

**Mathematical  
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**Volume 53**

# The Convenient Setting of Global Analysis

**Andreas Kriegl  
Peter W. Michor**



**American Mathematical Society**

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# **The Convenient Setting of Global Analysis**

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**Andreas Kriegl  
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1991 *Mathematics Subject Classification.* Primary 22E65, 26E15, 26E20, 46A17, 46G05, 46G20, 46E25, 46E50, 58B10, 58B12, 58B20, 58B25, 58C20, 46E50, 58D05, 58D10, 58D15, 58D17, 58D19, 58F25; Secondary 22E45, 58C40, 22E67, 46A16, 57N20, 58B05, 58D07, 58D25, 58D27, 58F05, 58F06, 58F07.

**ABSTRACT.** The aim of this book is to lay foundations of differential calculus in infinite dimensions and to discuss those applications in infinite dimensional differential geometry and global analysis which do not involve Sobolev completions and fixed point theory. The approach is very simple: A mapping is called smooth if it maps smooth curves to smooth curves. All other properties are proved results and not assumptions: Like chain rule, existence and linearity of derivatives, powerful smooth uniformly boundedness theorems are available. Up to Fréchet spaces this notion of smoothness coincides with all known reasonable concepts. In the same spirit calculus of holomorphic mappings (including Hartogs' theorem and holomorphic uniform boundedness theorems) and calculus of real analytic mappings are developed. Existence of smooth partitions of unity, the foundations of manifold theory in infinite dimensions, the relation between tangent vectors and derivations, and differential forms are discussed thoroughly. Special emphasis is given to the notion of regular infinite dimensional Lie groups. Many applications of this theory are included: manifolds of smooth mappings, groups of diffeomorphisms, geodesics on spaces of Riemannian metrics, direct limit manifolds, perturbation theory of operators, and differentiability questions of infinite dimensional representations.

Corrections and complements to this book will be posted on the internet at the URL  
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**To Elli, who made working on this  
book into a culinary experience.**

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## References

- Abraham, R., *Lectures of Smale on differential topology*, Lecture Notes, Columbia University, New York, 1962.
- Adam, E., *Smoothly real compact spaces*, Diplomarbeit, Universität Wien, 1993.
- Adam, E., *Approximation properties and spaces of smooth functions*, doctoral thesis, Universität Wien, Vienna, 1995.
- Adam, E.; Biström, P.; Kriegl, A., *Countably evaluating homomorphisms on real function algebras*, Preprint (1995).
- Adams, M.; Ratiu, T.; Schmid, R., *The Lie group structure of diffeomorphism groups and invertible Fourier Integral operators*, Infinite dimensional groups with applications (V. Kac, ed.), Springer-Verlag, New York, 1985, pp. 1–69.
- Adams, M.; Ratiu, T.; Schmid, R., *A Lie group structure for pseudo differential operators*, Math. Ann. **273** (1986a), 529–551.
- Adams, M.; Ratiu, T.; Schmid, R., *A Lie group structure for Fourier integral operators*, Math. Ann. **276** (1986b), 19–41.
- Aharoni, I.; Lindenstrauss, J., *Uniform equivalence between Banach spaces*, Bull. Am. Math. Soc. **84** (1978), 281–283.
- Alekseevsky, D.; Michor, P.W., *Differential geometry of  $\mathfrak{g}$ -manifolds*, Differ. Geom. Appl. **5** (1995a), 371–403.
- Alekseevsky, D.; Michor, P.W., *Differential geometry of Cartan connections*, Publ. Math. **47** (1995b), 349–375.
- Alekseevsky, D.; Kriegl, A.; Losik, M.; Michor, P.W., *Choosing roots of polynomials smoothly*, ESI preprint 314 (1997), 24.
- Ambrose, W.; Palais, R.S.; Singer, I.M., *Sprays*, An. Acad. Bras. Cienc. **32** (1960), 163–178.
- Amir, D.; Lindenstrauss, J., *The structure of weakly compact sets in Banach spaces*, Ann. Math. **88** (1968), 35–46.
- Argyros, S.; Mercourakis, S.; Negrepontis, S., *Functional-analytic properties of Corson-compact spaces*, Stud. Math. **89** (1988), 197–229.
- Arias-de-Reyna, J., *A real valued homomorphism on algebras of differentiable functions*, Proc. Am. Math. Soc. **104**, No. 4 (1988), 1054–1058.
- Arnold, V.I., *Sur la géométrie différentielle des groupes de Lie de dimension infinie et ses applications à l'hydrodynamique des fluides parfaits*, Ann. Inst. Fourier **16** (1966a), 319–361.
- Arnold, V.I., *An a priori estimate in the theory of hydrodynamic stability*, Russian, Izv. Vyssh. Uchebn. Zaved. Mat. **54,5** (1966b), 3–5.
- Arnold, V.I., *Mathematical methods of classical mechanics*, Graduate Texts in Math. 60, Springer-Verlag, New York, Heidelberg, 1978.
- Aron, R.M., *Compact polynomials and compact differentiable mappings between Banach spaces*, Sem. P. Lelong 1974/1975, Lecture notes in Math. 524, Springer-Verlag, 1976, pp. 231–222.
- Aronszajn, N., *Differentiability of Lipschitzian mappings between Banach spaces*, Stud. Math. **57** (1976), 147–190.
- Asplund, E., *Fréchet differentiability of convex functions*, Acta Math. **121** (1968), 31–48.
- Atiyah, M., *Complex analytic connections on fiber bundles*, Trans. Am. Math. Soc. **85** (1957), 181–207.
- Averbukh, V.I.; Smolyanov, O.G., *The various definitions of the derivative in linear topological spaces*, Russ. Math. Surv. **23** (1968), 67–113.
- Balanzat, M.M., *La différential en les espaces métricas affines*, Math. Notae **9** (1949), 29–51.
- Balanzat, M.M., *La différentielle d'Hadamard-Fréchet dans les espaces vectoriels topologiques*, C. R. Acad. Sci. Paris **251** (1960), 2459–2461.
- Banach, S., *Théorie des opérations linéaires*, Warszawa, 1932.
- Banaszczyk, W., *On the existence of exotic Banach Lie groups*, Math. Ann. **264** (1983), 485–493.
- Banaszczyk, W., *Characterization of nuclear spaces by means of additive subgroups*, Math. Z. **186** (1984), 125–133.
- Banaszczyk, W., *Pontryagin duality for subgroups and quotients of nuclear spaces*, Math. Ann. **273** (1986), 653–664.
- Banaszczyk, W., *Additive subgroups of topological vector spaces*, Lecture Notes in Math. 1466, Springer-Verlag, 1991.

