>2,d,r\geq 2$		$(ed,2ed,\ldots,(r-1)ed,rd)$	$(0,ed,\ldots,(r-1)ed)$	$s^{\frac{r}{(e\wedge r)}}(t_2't_2t_3\cdots t_r)^{\frac{e(r-1)}{(e\wedge r)}}$	$\mathbb{Q}(\zeta_{de})$	
G_{15}		$12, 24$	$0, 24$	$ustut{=}s(tu)^2$	$\mathbb{Q}(\zeta_{24})$	$\mathfrak{S}_4$
$\mathfrak{S}_{r+1}$		$(2,3,\ldots,\ldots,r+1)$	$(0,1,\ldots,\ldots,r-1)$	$(t_1\cdots t_r)^{r+1}$	$\mathbb{Q}$	
G_4		4,6	0,2	$(st)^3$	$\mathbb{Q}(\zeta_3)$	$\mathfrak{A}_4$
G_8		8,12	0,4	$(st)^3$	$\mathbb{Q}(i)$	$\mathfrak{S}_4$
G_{16}		20,30	0,10	$(st)^3$	$\mathbb{Q}(\zeta_5)$	$\mathfrak{A}_5$
G_{25}		6,9,12	0,3,6	$(stu)^4$	$\mathbb{Q}(\zeta_3)$	$3^2{\rtimes}SL_2(3)$

(continued)

Table A.1 (continued)

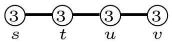
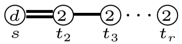
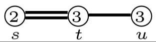
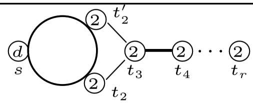
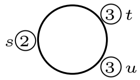
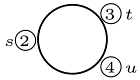
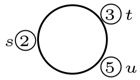
name	diagram	degrees	codegrees	β	field	$G/Z(G)$
G_{32}		$12,18,24,30$	$0,6,12,18$	$(stuv)^5$	$\mathbb{Q}(\zeta_3)$	$PSp_4(3)$
$G(d,1,r)$ $d\geq 2$		$(d,2d,\ldots,\ldots,rd)$	$(0,d,\ldots,\ldots,(r-1)d)$	$(st_2t_3\cdots t_r)^r$	$\mathbb{Q}(\zeta_d)$	
G_5		6,12	0,6	$(st)^2$	$\mathbb{Q}(\zeta_3)$	$\mathfrak{A}_4$
G_{10}		12,24	0,12	$(st)^2$	$\mathbb{Q}(\zeta_{12})$	$\mathfrak{S}_4$
G_{18}		30,60	0,30	$(st)^2$	$\mathbb{Q}(\zeta_{15})$	$\mathfrak{A}_5$
G_{26}		6,12,18	0,6,12	$(stu)^3$	$\mathbb{Q}(\zeta_3)$	$3^2\rtimes SL_2(3)$

Table A.2

name	diagram	degrees	codegrees	β	field	$G/Z(G)$
$G(2d,2,r)$ $d,r\geq 2$		$(2d,4d,\ldots 2(r-1)d,rd)$	$(0,2d,\ldots 2(r-1)d)$	$s^{\frac{r}{(2\wedge r)}}(t'_2t_2t_3\cdots t_r)^{\frac{2(r-1)}{(2\wedge r)}}$	$\mathbb{Q}(\zeta_{2d})$	
G_7		12,12	0,12	stu	$\mathbb{Q}(\zeta_{12})$	$\mathfrak{A}_4$
G_{11}		24,24	0,24	stu	$\mathbb{Q}(\zeta_{24})$	$\mathfrak{S}_4$
G_{19}		60,60	0,60	stu	$\mathbb{Q}(\zeta_{60})$	$\mathfrak{A}_5$

(continued)

Table A.2 (continued)

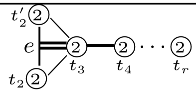
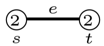
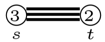
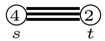
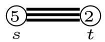
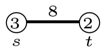
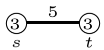
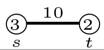
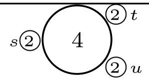
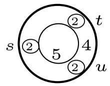
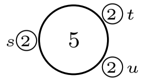
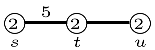
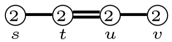
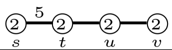
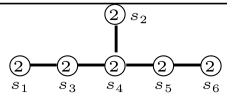
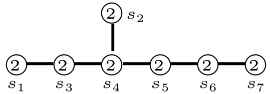
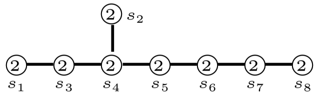
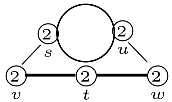
name	diagram	degrees	codegrees	β	field	$G/Z(G)$
$G(e,e,r)$ $e\geq 2, r>2$		$(e, 2e, \ldots, (r-1)e, r)$	$(0, e, \ldots, (r-2)e, (r-1)e-r)$	$(t_2' t_2 t_3 \cdots t_r)^{\frac{e(r-1)}{(e\wedge r)}}$	$\mathbb{Q}(\zeta_e)$	
$G(e,e,2)$ $e\geq 3$		2,e	0,e-2	$(st)^{e/(e\wedge 2)}$	$\mathbb{Q}(\zeta_e+\zeta_e^{-1})$	
G_6		4,12	0,8	$(st)^3$	$\mathbb{Q}(\zeta_{12})$	$\mathfrak{A}_4$
G_9		8,24	0,16	$(st)^3$	$\mathbb{Q}(\zeta_8)$	$\mathfrak{S}_4$
G_{17}		20,60	0,40	$(st)^3$	$\mathbb{Q}(\zeta_{20})$	$\mathfrak{A}_5$
G_{14}		6,24	0,18	$(st)^4$	$\mathbb{Q}(\zeta_3, \sqrt{-2})$	$\mathfrak{S}_4$
G_{20}		12,30	0,18	$(st)^5$	$\mathbb{Q}(\zeta_3, \sqrt{5})$	$\mathfrak{A}_5$
G_{21}		12,60	0,48	$(st)^5$	$\mathbb{Q}(\zeta_{12}, \sqrt{5})$	$\mathfrak{A}_5$

Table A.3

name	diagram	degrees	codegrees	β	field	$G/Z(G)$
G_{12}		6,8	0,10	$(stu)^4$	$\mathbb{Q}(\sqrt{-2})$	$\mathfrak{S}_4$
G_{13}		8,12	0,16	$(stu)^3$	$\mathbb{Q}(\zeta_8)$	$\mathfrak{S}_4$
G_{22}		12,20	0,28	$(stu)^5$	$\mathbb{Q}(i,\sqrt{5})$	$\mathfrak{A}_5$
G_{23}		2,6,10	0,4,8	$(stu)^5$	$\mathbb{Q}(\sqrt{5})$	$\mathfrak{A}_5$
G_{28}		2,6, 8,12	0,4, 6,10	$(stuv)^6$	$\mathbb{Q}$	$2^4 \rtimes (\mathfrak{S}_3 \times \mathfrak{S}_3)$ †
G_{30}		2,12, 20,30	0,10, 18,28	$(stuv)^{15}$	$\mathbb{Q}(\sqrt{5})$	$(\mathfrak{A}_5 \times \mathfrak{A}_5) \rtimes 2$ ‡

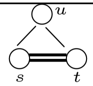
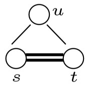
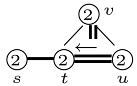
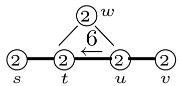
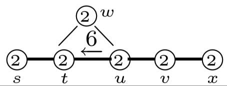
(continued)

Table A.3 (continued)

name	diagram	degrees	codegrees	β	field	$G/Z(G)$
G_{35}		2,5,6,8, 9,12	0,3,4,6, 7,10	$(s_1 \cdots s_6)^{12}$	$\mathbb{Q}$	$SO_6^-(2)'$
G_{36}		2,6,8, 10,12, 14,18	0,4,6, 8,10, 12,16	$(s_1 \cdots s_7)^9$	$\mathbb{Q}$	$SO_7(2)$
G_{37}		2,8,12, 14,18,20, 24,30	0,6,10, 12,16,18, 22,28	$(s_1 \cdots s_8)^{15}$	$\mathbb{Q}$	$SO_8^+(2)$
G_{31}		8,12, 20,24	0,12, 16,28	$(stuwv)^6$	$\mathbb{Q}(i)$	$2^4 \rtimes \mathfrak{S}_6$ ⋆

† The action of $\mathfrak{S}_3 \times \mathfrak{S}_3$ on 2^4 is irreducible.
‡ The automorphism of order 2 of $\mathfrak{A}_5 \times \mathfrak{A}_5$ permutes the two factors.
⋆ The group $G_{31}/Z(G_{31})$ is not isomorphic to the quotient of the Weyl group D_6 by its center.

Table A.4

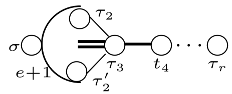
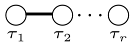
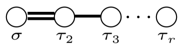
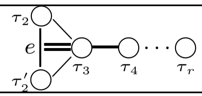
name	diagram	degrees	codegrees	β	field	$G/Z(G)$
G_{24}	 (*)	4,6,14	0,8,10	$(stu)^7$	$\mathbb{Q}(\sqrt{-7})$	$GL_3(2)$
G_{27}	 (**)	6,12,30	0,18,24	$(uts)^5$	$\mathbb{Q}(\zeta_3, \sqrt{5})$	$\mathfrak{A}_6$
G_{29}		4,8,12,20	0,8,12,16	$(stvu)^5$	$\mathbb{Q}(i)$	$2^4 \rtimes \mathfrak{S}_5$ †
G_{33}		4,6,10, 12,18	0,6,8, 12,14	$(stuvw)^9$	$\mathbb{Q}(\zeta_3)$	$SO_5(3)'$
G_{34}		6,12,18,24, 30,42	0,12,18,24, 30,36	$(stuvwx)^7$	$\mathbb{Q}(\zeta_3)$	$PSO_6^-(3)'{\cdot}2$

$(*) tu(stu)^2 s = utu(stu)^2$

$(**) tu(stu)^3 t = utu(stu)^3$

† The group $G_{29}/Z(G_{29})$ is not isomorphic to the Weyl group D_5. p

Table A.5 Braid diagrams

name	diagram	degrees	codegrees	β
$B(de,e,r)$ $e\geq 2, r\geq 2, d>1$		$e, 2e, \ldots, (r-1)e, r$	$0, e, \ldots, (r-1)e$	$\sigma^{\frac{r}{(e\wedge r)}} (\tau_2\tau_2'\tau_3\cdots\tau_r)^{\frac{e(r-1)}{(e\wedge r)}}$
$B(1,1,r)$		$2, 3, \ldots, r+1$	$0, 1, \ldots, r-1$	$(\tau_1\cdots\tau_r)^{r+1}$
$B(d,1,r)$ $d>1$		$1, 2, \ldots, r$	$0, , \ldots, (r-1)$	$(\sigma\tau_2\tau_3\cdots\tau_r)^r$
$B(e,e,r)$ $e\geq 2, r\geq 2$		$e, 2e, \ldots, (r-1)e, r$	$0, e, \ldots, (r-2)e, (r-1)e-r$	$(\tau_2\tau_2'\tau_3\cdots\tau_r)^{\frac{e(r-1)}{(e\wedge r)}}$

This table provides a complete list of the infinite families of braid diagrams and corresponding data. Note that the braid diagram $B(de,e,r)$ for $e=2, d>1$ can also be described by a diagram as the one used for $G(2d,2,r)$ in Table 2. Similarly, the diagram for $B(e,e,r)$, $e=2$, can also be described by the Coxeter diagram of type D_r. The list of exceptional diagrams is given by with tables 3 and 4.

References

[AtMD] M. Atiyah and I. G. MacDonald, *Introduction to commutative algebra,* Addison–Wesley, Reading, Mass. 1969.

[Au] M. Auslander, *On the purity of the branch locus,* Amer. J. of Math. **84** (1962), 116–125.

[Bena] D. Benard, *Polynomial Invariants of Finite Groups,* London Math. Soc. Lecture Note Series **190**, University Press, Cambridge, 1993.

[Ben] D. Benson, *Polynomial Invariants of Finite Groups,* London Math. Soc. Lecture Note Series **190**, University Press, Cambridge, 1993.

[Bes1] D. Bessis, *Sur le corps de définition d'un groupe de réflexions complexe,* Comm. in Algebra **25** (8) (1997), 2703–2716.

[Bes2] D. Bessis,, *The dual braid monoid,* Ann. Sci. École Norm. Sup. (4) **36** (2003), no. 5, 647–683.

[Bes3] D. Bessis,, *Finite complex arrangements are $K(\pi,1)$,* arXiv:math. GT/0610777 (2007).

[BeMi] D. Bessis and J .Michel, *Explicit presentations for exceptional braid group,* Experiment. math. **13** (2004), 257–266.

[BoLeMi] C. Bonnafé, G. I. Lehrer, J. Michel, *Twisted invariant theory for reflection groups,* Nagoya Math. J. **182** (2006), 135–170.

[Bou1] N. Bourbaki, *Groupes et algèbres de Lie, chap. 4, 5 et 6,* Hermann, Paris, 1968.

[Bou2] N. Bourbaki, *Algèbre Commutative, chap. 5 et 6,* Hermann, Paris, 1968.

[Bou3] N. Bourbaki, *Algèbre commutative, chap. 8 et 9,* Masson, Paris, 1983.