- Banyaga, A., *Sur la structure du groupe des difféomorphismes qui preservent une forme symplectique*, Comment. Math. Helv. **53** (1978), 174–227.
- Banyaga, A., *On fixed points of symplectic maps*, Invent. Math. **56** (1980), 215–229.
- Bartle, R.G.; Graves, L.M., *Mappings between function spaces*, Trans. Am. Math. Soc. **72** (1952), 400–413.
- Bastiani, A., *Applications différentiables et variétés différentiables de dimension infinie*, J. Anal. Math. **13** (1964), 1–114.
- Baumgärtel, H., *Endlichdimensionale analytische Störungstheorie*, Akademie-Verlag, Berlin, 1972.
- Bemelmans, J.; Hildebrandt, St.; von Wahl, W., *Partielle Differentialgleichungen und Variationsrechnung*, Ein Jahrhundert Mathematik 1890–1990 (Fischer, G.; Hirzebruch, F.; Scharlau, W.; Törnig, W., eds.), Festschrift zum Jubiläum der DMV, Vieweg, Braunschweig, Wiesbaden, 1990, pp. 149–230.
- Bessaga, C., *Every infinite-dimensional Hilbert space is diffeomorphic with its unit sphere*, Bull. Pol. Acad. Sci. Math. **14** (1966), 27–31.
- Bessaga, C.; Pelczyński, A., *Selected topics in infinite dimensional topology*, Monografie Matematyczne, Tom 58, Polish Scientific Publishers, Warszawa, 1975.
- Binz, E., *Ein Differenzierbarkeitsbegriff in limitierten Vektorräumen*, Comment. Math. Helv. **41** (1966), 137–156.
- Binz, E., *Two natural metrics and their covariant derivatives on a manifold of embeddings*, Monatsh. Math. **89** (1980), 275–288.
- Binz, E.; Fischer, H.R., *The manifold of embeddings of a closed manifold*, Proc. Differential geometric methods in theoretical physics, Clausthal 1978, Lecture Notes in Physics 139, Springer-Verlag, 1981.
- Biström, P., *The homomorphisms on algebras of functions defined on locally convex spaces and bounding sets*, Doctoral thesis, University of Åbo, 1993.
- Biström, P.; Bjon, S.; Lindström, M., *Homomorphisms on some function algebras*, Monatsh. Math. **111** (1990), 5.
- Biström, P.; Bjon, S.; Lindström, M., *Function algebras on which homomorphisms are point evaluations on sequences*, Manuscr. Math. **73** (1991), 179–185.
- Biström, P.; Bjon, S.; Lindström, M., *Remarks on homomorphisms on certain subalgebras of  $C(X)$* , Math. Jap. **37** (1992), 105–109.
- Biström, P.; Bjon, S.; Lindström, M., *On  $C^m$ -bounding sets*, J. Aust. Math. Soc. **54** (1993), 20–28.
- Biström, P.; Jaramillo, J.A.,  *$C^\infty$ -bounding sets and compactness*, Math. Scand. **75** (1994), 82–86.
- Biström, P.; Jaramillo, J.A.; Lindström, M., *Algebras of real analytic functions; Homomorphisms and bounding sets*, Stud. Math. **115** (1995), 23–37.
- Biström, P.; Lindström, M., *Homomorphisms on  $C^\infty(E)$  and  $C^\infty$ -bounding sets*, Monatsh. Math. **115** (1993a), 257–266.
- Biström, P.; Lindström, M., *Characterization of the spectra of certain function algebras*, Arch. Math. **60** (1993b), 177–181.
- Bochnak, J.; Siciak, J., *Analytic functions in topological vector spaces*, Stud. Math. **39** (1971), 77–112.
- Bockstein, M., *Une théorème de séparabilité pour les produits topologiques*, Fundam. Math. **35** (1948), 242–246.
- Bolza, O., *Vorlesungen über Variationsrechnung*, Leipzig, 1909; Second edition, New York, Chelsea, 1962.
- Boman, J., *Differentiability of a function and of its compositions with functions of one variable*, Math. Scand. **20** (1967), 249–268.
- Bonic, R.; Frampton, J., *Differentiable functions on certain Banach spaces*, Bull. Am. Math. Soc. **71** (1965), 393–395.
- Bonic, R.; Frampton, J., *Smooth functions on Banach manifolds*, J. Math. Mech. **15** (1966), 877–898.
- Bonic, R.; Reis, F., *A characterization of Hilbert space*, An. Acad. Bras. Cienc. **38** (1966), 239–241.
- Boothby, W.M., *The transitivity of the automorphisms of certain geometric structures*, Trans. Am. Math. Soc. **137** (1969), 93–100.
- Borel, A.; Harish-Chandra, *Arithmetic subgroups of algebraic groups*, Ann. Math. **75** (1962), 485–535.