[Bro1] M. Broué, *Reflection Groups, Braid Groups, Hecke Algebras, Finite Reductive Groups,* Current Developments in Mathematics, 2000 Harvard Univ. (B. Mazur, W. Schmidt, S. T. Yau) and M. I. T. (J. de Jong, D. Jerison, G. Lusztig) International Press, Boston (2001), 1–107.

[Bro2] M. Broué, *Introduction to Complex Reflection Groups and their Braid Groups,* Berkeley University (2008).

[BrMaMi] M. Broué, G. Malle and J. Michel, *Towards Spetses I,* Trans. Groups; **4** (2–3) (1999), 157–218.

[BrMaRo] M. Broué, G. Malle and R. Rouquier, *Complex reflection groups, braid groups, Hecke algebras,* J. reine angew. Math. **500** (1998), 127–190.

[BrMi] M. Broué and J. Michel, *Sur certains éléments réguliers des groupes de Weyl et les variétés de Deligne-Lusztig associées,* Progress in Math. **141** (1997), 73–140.

[Ch] C. Chevalley, *Invariants of finite groups generated by reflections,* Amer. J. Math **77** (1955), 778–782.

[Co] A. M. Cohen, *Finite complex reflection groups,* Ann. scient. Éc. Norm. Sup. **9** (1976), 379–436.

[CoHeLo] W. Couwenberg, G. Heckman and E. Looijenga, *Geometric structures on the complement of a projective arrangement,* Publ. Math. de l'IHES **101** (2005), 69–161.

[Cx] H. S. M. Coxeter, *Finite groups generated by unitary reflections,* Abh. math. Sem. Univ. Hamburg **31** (1967), 125–135.

[Del] P. Deligne, *Les immeubles des groupes de tresses généralisés,* Invent. Math. **17** (1972), 273–302.

[DeLo] J. Denef and F. Loeser, *Regular elements and monodromy of discriminants of finite reflection groups,* Indag. Mathem. **6** (2) (1995), 129–143.

[DiMi1] F. Digne and J. Michel, *Endomorphisms of Deligne-Lusztig varieties,* Nagoya Mathematical Journal **183** (2006), 35–103.

[DuOp] C. F. Dunkl and E. M. Opdam, *Dunkl operators for real for complex reflection groups,* Proc. London Math. Soc. (3) **86** (2003), 70–108.

[Ei] D. Eisenbud, *Commutative Algebra with a View Toward Algebraic Geometry,* Graduate Texts in Mathematics **150**, Springer Verlag, Berlin Heidelberg New–York, 1995.

[Gut] E. A. Gutkin, *Matrices connected with groups generated by mappings,* Func. Anal. and Appl. (Funkt. Anal. i Prilozhen) **7** (1973), 153–154 (81–82).

[Ja] N. Jacobson, *Basic Algebra II,* Freeman, San Francisco, 1980.

[Ka] R. Kane, *Reflection Groups and Invariant Theory,* CMS Books in Mathematics, Canadian mathematical society, 2001.

[Le] G. I. Lehrer, *A new proof of Steinberg's Fixed-point Theorem,* International Mathematics Research Notices **28** (2004), 1409–1411.

[LeMi] G. I. Lehrer and J. Michel, *Invariant theory and eigenspaces for unitary reflection groups,* C.R.Acad.Sc., Sér. I **336** (2003), 795–800.

[LeSp] G. I. Lehrer and T. Springer, *Reflection subquotients of unitary reflection groups,* Canad. J. Math. **51** (1999), 1175–1193.

[LeTa] G. I. Lehrer and D. E. Taylor, *Unitary Reflection Groups,* Australian Mathematical Society Lecture Series, Paperback , 2009.

[Ma1] G. Malle, *Spetses,* Doc. Math. ICM II (1998), 87–96.

[MaMi] G. Malle and J. Michel, *Constructing representations of Hecke algebras for complex reflection groups,* arXiv:0909.4040, (2009).

[Mat] H. Masumura, *Commutative ring theory,* Cambridge University Press, Cambridge studies in advanced mathematics 8, Cambridge, 1992.

[Mi] J. Michel, *Private communication,* 1990–2009.

[Op1] E. M. Opdam, *Complex Reflection Groups and Fake Degrees,* Unpublished manuscript (1998).

[Op2] E. M. Opdam, *Lectures on Dunkl operators for real and complex reflection groups,* MSJ Memoirs 8 (Monograph), Math. Soc. of Japan (2000).

[OrSo1] P. Orlik and L. Solomon, *Combinatorics and topology of complements of hyperplanes,* Invent. Math. **56** (1980), 167–189.

[OrSo2] P. Orlik and L. Solomon, *Unitary reflection groups and cohomology,* Invent. Math. **59** (1980), 77–94.

[OrSo3] P. Orlik and L. Solomon, *Braids and discriminants,* Braids (eds. J. S. Birman and A. Lebgober), Contemp. Math. **78** AMS, Providence (1988), 605–613.

[OrTe] P. Orlik and H. Terao, *Arrangements of hyperplanes,* Springer, Berlin - Heidelberg 1992).

[PiWe] A. Pianzola and A.Weiss, *Monstrous E10's and a generalization of a theorem of L. Solomon,* C. R. Math. Rep. Acad. Sci. Canada **11** (1989), 189–194.

[Se1] J.-P. Serre, *Groupes finis d'automorphismes d'anneaux locaux réguliers* Colloque d'Algèbre, École Normale Supérieure de Jeunes Filles, Paris, 1967.

[Se2] J.-P. Serre, *Algèbre locale – Multiplicités,* Springer, Berlin/New-York Springer Lect. Notes in Math. **11**, 1965.

[ShTo] G. C. Shephard and J. A. Todd, *Finite unitary reflection groups,* Canad. J. Math. **6** (1954), 274–304.

[So] L. Solomon, *Invariants of finite reflection groups,* Nagoya Math. J. **22** (1963), 57–64.

[Sp] T. A. Springer, *Regular elements of finite reflection groups,* Invent. Math. **25** (1974), 159–198.

[Sta] R. Stanley, *Relative invariants of finite groups generated by pseudoreflections,* J. of Algebra **49** (1977), 134–148.

[St] R. Steinberg, *Differential equations invariant under finite reflection groups,* Trans. Amer. Math. Soc. **112** (1964), 392–400.

Index

Lecture Notes in Mathematics

For information about earlier volumes
please contact your bookseller or Springer
LNM Online archive: springerlink.com

Vol. 1805: F. Cao, Geometric Curve Evolution and Image Processing (2003)
Vol. 1806: H. Broer, I. Hoveijn. G. Lunther, G. Vegter, Bifurcations in Hamiltonian Systems. Computing Singularities by Gröbner Bases (2003)
Vol. 1807: V. D. Milman, G. Schechtman (Eds.), Geometric Aspects of Functional Analysis. Israel Seminar 2000-2002 (2003)
Vol. 1808: W. Schindler, Measures with Symmetry Properties (2003)
Vol. 1809: O. Steinbach, Stability Estimates for Hybrid Coupled Domain Decomposition Methods (2003)
Vol. 1810: J. Wengenroth, Derived Functors in Functional Analysis (2003)
Vol. 1811: J. Stevens, Deformations of Singularities (2003)
Vol. 1812: L. Ambrosio, K. Deckelnick, G. Dziuk, M. Mimura, V. A. Solonnikov, H. M. Soner, Mathematical Aspects of Evolving Interfaces. Madeira, Funchal, Portugal 2000. Editors: P. Colli, J. F. Rodrigues (2003)
Vol. 1813: L. Ambrosio, L. A. Caffarelli, Y. Brenier, G. Buttazzo, C. Villani, Optimal Transportation and its Applications. Martina Franca, Italy 2001. Editors: L. A. Caffarelli, S. Salsa (2003)
Vol. 1814: P. Bank, F. Baudoin, H. Föllmer, L.C.G. Rogers, M. Soner, N. Touzi, Paris-Princeton Lectures on Mathematical Finance 2002 (2003)
Vol. 1815: A. M. Vershik (Ed.), Asymptotic Combinatorics with Applications to Mathematical Physics. St. Petersburg, Russia 2001 (2003)
Vol. 1816: S. Albeverio, W. Schachermayer, M. Talagrand, Lectures on Probability Theory and Statistics. Ecole d'Eté de Probabilités de Saint-Flour XXX-2000. Editor: P. Bernard (2003)
Vol. 1817: E. Koelink, W. Van Assche (Eds.), Orthogonal Polynomials and Special Functions. Leuven 2002 (2003)
Vol. 1818: M. Bildhauer, Convex Variational Problems with Linear, nearly Linear and/or Anisotropic Growth Conditions (2003)
Vol. 1819: D. Masser, Yu. V. Nesterenko, H. P. Schlickewei, W. M. Schmidt, M. Waldschmidt, Diophantine Approximation. Cetraro, Italy 2000. Editors: F. Amoroso, U. Zannier (2003)
Vol. 1820: F. Hiai, H. Kosaki, Means of Hilbert Space Operators (2003)
Vol. 1821: S. Teufel, Adiabatic Perturbation Theory in Quantum Dynamics (2003)
Vol. 1822: S.-N. Chow, R. Conti, R. Johnson, J. Mallet-Paret, R. Nussbaum, Dynamical Systems. Cetraro, Italy 2000. Editors: J. W. Macki, P. Zecca (2003)
Vol. 1823: A. M. Anile, W. Allegretto, C. Ringhofer, Mathematical Problems in Semiconductor Physics. Cetraro, Italy 1998. Editor: A. M. Anile (2003)
Vol. 1824: J. A. Navarro González, J. B. Sancho de Salas, $\mathscr{C}^\infty$ – Differentiable Spaces (2003)
Vol. 1825: J. H. Bramble, A. Cohen, W. Dahmen, Multiscale Problems and Methods in Numerical Simulations, Martina Franca, Italy 2001. Editor: C. Canuto (2003)
Vol. 1826: K. Dohmen, Improved Bonferroni Inequalities via Abstract Tubes. Inequalities and Identities of Inclusion-Exclusion Type. VIII, 113 p, 2003.
Vol. 1827: K. M. Pilgrim, Combinations of Complex Dynamical Systems. IX, 118 p, 2003.
Vol. 1828: D. J. Green, Gröbner Bases and the Computation of Group Cohomology. XII, 138 p, 2003.
Vol. 1829: E. Altman, B. Gaujal, A. Hordijk, Discrete-Event Control of Stochastic Networks: Multimodularity and Regularity. XIV, 313 p, 2003.
Vol. 1830: M. I. Gil', Operator Functions and Localization of Spectra. XIV, 256 p, 2003.
Vol. 1831: A. Connes, J. Cuntz, E. Guentner, N. Higson, J. E. Kaminker, Noncommutative Geometry, Martina Franca, Italy 2002. Editors: S. Doplicher, L. Longo (2004)
Vol. 1832: J. Azéma, M. Émery, M. Ledoux, M. Yor (Eds.), Séminaire de Probabilités XXXVII (2003)
Vol. 1833: D.-Q. Jiang, M. Qian, M.-P. Qian, Mathematical Theory of Nonequilibrium Steady States. On the Frontier of Probability and Dynamical Systems. IX, 280 p, 2004.
Vol. 1834: Yo. Yomdin, G. Comte, Tame Geometry with Application in Smooth Analysis. VIII, 186 p, 2004.
Vol. 1835: O.T. Izhboldin, B. Kahn, N.A. Karpenko, A. Vishik, Geometric Methods in the Algebraic Theory of Quadratic Forms. Summer School, Lens, 2000. Editor: J.-P. Tignol (2004)
Vol. 1836: C. Năstăsescu, F. Van Oystaeyen, Methods of Graded Rings. XIII, 304 p, 2004.
Vol. 1837: S. Tavaré, O. Zeitouni, Lectures on Probability Theory and Statistics. Ecole d'Eté de Probabilités de Saint-Flour XXXI-2001. Editor: J. Picard (2004)
Vol. 1838: A.J. Ganesh, N.W. O'Connell, D.J. Wischik, Big Queues. XII, 254 p, 2004.
Vol. 1839: R. Gohm, Noncommutative Stationary Processes. VIII, 170 p, 2004.
Vol. 1840: B. Tsirelson, W. Werner, Lectures on Probability Theory and Statistics. Ecole d'Eté de Probabilités de Saint-Flour XXXII-2002. Editor: J. Picard (2004)
Vol. 1841: W. Reichel, Uniqueness Theorems for Variational Problems by the Method of Transformation Groups (2004)
Vol. 1842: T. Johnsen, A. L. Knutsen, K_3 Projective Models in Scrolls (2004)
Vol. 1843: B. Jefferies, Spectral Properties of Noncommuting Operators (2004)
Vol. 1844: K.F. Siburg, The Principle of Least Action in Geometry and Dynamics (2004)
Vol. 1845: Min Ho Lee, Mixed Automorphic Forms, Torus Bundles, and Jacobi Forms (2004)