- Borel, A.; Serre, J.P., *Corners and arithmetic groups*, Comment. Math. Helv. **48** (1973), 436–491.
- Borwein, J.; Fitzpatrick, S.; Kenderov, P., *Minimal convex uscos and monotone operators on small sets*, Can. J. Math. **43** (1991), 461–476.
- Bourbaki, N., *General Topology*, Hermann, Paris, 1966.
- Bourguignon, J.-P., *Une stratification de l'espace des structures Riemanniens*, Compos. Math. **30** (1975), 1–41.
- Bröcker, T.; Jänich, K., *Einführung in die Differentialtopologie*, Heidelberger Taschenbücher 143, Springer-Verlag, Heidelberg, 1973.
- Browder, W., *Diffeomorphisms of 1-connected manifolds*, Trans. Am. Math. Soc. **128** (1967), 155–163.
- Brown, R., *Some problems of algebraic topology*, Ph. D. Thesis, Oxford, 1961.
- Brown, R., *Ten topologies for  $X \times Y$* , Q. J. Math. Oxf. **14** (1963), 303–319.
- Brown, R., *Function spaces and product topologies*, Q. J. Math. Oxf. **15** (1964), 238–250.
- Buchwalter, H., *Espaces vectoriels bornologiques*, Publ. Dep. Math. Lyon **2** (1965), 1–53.
- Cap, A.; Kriegel, A.; Michor, P.W.; Vanžura, J., *The Frölicher-Nijenhuis bracket in non commutative differential geometry*, Acta Math. Univ. Comenianae **62** (1993), 17–49.
- Carne, T.K.; Cole, B.; Gamelin, T.W., *A uniform algebra of analytic functions on a Banach space*, Trans. Am. Math. Soc. **314** (1989), 639–659.
- Cartan, H.; Eilenberg, S., *Homological Algebra*, Princeton University Press, Princeton, 1956.
- Cascales, B.; Orihuela, J., *On compactness in locally convex spaces*, Math. Z. **195** (1987), 365–381.
- Cerf, J., *La stratification naturelle des espaces de fonctions différentiables réelles et le théorème de la pseudoisotopie*, Publ. Math. Inst. Hautes Etud. Sci. **39** (1970).
- Cervera, V.; Mascaro, F.; Michor, P.W., *The orbit structure of the action of the diffeomorphism group on the space of immersions*, Differ. Geom. Appl. **1** (1991), 391–401.
- Ciesielski, K.; Pol, R., *A weakly Lindelöf function space  $C(K)$  without continuous injection into  $c_0(\Gamma)$* , Bull. Pol. Acad. Sci. Math. **32** (1984), 681–688.
- Cigler, J.; Losert, V.; Michor, P.W., *Banach modules and functors on categories of Banach spaces*, Lecture Notes in Pure and Applied Mathematics 46, Marcel Dekker Inc., 1979, pp. xv+282.
- Collier, J.B., *A class of strong differentiability spaces*, Proc. Am. Math. Soc. **53** (1975), 420–422.
- Colombeau, J.F., *Différentiation et Bornologie*, Dissertation, Bordeaux, 1973.
- Colombeau, J.F., *Infinite dimensional  $C^\infty$ -mappings with a given sequence of derivatives at a given point*, J. Math. Anal. Appl. **71** (1979), 95–104.
- Colombeau, J.F., *Differential Calculus and Holomorphy*, Math. Studies 64, North Holland, Amsterdam, 1982.
- Colombeau, J.F.; Meise, R.,  *$C^\infty$ -functions on locally convex and on bornological vector spaces*, Functional analysis, holomorphy, and approximation theory, Proc. Semin., Rio de Janeiro 1978, Lect. Notes Math. 843, Springer-Verlag, 1981, pp. 195–216.
- Colombeau, J.F.; Perrot, B., *The (partial d) equation in DFN spaces*, J. Math. Anal. Appl. **78** (1980), 466–487.
- Corson, H.H., *The weak topology of a Banach space*, Trans. Am. Math. Soc. **101** (1961), 1–15.
- Cudia, D., *The geometry of Banach spaces. Smoothness*, Trans. Am. Math. Soc. **110** (1964), 284–314.
- Daniell, P.J., *The derivative of a functional*, Bull. Am. Math. Soc. **25** (1919), 414–416.
- Day, M.M., *Strict convexity and smoothness of normed spaces*, Trans. Am. Math. Soc. **78** (1955), 516–528.
- Deville, R.; Godefroy, G.; Zizler, V.E., *The three space problem for smooth partitions of unity and  $C(K)$  spaces*, Math. Ann. **288** (1990), 613–625.
- Deville, R.; Godefroy, G.; Zizler, V.E., *Smoothness and renormings in Banach spaces*, Pitman Monographs and Surveys in Pure and Applied Mathematics 64, Longman, John Wiley, London, New York, 1993.
- De Wilde, M., *Closed graph theorems and webbed spaces*, Pitman, London, 1978.
- DeWitt, B.S., *Quantum theory of gravity. I. The canonical theory*, Phys. Rev. **160** (5) (1967), 1113–1148.
- Diestel, J., *Geometry of Banach spaces, selected topics*, Lecture Notes in Math. 485, Springer-Verlag, 1975, pp. New York.
- Diestel, J., *Sequences and series in Banach spaces*, Springer Verlag, 1984.
- Dieudonné, J., *Sur les espaces uniformes complets*, Ann. Sci. Éc. Norm. Supér. **56** (1939), 277–291.

- Dieudonné, J.A., *Foundations of modern analysis, I*, Academic Press, New York, London, 1960.
- Dieudonné, J., *Sur un théorème de Glaeser*, J. Anal. Math. **23** (1970), 85–88.
- Douady, A., *Le problème des modules pour les sous-espaces analytiques compacts d'un espace analytique donné*, Ann. Inst. Fourier **16** (1966), 1–95.
- Dubois-Violette, M.; Michor, P.W., *A common generalization of the Frölicher-Nijenhuis bracket and the Schouten bracket for symmetric multi vector fields*, Indag. Math. New Ser. **6** (1995), 51–66.
- Dubois-Violette, M.; Michor, P.W., *More on the Frölicher-Nijenhuis bracket in non commutative differential geometry*, to appear, J. Pure Appl. Algebra (1997).
- Ebin, D., *The manifold of Riemannian metrics*, Proc. Symp. Pure Math. 15, Am. Math. Soc., 1970, pp. 11–40.
- Ebin, D.G.; Marsden, J.E., *Groups of diffeomorphisms and the motion of an incompressible fluid*, Ann. Math. **92** (1970), 102–163.
- Edgar, G.A., *Measurability in Banach spaces*, Indiana Univ. Math. J. **26** (1977), 663–677.
- Edgar, G.A., *Measurability in a Banach space, II*, Indiana Univ. Math. J. **28** (1979), 559–579.
- Eells, J., *A setting for global analysis*, Bull. Am. Math. Soc. **72** (1966), 571–807.
- Eells, J.; Elworthy, K.D., *Open embeddings of certain Banach manifolds*, Ann. Math. **91** (1970), 465–485.
- Eichhorn, J., *Gauge theory on open manifolds of bounded geometry*, Int. J. Mod. Phys. A **7** (1992), 3927–3977.
- Eichhorn, J., *The manifold structure of maps between open manifolds*, Ann. Global Anal. Geom. **11** (1993), 253–300.
- Eichhorn, J., *Spaces of Riemannian metrics on open manifolds*, Preprint (1994).
- Ehresmann, C., *Les prolongements d'une variété différentiable, I: Calcul des jets, prolongement principal, II: L'espace des jets d'ordre  $r$  de  $V_n$  dans  $V_m$* , C. R. Acad. Sci. Paris **233** (1951), 598–600, 777–779.
- Ekeland, I.; Lebourg, G., *Generic Fréchet-differentiability and perturbed optimization problems in Banach spaces*, Trans. Am. Math. Soc. **224** (1976), 193–216.
- Enflo, P., *Uniform structures and square roots in topological groups II*, Isr. J. Math. **9** (1970), 253–272.
- Enflo, P., *On Banach spaces which can be given an equivalent uniformly convex norm*, Isr. J. Math. **13** (1972), 114–146.
- Enflo, P.; Lindenstrauss, J.; Pisier, G., *On the ‘three space problem’*, Math. Scand. **36** (1975), 199–210.
- Engelking, R., *Outline of General Topology*, Polish Scientific Publishers, Warszawa, 1968.
- Engelking, R., *General Topology*, revised and completed edition, Heldermann-Verlag, Berlin, 1989.
- Epstein, D.B.A., *The simplicity of certain groups of homeomorphisms*, Compos. Math. **22** (1970), 165–173.
- Fabian, M.; Godefroy, G., *The dual of every Asplund space admits a projectional resolution of identity*, Stud. Math. **91** (1988), 141–151.
- Fantappié, L., *I funzionali analitici*, Atti Accad. Naz. Lincei, Mem. **3–11** (1930), 453–683.
- Fantappié, L., *Überblick über die Theorie der analytischen Funktionale und ihre Anwendungen*, Jahresber. Dtsch. Math. Ver. **43** (1933), 1–25.
- Faure, C.-A., *Sur un théorème de Boman*, C. R. Acad. Sci. Paris **309** (1989), 1003–1006.
- Faure, C.-A., *Théorie de la différentiation dans les espaces convenables*, Thèse, Université de Genève, 1991.
- Federer, H., *Geometric Measure Theory*, Springer-Verlag, Berlin, 1969.
- Fitzpatrick, S., *Metric projections and the differentiability of distance functions*, Bull. Aust. Math. Soc. **22** (1980), 291–312.
- Floret, K., *Lokalkonvexe Sequenzen mit kompakten Abbildungen*, J. Reine Angew. Math. **247** (1971), 155–195.
- Fréchet, M., *Sur la notion de différentielle*, C. R. Acad. Sci. Paris **152** (1911), 845–847, 1050–1051.
- Fréchet, M., *Sur la notion de différentielle dans l'analyse générale*, C. R. Acad. Sci. Paris **180** (1925a), 806–809.
- Fréchet, M., *La notion de différentielle dans l'Analyse générale*, Ann. Sci. Ec. Norm. Super. **XLII** (1925b), 293–323.
- Fréchet, M., *Sur la notion de différentielle*, J. Math. Pures Appl. **16** (1937), 233–250.