Vol. 1846: H. Ammari, H. Kang, Reconstruction of Small Inhomogeneities from Boundary Measurements (2004)
Vol. 1847: T.R. Bielecki, T. Björk, M. Jeanblanc, M. Rutkowski, J.A. Scheinkman, W. Xiong, Paris-Princeton Lectures on Mathematical Finance 2003 (2004)
Vol. 1848: M. Abate, J. E. Fornaess, X. Huang, J. P. Rosay, A. Tumanov, Real Methods in Complex and CR Geometry, Martina Franca, Italy 2002. Editors: D. Zaitsev, G. Zampieri (2004)
Vol. 1849: Martin L. Brown, Heegner Modules and Elliptic Curves (2004)
Vol. 1850: V. D. Milman, G. Schechtman (Eds.), Geometric Aspects of Functional Analysis. Israel Seminar 2002-2003 (2004)
Vol. 1851: O. Catoni, Statistical Learning Theory and Stochastic Optimization (2004)
Vol. 1852: A.S. Kechris, B.D. Miller, Topics in Orbit Equivalence (2004)
Vol. 1853: Ch. Favre, M. Jonsson, The Valuative Tree (2004)
Vol. 1854: O. Saeki, Topology of Singular Fibers of Differential Maps (2004)
Vol. 1855: G. Da Prato, P.C. Kunstmann, I. Lasiecka, A. Lunardi, R. Schnaubelt, L. Weis, Functional Analytic Methods for Evolution Equations. Editors: M. Iannelli, R. Nagel, S. Piazzera (2004)
Vol. 1856: K. Back, T.R. Bielecki, C. Hipp, S. Peng, W. Schachermayer, Stochastic Methods in Finance, Bressanone/Brixen, Italy, 2003. Editors: M. Fritelli, W. Runggaldier (2004)
Vol. 1857: M. Émery, M. Ledoux, M. Yor (Eds.), Séminaire de Probabilités XXXVIII (2005)
Vol. 1858: A.S. Cherny, H.-J. Engelbert, Singular Stochastic Differential Equations (2005)
Vol. 1859: E. Letellier, Fourier Transforms of Invariant Functions on Finite Reductive Lie Algebras (2005)
Vol. 1860: A. Borisyuk, G.B. Ermentrout, A. Friedman, D. Terman, Tutorials in Mathematical Biosciences I. Mathematical Neurosciences (2005)
Vol. 1861: G. Benettin, J. Henrard, S. Kuksin, Hamiltonian Dynamics – Theory and Applications, Cetraro, Italy, 1999. Editor: A. Giorgilli (2005)
Vol. 1862: B. Helffer, F. Nier, Hypoelliptic Estimates and Spectral Theory for Fokker-Planck Operators and Witten Laplacians (2005)
Vol. 1863: H. Führ, Abstract Harmonic Analysis of Continuous Wavelet Transforms (2005)
Vol. 1864: K. Efstathiou, Metamorphoses of Hamiltonian Systems with Symmetries (2005)
Vol. 1865: D. Applebaum, B.V. R. Bhat, J. Kustermans, J. M. Lindsay, Quantum Independent Increment Processes I. From Classical Probability to Quantum Stochastic Calculus. Editors: M. Schürmann, U. Franz (2005)
Vol. 1866: O.E. Barndorff-Nielsen, U. Franz, R. Gohm, B. Kümmerer, S. Thorbjønsen, Quantum Independent Increment Processes II. Structure of Quantum Lévy Processes, Classical Probability, and Physics. Editors: M. Schürmann, U. Franz, (2005)
Vol. 1867: J. Sneyd (Ed.), Tutorials in Mathematical Biosciences II. Mathematical Modeling of Calcium Dynamics and Signal Transduction. (2005)
Vol. 1868: J. Jorgenson, S. Lang, $\mathrm{Pos}_n(\mathrm{R})$ and Eisenstein Series. (2005)
Vol. 1869: A. Dembo, T. Funaki, Lectures on Probability Theory and Statistics. Ecole d'Eté de Probabilités de Saint-Flour XXXIII-2003. Editor: J. Picard (2005)
Vol. 1870: V.I. Gurariy, W. Lusky, Geometry of Müntz Spaces and Related Questions. (2005)
Vol. 1871: P. Constantin, G. Gallavotti, A.V. Kazhikhov, Y. Meyer, S. Ukai, Mathematical Foundation of Turbulent Viscous Flows, Martina Franca, Italy, 2003. Editors: M. Cannone, T. Miyakawa (2006)
Vol. 1872: A. Friedman (Ed.), Tutorials in Mathematical Biosciences III. Cell Cycle, Proliferation, and Cancer (2006)
Vol. 1873: R. Mansuy, M. Yor, Random Times and Enlargements of Filtrations in a Brownian Setting (2006)
Vol. 1874: M. Yor, M. Émery (Eds.), In Memoriam Paul-André Meyer - Séminaire de Probabilités XXXIX (2006)
Vol. 1875: J. Pitman, Combinatorial Stochastic Processes. Ecole d'Eté de Probabilités de Saint-Flour XXXII-2002. Editor: J. Picard (2006)
Vol. 1876: H. Herrlich, Axiom of Choice (2006)
Vol. 1877: J. Steuding, Value Distributions of *L*-Functions (2007)
Vol. 1878: R. Cerf, The Wulff Crystal in Ising and Percolation Models, Ecole d'Eté de Probabilités de Saint-Flour XXXIV-2004. Editor: Jean Picard (2006)
Vol. 1879: G. Slade, The Lace Expansion and its Applications, Ecole d'Eté de Probabilités de Saint-Flour XXXIV-2004. Editor: Jean Picard (2006)
Vol. 1880: S. Attal, A. Joye, C.-A. Pillet, Open Quantum Systems I, The Hamiltonian Approach (2006)
Vol. 1881: S. Attal, A. Joye, C.-A. Pillet, Open Quantum Systems II, The Markovian Approach (2006)
Vol. 1882: S. Attal, A. Joye, C.-A. Pillet, Open Quantum Systems III, Recent Developments (2006)
Vol. 1883: W. Van Assche, F. Marcellàn (Eds.), Orthogonal Polynomials and Special Functions, Computation and Application (2006)
Vol. 1884: N. Hayashi, E.I. Kaikina, P.I. Naumkin, I.A. Shishmarev, Asymptotics for Dissipative Nonlinear Equations (2006)
Vol. 1885: A. Telcs, The Art of Random Walks (2006)
Vol. 1886: S. Takamura, Splitting Deformations of Degenerations of Complex Curves (2006)
Vol. 1887: K. Habermann, L. Habermann, Introduction to Symplectic Dirac Operators (2006)
Vol. 1888: J. van der Hoeven, Transseries and Real Differential Algebra (2006)
Vol. 1889: G. Osipenko, Dynamical Systems, Graphs, and Algorithms (2006)
Vol. 1890: M. Bunge, J. Funk, Singular Coverings of Toposes (2006)
Vol. 1891: J.B. Friedlander, D.R. Heath-Brown, H. Iwaniec, J. Kaczorowski, Analytic Number Theory, Cetraro, Italy, 2002. Editors: A. Perelli, C. Viola (2006)
Vol. 1892: A. Baddeley, I. Bárány, R. Schneider, W. Weil, Stochastic Geometry, Martina Franca, Italy, 2004. Editor: W. Weil (2007)
Vol. 1893: H. Hanßmann, Local and Semi-Local Bifurcations in Hamiltonian Dynamical Systems, Results and Examples (2007)
Vol. 1894: C.W. Groetsch, Stable Approximate Evaluation of Unbounded Operators (2007)
Vol. 1895: L. Molnár, Selected Preserver Problems on Algebraic Structures of Linear Operators and on Function Spaces (2007)
Vol. 1896: P. Massart, Concentration Inequalities and Model Selection, Ecole d'Été de Probabilités de Saint-Flour XXXIII-2003. Editor: J. Picard (2007)