- Freed, D.S. ; Grotisser, D., *The basic geometry of the manifold of Riemannian metrics and of its quotient by the diffeomorphism group*, Mich. Math. J. **36** (1989), 323–344.
- Freed, D.; Uhlenbeck, K., *Instantons and 4-manifolds*, MSRI Publications 1, Springer-Verlag, New York, 1984.
- Freedman, M.H., *The topology of four dimensional manifolds*, J. Differ. Geo. **17** (1982), 357–454.
- Freifeld, C., *One-parameter subgroups do not fill a neighborhood of the identity in an infinite dimensional Lie (pseudo)-group*, Battelle Rencontres, Lectures in Mathematics and Physics, Benjamin, New York, 1967, pp. 538–543.
- Frölicher, A., *Categories cartésiennement fermées engendrées par des monoides*, Cah. Topologie Géom. Differ. **21** (1980), 367–375.
- Frölicher, A., *Applications lisses entre espaces et variétés de Fréchet*, C. R. Acad. Sci. Paris **293** (1981), 125–127.
- Frölicher, A.; Bucher, W., *Calculus in vector spaces without norm*, Lecture Notes in Math. 30, Springer-Verlag, Heidelberg, 1966.
- Frölicher, A.; Gisin, B.; Kriegel, A., *General differentiation theory*, Various publications series No. 35, Aarhus Universitet, 1983, pp. 125–153.
- Frölicher, A.; Kriegel, A., *Convergence vector spaces for Analysis*, Convergence Structures 1984, Akademie Verlag, Berlin, 1985, pp. 115–126.
- Frölicher, A.; Kriegel, A., *Linear spaces and differentiation theory*, Pure and Applied Mathematics, J. Wiley, Chichester, 1988.
- Frölicher, A.; Kriegel, A., *Differentiable extensions of functions*, Differ. Geom. Appl. **3** (1993), 71–90.
- Fuks, D.B., *Cohomology of infinite dimensional Lie algebras*, (Russian), Nauka, Moscow, 1984; English, Contemporary Soviet Mathematics, Consultants Bureau (Plenum Press), New York, 1986.
- Fulp, R.O., *Connections on the path bundle of a principal fiber bundle*, Differ. Geom. Appl. **4** (1994), 201–237.
- Gabriel, P.; Zisman, M., *Fondements de la topologie simpliciale*, Séminaire homotopique, Université de Strasbourg, 1963/64.
- Gähler, W., *Grundstrukturen der Analysis I, II*, Birkhäuser/Akademie Verlag, Basel/Berlin, 1977, 1978.
- Garrido, I.; Gómez, J.; Jaramillo, J.A., *Homomorphisms on function algebras*, Can. J. Math. **46** (1994), 734–745.
- Gâteaux, M.R., *Sur les fonctionnelles continues et les fonctionnelles analytiques*, C. R. Acad. Sci. Paris **157** (1913), 325–327.
- Gâteaux, M.R., *Fonctions d'une infinité de variables indépendantes*, Bull. Soc. Math. Fr. **47** (1919), 70–96.
- Gâteaux, M.R., *Sur les fonctionnelles continues et les fonctionnelles analytiques*, Bull. Soc. Math. Fr. **50** (1922), 1–21.
- Gelfand, I.M.; Dorfman, I.Y., *Hamiltonian operators and the algebraic structures connected with them*, Funct. Anal. Appl. **13** (1979), 13–30.
- Gieraltowska-Kedzierska, M.; Van Vleck, F.S., *Fréchet differentiability of regular locally Lipschitzian functions*, J. Math. Anal. Appl. **159** (1991), 147–157.
- Gillman, L.; Jerison, M., *Rings of continuous functions*, Van Nostrand, Princeton, 1960.
- Gil-Medrano, O.; Michor, P.W., *The Riemannian manifold of all Riemannian metrics*, Q. J. Math. Oxf. **42** (1991), 183–202.
- Gil-Medrano, O.; Michor, P.W.; Neuwirthner, M., *Pseudoriemannian metrics on spaces of bilinear structures*, Q. J. Math. Oxf. **43** (1992), 201–221.
- Gil-Medrano, O.; Michor, P.W., *Pseudoriemannian metrics on spaces of almost hermitian structures*, to appear, Isr. J. Math. (1994), 11.
- Glaeser, G., *Racine carré d'une fonction différentiable*, Ann. Inst. Fourier **13,2** (1963), 203–210.
- Godefroy, G.; Pelant, J.; Whitefield, J.H.M.; Zizler, V.E., *Banach space properties of Ciesielinski-Pol's  $C(K)$ -space*, Proc. Am. Math. Soc. **103** (1988), 1087–1093.
- Godefroy, G.; Troyanski, S.L.; Whitefield, J.H.M.; Zizler, V.E., *Smoothness in weakly compactly generated spaces*, J. Funct. Anal. **52** (1983), 344–352.
- Godefroy, G.; Troyanski, S.L.; Whitefield, J.H.M.; Zizler, V.E., *Locally uniformly rotund renorming and injection into  $c_0(\Gamma)$* , Can. Math. Bull. **27** (1984), 494–500.
- Godement, R., *Topologie algébrique et théorie des faisceaux*, Hermann, Paris, 1958.

- Gómez, J.; Llavona, J.G., *Multiplicative functionals on function algebras*, Rev. Mat. Univ. Complutense Madrid **1** (1988), 19–22.
- Grabowski, J., *Free subgroups of diffeomorphism groups*, Fundam. Math. **131** (1988), 103–121.
- Grabowski, J., *Derivative of the exponential mapping for infinite dimensional Lie groups*, Ann. Global Anal. Geom. **11** (1993), 213–220.
- Grauert, H., *On Levi's problem and the embedding of real analytic manifolds*, Ann. Math. **68** (1958), 460–472.
- Greub, W.; Halperin, S.; Vanstone, R., *Connections, Curvature, and Cohomology I, II, III*, Academic Press, New York, London, 1972, 1973, 1976.
- Griffiths, P., *On Cartan's method of Lie groups and moving frames as applied to uniqueness and existence questions in differential geometry*, Duke Math. J. **41** (1974), 775–814.
- Gromov, M., *Partial differential relations*, Ergebnisse 3. Folge, Band 9, Springer-Verlag, Berlin, Heidelberg, New York, 1986.
- Grothendieck, A., *Sur certains espaces de fonctions holomorphes. I*, J. Reine Angew. Math. **192** (1953), 35–64.
- Grothendieck, A., *Produits tensoriels topologiques et espaces nucléaires*, Mem. Am. Math. Soc. **16**, Am. Math. Soc., 1955.
- Gunning, R.C.; Rossi, H., *Analytic functions in several complex variables*, Prentice-Hall, Englewood Cliffs, N.J., 1965.
- Günther, M., *Beiträge zur lokalen Lösbarkeit nichtlinearer partieller Differentialgleichungen*, Dissertation, Karl-Marx-Universität, Leipzig, 1988, pp. 150.
- Günther, M., *On the perturbation problem associated to isometric embeddings of Riemannian manifolds*, Ann. Global Anal. Geom. **7,1** (1989), 69–77.
- Günther, M., *Isometric embeddings of Riemannian manifolds*, Proc. Int. Congr. Math., Kyoto 1990, Vol. II, 1991, pp. 1137–1143.
- Hadamard, J., *Leçons sur le calcul des variations*, Hermann, Paris, 1910.
- Hadamard, J., *La notion de différentielle dans l'enseignement*, Scripta Univ. Ab. 3, Bib Hiersolymitanarum, Jérusalem, 1923.
- Hahn, H., *Über lineare Gleichungssysteme in linearen Räumen*, J. Reine Angew. Math. **157** (1926), 214–229.
- Hahn, H., *Reelle Funktionen I* (1932), Leipzig.
- Hamilton, R.S., *The inverse function theorem of Nash and Moser*, Bull. Am. Math. Soc. **7** (1982), 65–222.
- de la Harpe, P., *Classical Banach-Lie algebras and Banach-Lie groups of operators in Hilbert space*, Lecture Notes in Math. 285, Springer-Verlag, 1972.
- Hatakeyama, Y., *Some notes on the groups of automorphisms of contact and symplectic structures*, Tôhoku Math. J. **18** (1966), 338–347.
- Hatcher, A., *A proof of a Smale conjecture*, Ann. Math. **117** (1983), 553–607.
- Hatcher, A.; Wagoner, J., *Pseudo-isotopies of compact manifolds*, Astérisque **6** (1973).
- Haydon, R., *A counterexample to several questions about scattered compact spaces*, Bull. Lond. Math. Soc. **22** (1990), 261–268.
- Haydon, R., *Trees and renormings*, Publ. Math. Univ. Pierre Marie Curie **104, No.8** (1991).
- Heber, G., *Die Topologie des Konfigurationsraumes der Yang-Mills-Theorie über offenen Mannigfaltigkeiten beschränkter Geometrie*, Dissertation, Universität Greifswald, 1994.
- Hewitt, E., *Rings of real valued continuous functions. I*, Trans. Am. Math. Soc. **64** (1948), 45–99.
- Hewitt, E., *Linear functionals on spaces of continuous functions*, Fundam. Math. **37** (1950), 161–189.
- Hirai, T., *Irreducible unitary representations of the group of diffeomorphisms of a non-compact manifold*, J. Math. Kyoto Univ. **33, 3** (1993), 827–864.
- Hirsch, M.W., *Differential topology*, GTM 33, Springer-Verlag, New York, 1976.
- Hirzebruch, F., *Neue topologische Methoden in der algebraischen Topologie*, Ergebnisse der Math. 9, 2. edition, Springer-Verlag, Berlin, Göttingen, Heidelberg, 1962.
- Hogbe-Nlend, H., *Complétions, tenseurs, nucléarité en bornologie*, J. Math. Pures Appl. (1970).
- Hogbe-Nlend, H., *Théorie des Bornologies et Applications*, Lecture Notes in Math. 213, Springer-Verlag, Berlin, 1971.
- Hogbe-Nlend, H., *Bornologies and Functional Analysis*, Math. Studies 26, North Holland, Amsterdam, 1977.

- Hörmander, L., *The Analysis of linear partial differential operators I*, Grundlehren 256, Springer-Verlag, Berlin, 1983.
- Horváth, J., *Topological vector spaces and distributions*, Addison Wesley, Reading, Mass., 1966.
- Igusa, K., *What happens to Hatcher and Wagoner's formula for  $\pi_0(C(M))$  when the first Postnikov invariant of  $M$  is nontrivial*, Lecture Notes in Math. 1046, Springer-Verlag, New York, Heidelberg, 1984, pp. 104–172.
- Imayoshi, Y., *Holomorphic maps of compact Riemannian surfaces into 2-dimensional compact C-hyperbolic manifolds*, Math. Ann. **270** (1985), 403–416.
- Imayoshi, Y., *Holomorphic maps of projective algebraic manifolds into compact C-hyperbolic manifolds*, J. Math. Soc. Japan **46** (1994), 289–307.
- Jacobowitz, H., *Implicit function theorems and isometric embeddings*, Ann. Math. **95** (1972), 191–225.
- James, R.C., *A non-reflexive Banach space isometric with its second conjugate space*, Proc. Natl. Acad. Sci. USA **37** (1951), 174–177.
- Jaramillo, J.A., *Multiplicative functionals on algebras of differentiable functions*, To appear in, Arch Math. **58** (1992), 384–387.
- Jarchow, H., *Locally convex spaces*, Teubner, Stuttgart, 1981.
- Jayne, J.E.; Rogers, C.A., *Borel selectors for upper semicontinuous set valued maps*, Acta Math. **155** (1985), 41–79.
- John, K.; Torunczyk, H.; Zizler, V., *Uniformly smooth partitions of unity on superreflexive Banach spaces*, Stud. Math. **70** (1981), 129–137.
- John, K.; Zizler, V., *A note on strong differentiability spaces*, Commentat. Math. Univ. Carol. **17** (1976), 127–134.
- John, K.; Zizler, V., *On rough norms on Banach spaces*, Commentat. Math. Univ. Carol. **19** (1978), 335–349.
- Johnson, W.B.; Lindenstrauss, J., *Some remarks on weakly compactly generated Banach spaces*, Isr. J. Math. **17** (1974), 219–230.
- Joris, H., *Une  $C^\infty$ -application non-immersive qui possède la propriété universelle des immersions*, Arch Math. **39** (1982), 269–277.
- Josephson, B., *Bounding subsets of  $\ell^\infty(A)$* , J. Math. Pures Appl. **57** (1978), 397–421.
- Kadec, M.I., *Spaces isomorphic to a locally uniformly convex space*, Izv. Vyssh. Učebn. Zaved. Mat. **13** (1959), 51–57.
- Kadec, M.I., *Letters to the editors*, Izv. Vyssh. Učebn. Zaved. Mat. **15** (1961), 139–141.
- Kadec, M.I., *Some conditions of the differentiability of the norm of Banach spaces*, Uspechi Mat. Nauk **20** (1965), 183–187.
- Kainz, G., *A note on the manifold of immersions and its Riemannian curvature*, Monatsh. Math. **98** (1984), 211–217.
- Kainz, G.; Kriegel, A.; Michor, P.W.,  *$C^\infty$ -algebras from the functional analytic viewpoint*, J. Pure Appl. Algebra **46** (1987), 89–107.
- Kainz, G.; Michor, P.W., *Natural transformations in differential geometry*, Czech. Math. J. **37** (1987), 584–607.
- Kashiwara, M.; Kawai, T.; Kimura, T., *Foundations of algebraic analysis*, Princeton Univ. Press, Princeton, 1986.
- Katětov, M., *Measures in fully normal spaces*, Fundam. Math. **38** (1951), 73–84.
- Kato, T., *Perturbation theory for linear operators*, Grundlehren 132, Springer-Verlag, Berlin, 1976.
- Keller, H.H., *Räume stetiger multilinearerer Abbildungen als Limesräume*, Math. Ann. **159** (1965), 259–270.
- Keller, H.H., *Differential calculus in locally convex spaces*, Lecture Notes in Math. 417, Springer-Verlag, 1974.
- Kenderov, P.S., *The quasi-differentiable functionals are almost everywhere differentiable*, Math. Educ. **2** (1974), 123–126.
- Kervaire, M.; Milnor, J., *Groups of homotopy spheres, I*, Ann. Math. **77** (1963), 504–537.
- Kirillov, A.A., *Elements of the theory of representations*, Springer-Verlag, Berlin, 1976.
- Kirillov, A.A., *The orbits of the group of diffeomorphisms of the circle, and local Lie superalgebras*, Funct. Anal. Appl. **15** (1981), 135–136.