Vol. 1897: R. Doney, Fluctuation Theory for Lévy Processes, Ecole d'Été de Probabilités de Saint-Flour XXXV-2005. Editor: J. Picard (2007)
Vol. 1898: H.R. Beyer, Beyond Partial Differential Equations, On linear and Quasi-Linear Abstract Hyperbolic Evolution Equations (2007)
Vol. 1899: Séminaire de Probabilités XL. Editors: C. Donati-Martin, M. Émery, A. Rouault, C. Stricker (2007)
Vol. 1900: E. Bolthausen, A. Bovier (Eds.), Spin Glasses (2007)
Vol. 1901: O. Wittenberg, Intersections de deux quadriques et pinceaux de courbes de genre 1, Intersections of Two Quadrics and Pencils of Curves of Genus 1 (2007)
Vol. 1902: A. Isaev, Lectures on the Automorphism Groups of Kobayashi-Hyperbolic Manifolds (2007)
Vol. 1903: G. Kresin, V. Maz'ya, Sharp Real-Part Theorems (2007)
Vol. 1904: P. Giesl, Construction of Global Lyapunov Functions Using Radial Basis Functions (2007)
Vol. 1905: C. Prévôt, M. Röckner, A Concise Course on Stochastic Partial Differential Equations (2007)
Vol. 1906: T. Schuster, The Method of Approximate Inverse: Theory and Applications (2007)
Vol. 1907: M. Rasmussen, Attractivity and Bifurcation for Nonautonomous Dynamical Systems (2007)
Vol. 1908: T.J. Lyons, M. Caruana, T. Lévy, Differential Equations Driven by Rough Paths, Ecole d'Été de Probabilités de Saint-Flour XXXIV-2004 (2007)
Vol. 1909: H. Akiyoshi, M. Sakuma, M. Wada, Y. Yamashita, Punctured Torus Groups and 2-Bridge Knot Groups (I) (2007)
Vol. 1910: V.D. Milman, G. Schechtman (Eds.), Geometric Aspects of Functional Analysis. Israel Seminar 2004-2005 (2007)
Vol. 1911: A. Bressan, D. Serre, M. Williams, K. Zumbrun, Hyperbolic Systems of Balance Laws. Cetraro, Italy 2003. Editor: P. Marcati (2007)
Vol. 1912: V. Berinde, Iterative Approximation of Fixed Points (2007)
Vol. 1913: J.E. Marsden, G. Misiołek, J.-P. Ortega, M. Perlmutter, T.S. Ratiu, Hamiltonian Reduction by Stages (2007)
Vol. 1914: G. Kutyniok, Affine Density in Wavelet Analysis (2007)
Vol. 1915: T. Bıyıkoğlu, J. Leydold, P.F. Stadler, Laplacian Eigenvectors of Graphs. Perron-Frobenius and Faber-Krahn Type Theorems (2007)
Vol. 1916: C. Villani, F. Rezakhanlou, Entropy Methods for the Boltzmann Equation. Editors: F. Golse, S. Olla (2008)
Vol. 1917: I. Veselić, Existence and Regularity Properties of the Integrated Density of States of Random Schrödinger (2008)
Vol. 1918: B. Roberts, R. Schmidt, Local Newforms for GSp(4) (2007)
Vol. 1919: R.A. Carmona, I. Ekeland, A. Kohatsu-Higa, J.-M. Lasry, P.-L. Lions, H. Pham, E. Taflin, Paris-Princeton Lectures on Mathematical Finance 2004. Editors: R.A. Carmona, E. Çinlar, I. Ekeland, E. Jouini, J.A. Scheinkman, N. Touzi (2007)
Vol. 1920: S.N. Evans, Probability and Real Trees. Ecole d'Été de Probabilités de Saint-Flour XXXV-2005 (2008)
Vol. 1921: J.P. Tian, Evolution Algebras and their Applications (2008)
Vol. 1922: A. Friedman (Ed.), Tutorials in Mathematical BioSciences IV. Evolution and Ecology (2008)
Vol. 1923: J.P.N. Bishwal, Parameter Estimation in Stochastic Differential Equations (2008)
Vol. 1924: M. Wilson, Littlewood-Paley Theory and Exponential-Square Integrability (2008)
Vol. 1925: M. du Sautoy, L. Woodward, Zeta Functions of Groups and Rings (2008)
Vol. 1926: L. Barreira, V. Claudia, Stability of Nonautonomous Differential Equations (2008)
Vol. 1927: L. Ambrosio, L. Caffarelli, M.G. Crandall, L.C. Evans, N. Fusco, Calculus of Variations and Non-Linear Partial Differential Equations. Cetraro, Italy 2005. Editors: B. Dacorogna, P. Marcellini (2008)
Vol. 1928: J. Jonsson, Simplicial Complexes of Graphs (2008)
Vol. 1929: Y. Mishura, Stochastic Calculus for Fractional Brownian Motion and Related Processes (2008)
Vol. 1930: J.M. Urbano, The Method of Intrinsic Scaling. A Systematic Approach to Regularity for Degenerate and Singular PDEs (2008)
Vol. 1931: M. Cowling, E. Frenkel, M. Kashiwara, A. Valette, D.A. Vogan, Jr., N.R. Wallach, Representation Theory and Complex Analysis. Venice, Italy 2004. Editors: E.C. Tarabusi, A. D'Agnolo, M. Picardello (2008)
Vol. 1932: A.A. Agrachev, A.S. Morse, E.D. Sontag, H.J. Sussmann, V.I. Utkin, Nonlinear and Optimal Control Theory. Cetraro, Italy 2004. Editors: P. Nistri, G. Stefani (2008)
Vol. 1933: M. Petkovic, Point Estimation of Root Finding Methods (2008)
Vol. 1934: C. Donati-Martin, M. Émery, A. Rouault, C. Stricker (Eds.), Séminaire de Probabilités XLI (2008)
Vol. 1935: A. Unterberger, Alternative Pseudodifferential Analysis (2008)
Vol. 1936: P. Magal, S. Ruan (Eds.), Structured Population Models in Biology and Epidemiology (2008)
Vol. 1937: G. Capriz, P. Giovine, P.M. Mariano (Eds.), Mathematical Models of Granular Matter (2008)
Vol. 1938: D. Auroux, F. Catanese, M. Manetti, P. Seidel, B. Siebert, I. Smith, G. Tian, Symplectic 4-Manifolds and Algebraic Surfaces. Cetraro, Italy 2003. Editors: F. Catanese, G. Tian (2008)
Vol. 1939: D. Boffi, F. Brezzi, L. Demkowicz, R.G. Durán, R.S. Falk, M. Fortin, Mixed Finite Elements, Compatibility Conditions, and Applications. Cetraro, Italy 2006. Editors: D. Boffi, L. Gastaldi (2008)
Vol. 1940: J. Banasiak, V. Capasso, M.A.J. Chaplain, M. Lachowicz, J. Miękisz, Multiscale Problems in the Life Sciences. From Microscopic to Macroscopic. Będlewo, Poland 2006. Editors: V. Capasso, M. Lachowicz (2008)
Vol. 1941: S.M.J. Haran, Arithmetical Investigations. Representation Theory, Orthogonal Polynomials, and Quantum Interpolations (2008)
Vol. 1942: S. Albeverio, F. Flandoli, Y.G. Sinai, SPDE in Hydrodynamic. Recent Progress and Prospects. Cetraro, Italy 2005. Editors: G. Da Prato, M. Röckner (2008)
Vol. 1943: L.L. Bonilla (Ed.), Inverse Problems and Imaging. Martina Franca, Italy 2002 (2008)
Vol. 1944: A. Di Bartolo, G. Falcone, P. Plaumann, K. Strambach, Algebraic Groups and Lie Groups with Few Factors (2008)
Vol. 1945: F. Brauer, P. van den Driessche, J. Wu (Eds.), Mathematical Epidemiology (2008)