- Kirillov, A.A., *The orbit method I: geometric quantization; II: Infinite dimensional Lie groups and Lie algebras*, Notes by J. Adams, A. Kleppner, R. Lipsman, J.-Sh. Li, and J. Rosenberg, Department of Math., University of Maryland, 1991.
- Knapp, A.W., *Representation theory of semisimple Lie groups*, Princeton University Press, Princeton, 1986.
- Kneser, A., *Lehrbuch der Variationsrechnung*, Vieweg, Braunschweig, 1900.
- Kodaira, K; Spencer, D.C., *On the deformations of complex analytic structures*, Ann. Math. **67** (1958), 328–460.
- Kodaira, K; Nirenberg, L; Spencer, D.C., *On the existence of deformations of complex analytic structures*, Ann. Math. **68** (1958), 450–459.
- Kolář, I.; Michor, P.W., *Determination of all natural concomitants of the type of the Frölicher Nijenhuis bracket*, Rend. Circ. Mat. Palermo, Suppl. **16** (1987), 101–108.
- Kolář, I.; Michor, P.W.; Slovák, J., *Natural operations in differential geometry*, Springer-Verlag, Berlin, Heidelberg, New York, 1993.
- Koppell, N., *Commuting diffeomorphisms*, Proc. Symp. Pure Math. **14** (1970), Am. Math. Soc., 165–184.
- Koszul, J.L., *Homologie et Cohomologie des algèbres de Lie*, Bull. Soc. Math. Fr. **78** (1950), 65–127.
- Köthe, G., *Dualität in der Funktionentheorie*, J. Reine Angew. Math. **191** (1953), 30–49.
- Kriegl, A., *Eine Theorie glatter Mannigfaltigkeiten und Vektorbündel*, Dissertation, Universität Wien, 1980.
- Kriegl, A., *Die richtigen Räume für Analysis im Unendlich - Dimensionalen*, Monatsh. Math. **94** (1982), 109–124.
- Kriegl, A., *Eine kartesisch abgeschlossene Kategorie glatter Abbildungen zwischen beliebigen lokalkonvexen Vektorräumen*, Monatsh. Math. **95** (1983), 287–309.
- Kriegl, A., *A cartesian closed extension of the category of smooth Banach manifolds*, Categorical Topology, Proc. Conference Toledo, Ohio, 1983 (Bentley, L., eds.), Heldermann, Berlin, 1984, pp. 323–336.
- Kriegl, A., *Remarks on germs in infinite dimensions*, Acta Math. Univ. Comenianae **66** (1997), 1–18.
- Kriegl, A.; Michor, P.W., *A convenient setting for real analytic mappings*, Acta Math. **165** (1990), 105–159.
- Kriegl, A.; Michor, P.W., *Aspects of the theory of infinite dimensional manifolds*, Differ. Geom. Appl. **1** (1991), 159–176.
- Kriegl, A.; Michor, P.W., *More smoothly real compact spaces*, Proc. Am. Math. Soc. **117** (1993), 467–471.
- Kriegl, A.; Michor, P.W., *Regular infinite dimensional Lie groups*, to appear, J. Lie Theory **7**, 1 (1997), 61–99, ESI Preprint 200.
- Kriegl, A.; Michor, P.W.; Schachermayer, W., *Characters on algebras of smooth functions*, Ann. Global Anal. Geom. **7**, No. **2** (1989), 85–92.
- Kriegl, A.; Nel, L.D., *A convenient setting for holomorphy*, Cah. Topologie Géom. Differ. **26** (1985), 273–309.
- Kriegl, A.; Nel, L.D., *Convenient vector spaces of smooth functions*, Math. Nachr. **147** (1990), 7.
- Kuranishi, M., *On the locally complete families of complex analytic structures*, Ann. Math. **75** (1962), 536–577.
- Kurzweil, J., *On approximation in real Banach spaces*, Stud. Math. **14** (1954), 214–231.
- Ky Fan, M., *Sur quelques notions fondamentales de l'analyse générale*, J. Math. Pures Appl. **21** (1942), 289–368.
- Lang, S., *Differential manifolds*, Addison Wesley, 1972.
- Lawvere, F.W., *Categorical dynamics*, Lectures given 1967 at the University of Chicago, reprinted in, Topos Theoretical Methods in Geometry (A. Kock, ed.), Aarhus Math. Inst. Var. Publ. Series 30, Aarhus Universitet, 1979.
- Lawvere, F.W.; Schanuel, S.H.; Zame, W.R., *On  $C^\infty$ -function spaces*, Preprint, State University of New York, Buffalo (1981).
- Lazet, D., *Sur la différentiabilité des applications analytiques en dimension infinie*, C. R. Acad. Sci. Paris **273** (1971), 155–157.
- Leach, E.B.; Whitfield, J.H.M., *Differentiable functions and rough norms on Banach spaces*, Proc. Am. Math. Soc. **33** (1972), 120–126.