Vol. 1946: G. Allaire, A. Arnold, P. Degond, T.Y. Hou, Quantum Transport. Modelling, Analysis and Asymptotics. Cetraro, Italy 2006. Editors: N.B. Abdallah, G. Frosali (2008)
Vol. 1947: D. Abramovich, M. Mariño, M. Thaddeus, R. Vakil, Enumerative Invariants in Algebraic Geometry and String Theory. Cetraro, Italy 2005. Editors: K. Behrend, M. Manetti (2008)
Vol. 1948: F. Cao, J-L. Lisani, J-M. Morel, P. Musé, F. Sur, A Theory of Shape Identification (2008)
Vol. 1949: H.G. Feichtinger, B. Helffer, M.P. Lamoureux, N. Lerner, J. Toft, Pseudo-Differential Operators. Quantization and Signals. Cetraro, Italy 2006. Editors: L. Rodino, M.W. Wong (2008)
Vol. 1950: M. Bramson, Stability of Queueing Networks, Ecole d'Eté de Probabilités de Saint-Flour XXXVI-2006 (2008)
Vol. 1951: A. Moltó, J. Orihuela, S. Troyanski, M. Valdivia, A Non Linear Transfer Technique for Renorming (2009)
Vol. 1952: R. Mikhailov, I.B.S. Passi, Lower Central and Dimension Series of Groups (2009)
Vol. 1953: K. Arwini, C.T.J. Dodson, Information Geometry (2008)
Vol. 1954: P. Biane, L. Bouten, F. Cipriani, N. Konno, N. Privault, Q. Xu, Quantum Potential Theory. Editors: U. Franz, M. Schuermann (2008)
Vol. 1955: M. Bernot, V. Caselles, J.-M. Morel, Optimal Transportation Networks (2008)
Vol. 1956: C.H. Chu, Matrix Convolution Operators on Groups (2008)
Vol. 1957: A. Guionnet, On Random Matrices: Macroscopic Asymptotics, Ecole d'Eté de Probabilités de Saint-Flour XXXVI-2006 (2009)
Vol. 1958: M.C. Olsson, Compactifying Moduli Spaces for Abelian Varieties (2008)
Vol. 1959: Y. Nakkajima, A. Shiho, Weight Filtrations on Log Crystalline Cohomologies of Families of Open Smooth Varieties (2008)
Vol. 1960: J. Lipman, M. Hashimoto, Foundations of Grothendieck Duality for Diagrams of Schemes (2009)
Vol. 1961: G. Buttazzo, A. Pratelli, S. Solimini, E. Stepanov, Optimal Urban Networks via Mass Transportation (2009)
Vol. 1962: R. Dalang, D. Khoshnevisan, C. Mueller, D. Nualart, Y. Xiao, A Minicourse on Stochastic Partial Differential Equations (2009)
Vol. 1963: W. Siegert, Local Lyapunov Exponents (2009)
Vol. 1964: W. Roth, Operator-valued Measures and Integrals for Cone-valued Functions and Integrals for Cone-valued Functions (2009)
Vol. 1965: C. Chidume, Geometric Properties of Banach Spaces and Nonlinear Iterations (2009)
Vol. 1966: D. Deng, Y. Han, Harmonic Analysis on Spaces of Homogeneous Type (2009)
Vol. 1967: B. Fresse, Modules over Operads and Functors (2009)
Vol. 1968: R. Weissauer, Endoscopy for GSP(4) and the Cohomology of Siegel Modular Threefolds (2009)
Vol. 1969: B. Roynette, M. Yor, Penalising Brownian Paths (2009)
Vol. 1970: M. Biskup, A. Bovier, F. den Hollander, D. Ioffe, F. Martinelli, K. Netočný, F. Toninelli, Methods of Contemporary Mathematical Statistical Physics. Editor: R. Kotecký (2009)
Vol. 1971: L. Saint-Raymond, Hydrodynamic Limits of the Boltzmann Equation (2009)
Vol. 1972: T. Mochizuki, Donaldson Type Invariants for Algebraic Surfaces (2009)
Vol. 1973: M.A. Berger, L.H. Kauffmann, B. Khesin, H.K. Moffatt, R.L. Ricca, De W. Sumners, Lectures on Topological Fluid Mechanics. Cetraro, Italy 2001. Editor: R.L. Ricca (2009)
Vol. 1974: F. den Hollander, Random Polymers: École d'Été de Probabilités de Saint-Flour XXXVII – 2007 (2009)
Vol. 1975: J.C. Rohde, Cyclic Coverings, Calabi-Yau Manifolds and Complex Multiplication (2009)
Vol. 1976: N. Ginoux, The Dirac Spectrum (2009)
Vol. 1977: M.J. Gursky, E. Lanconelli, A. Malchiodi, G. Tarantello, X.-J. Wang, P.C. Yang, Geometric Analysis and PDEs. Cetraro, Italy 2001. Editors: A. Ambrosetti, S.-Y.A. Chang, A. Malchiodi (2009)
Vol. 1978: M. Qian, J.-S. Xie, S. Zhu, Smooth Ergodic Theory for Endomorphisms (2009)
Vol. 1979: C. Donati-Martin, M. Émery, A. Rouault, C. Stricker (Eds.), Śeminaire de Probablitiés XLII (2009)
Vol. 1980: P. Graczyk, A. Stos (Eds.), Potential Analysis of Stable Processes and its Extensions (2009)
Vol. 1981: M. Chlouveraki, Blocks and Families for Cyclotomic Hecke Algebras (2009)
Vol. 1982: N. Privault, Stochastic Analysis in Discrete and Continuous Settings. With Normal Martingales (2009)
Vol. 1983: H. Ammari (Ed.), Mathematical Modeling in Biomedical Imaging I. Electrical and Ultrasound Tomographies, Anomaly Detection, and Brain Imaging (2009)
Vol. 1984: V. Caselles, P. Monasse, Geometric Description of Images as Topographic Maps (2010)
Vol. 1985: T. Linß, Layer-Adapted Meshes for Reaction-Convection-Diffusion Problems (2010)
Vol. 1986: J.-P. Antoine, C. Trapani, Partial Inner Product Spaces. Theory and Applications (2009)
Vol. 1987: J.-P. Brasselet, J. Seade, T. Suwa, Vector Fields on Singular Varieties (2010)
Vol. 1988: M. Broué, Introduction to Complex Reflection Groups and Their Braid Groups (2010)

Recent Reprints and New Editions

Vol. 1702: J. Ma, J. Yong, Forward-Backward Stochastic Differential Equations and their Applications. 1999 – Corr. 3rd printing (2007)
Vol. 830: J.A. Green, Polynomial Representations of GL_n, with an Appendix on Schensted Correspondence and Littelmann Paths by K. Erdmann, J.A. Green and M. Schoker 1980 – 2nd corr. and augmented edition (2007)
Vol. 1693: S. Simons, From Hahn-Banach to Monotonicity (Minimax and Monotonicity 1998) – 2nd exp. edition (2008)
Vol. 470: R.E. Bowen, Equilibrium States and the Ergodic Theory of Anosov Diffeomorphisms. With a preface by D. Ruelle. Edited by J.-R. Chazottes. 1975 – 2nd rev. edition (2008)
Vol. 523: S.A. Albeverio, R.J. Høegh-Krohn, S. Mazzucchi, Mathematical Theory of Feynman Path Integral. 1976 – 2nd corr. and enlarged edition (2008)
Vol. 1764: A. Cannas da Silva, Lectures on Symplectic Geometry 2001 – Corr. 2nd printing (2008)

LECTURE NOTES IN MATHEMATICS

Springer

Edited by J.-M. Morel, F. Takens, B. Teissier, P.K. Maini

Editorial Policy (for the publication of monographs)

1. Lecture Notes aim to report new developments in all areas of mathematics and their applications - quickly, informally and at a high level. Mathematical texts analysing new developments in modelling and numerical simulation are welcome.

   Monograph manuscripts should be reasonably self-contained and rounded off. Thus they may, and often will, present not only results of the author but also related work by other people. They may be based on specialised lecture courses. Furthermore, the manuscripts should provide sufficient motivation, examples and applications. This clearly distinguishes Lecture Notes from journal articles or technical reports which normally are very concise. Articles intended for a journal but too long to be accepted by most journals, usually do not have this "lecture notes" character. For similar reasons it is unusual for doctoral theses to be accepted for the Lecture Notes series, though habilitation theses may be appropriate.

2. Manuscripts should be submitted either online at www.editorialmanager.com/lnm to Springer's mathematics editorial in Heidelberg, or to one of the series editors. In general, manuscripts will be sent out to 2 external referees for evaluation. If a decision cannot yet be reached on the basis of the first 2 reports, further referees may be contacted: The author will be informed of this. A final decision to publish can be made only on the basis of the complete manuscript, however a refereeing process leading to a preliminary decision can be based on a pre-final or incomplete manuscript. The strict minimum amount of material that will be considered should include a detailed outline describing the planned contents of each chapter, a bibliography and several sample chapters.

   Authors should be aware that incomplete or insufficiently close to final manuscripts almost always result in longer refereeing times and nevertheless unclear referees' recommendations, making further refereeing of a final draft necessary.

   Authors should also be aware that parallel submission of their manuscript to another publisher while under consideration for LNM will in general lead to immediate rejection.

3. Manuscripts should in general be submitted in English. Final manuscripts should contain at least 100 pages of mathematical text and should always include

   - a table of contents;
   - an informative introduction, with adequate motivation and perhaps some historical remarks: it should be accessible to a reader not intimately familiar with the topic treated;
   - a subject index: as a rule this is genuinely helpful for the reader.

   For evaluation purposes, manuscripts may be submitted in print or electronic form (print form is still preferred by most referees), in the latter case preferably as pdf- or zipped ps-files. Lecture Notes volumes are, as a rule, printed digitally from the authors' files. To ensure best results, authors are asked to use the LaTeX2e style files available from Springer's web-server at:

   ftp://ftp.springer.de/pub/tex/latex/svmonot1/ (for monographs) and
   ftp://ftp.springer.de/pub/tex/latex/svmultt1/ (for summer schools/tutorials).

Additional technical instructions, if necessary, are available on request from: lnm@springer.com.

4. Careful preparation of the manuscripts will help keep production time short besides ensuring satisfactory appearance of the finished book in print and online. After acceptance of the manuscript authors will be asked to prepare the final LaTeX source files and also the corresponding dvi-, pdf- or zipped ps-file. The LaTeX source files are essential for producing the full-text online version of the book (see http://www.springerlink.com/openurl.asp?genre=journal&issn=0075-8434 for the existing online volumes of LNM).
   The actual production of a Lecture Notes volume takes approximately 12 weeks.

5. Authors receive a total of 50 free copies of their volume, but no royalties. They are entitled to a discount of 33.3% on the price of Springer books purchased for their personal use, if ordering directly from Springer.

6. Commitment to publish is made by letter of intent rather than by signing a formal contract. Springer-Verlag secures the copyright for each volume. Authors are free to reuse material contained in their LNM volumes in later publications: a brief written (or e-mail) request for formal permission is sufficient.

Addresses:

Professor J.-M. Morel, CMLA,
École Normale Supérieure de Cachan,
61 Avenue du Président Wilson, 94235 Cachan Cedex, France
E-mail: Jean-Michel.Morel@cmla.ens-cachan.fr

Professor F. Takens, Mathematisch Instituut,
Rijksuniversiteit Groningen, Postbus 800,
9700 AV Groningen, The Netherlands
E-mail: F.Takens@rug.nl

Professor B. Teissier, Institut Mathématique de Jussieu,
UMR 7586 du CNRS, Équipe "Géométrie et Dynamique",
175 rue du Chevaleret,
75013 Paris, France
E-mail: teissier@math.jussieu.fr

For the "Mathematical Biosciences Subseries" of LNM:

Professor P.K. Maini, Center for Mathematical Biology,
Mathematical Institute, 24-29 St Giles,
Oxford OX1 3LP, UK
E-mail: maini@maths.ox.ac.uk

Springer, Mathematics Editorial, Tiergartenstr. 17,
69121 Heidelberg, Germany,
Tel.: +49 (6221) 487-259
Fax: +49 (6221) 4876-8259
E-mail: lnm@springer.com