- Leduc, M., *Densité de certaines familles d'hyperplans tangents*, C. R. Acad. Sci. Paris **270** (1970), 326–328.
- Leslie, J., *On a differential structure for the group of diffeomorphisms*, Topology **6** (1967), 264–271.
- Leslie, J., *On the group of real analytic diffeomorphisms of a compact real analytic manifold*, Trans. Am. Math. Soc. **274** (2) (1982), 651–669.
- Lévy, M.P., *Leçons d'analyse fonctionnelle*, Gauthier-Villars, Paris, 1922.
- Libermann, P.; Marle, C.M., *Symplectic geometry and analytical mechanics*, Mathematics and its applications, D. Reidel, Dordrecht, 1987.
- Lindenstrauss, J.; Tzafriri, L., *On the complemented subspace problem*, Isr. J. Math. **9** (1971), 263–269.
- Llavona, J.G., *Approximation of continuously differentiable functions*, North-Holland, 1986.
- Long de Foglio, S. Fernandez, *La différentielle au sens d'Hadamard dans les espaces  $L$  vectorielles*, Port. Math. **19** (1960), 165–184.
- Lovaglia, A.R., *Locally uniformly convex Banach spaces*, Trans. Am. Math. Soc. **78** (1955), 225–238.
- Lychagin, V., *On sufficient orbits of a group of contact diffeomorphisms*, Math. USSR Sb. **33** (1977), 223–242.
- Mackey, G.W., *Equivalence of a problem in measure theory to a problem in the theory of vector lattices*, Bull. Am. Math. Soc. **50** (1944), 719–722.
- Mackey, G.W., *On infinite dimensional spaces*, Trans. Am. Math. Soc. **57** (1945), 155–207.
- MacLaughlin, D.P., *Smooth partitions of unity in preduals of WCG spaces*, Math. Z. **211** (1992), 189–194.
- Maiissen, B., *Lie Gruppen mit Banach Räumen als Parameterräumen*, Acta Math. **108** (1962), 229–270.
- Maiissen, B., *Über Topologien im Endomorphismenraum eines topologischen Vektorraums*, Math. Ann. **151** (1963), 283–285.
- Malgrange, B., *Ideals of differentiable functions*, Oxford Univ. Press, London, 1966.
- Margalef Roig, J.; Outerelo Dominguez, E., *Une variedad diferenciable de dimensión infinita, separada y no regular*, Rev. Mat. Hisp.-Amer. **42** (1982), 51–55.
- Marinescu, G., *Espaces vectoriels pseudo topologiques et le théorie des distributions*, Deutsche Verlag d. Wiss., Berlin, 1963.
- Mather, J.N., *Commutators of diffeomorphisms I*, Comment. Math. Helv. **49** (1974), 512–528.
- Mather, J.N., *Commutators of diffeomorphisms II*, Comment. Math. Helv. **50** (1975), 33–40.
- Mather, J.N., *A curious remark concerning the geometric transfer map*, Comment. Math. Helv. **59** (1984), 86–110.
- Mather, J.N., *Commutators of diffeomorphisms III*, Comment. Math. Helv. **60** (1985), 122–124.
- Mattes, J., *On the convenient setting for real analytic mappings*, Monatsh. Math. **116** (1993), 127–141.
- Mauhart, M.; Michor, P.W., *Commutators of flows and fields*, Arch. Math. Brno **28** (1992), 228–236.
- Mazur, S., *Über konvexe Mengen in linearen normierten Räumen*, Stud. Math. **4** (1933), 70–84.
- Mazur, S., *On continuous mappings on cartesian products*, Fundam. Math. **39** (1952), 229–238.
- Mazur, S.; Orlicz, W., *Grundlegende Eigenschaften der polynomischen Operationen*, Stud. Math. **5** (1935), 50–68.
- Meshkov, V.Z., *Smoothness properties in Banach spaces*, Stud. Math. **63** (1978), 111–123.
- Michal, A.D., *Differential calculus in linear topological spaces*, Proc. Natl. Acad. Sci. USA **24** (1938), 340–342.
- Michor, P.W., *Manifolds of smooth maps*, Cah. Topologie Géom. Differ. **19** (1978), 47–78.
- Michor, P.W., *Manifolds of smooth maps II: The Lie group of diffeomorphisms of a non compact smooth manifold*, Cah. Topologie Géom. Differ. **21** (1980a), 63–86.
- Michor, P.W., *Manifolds of smooth maps III: The principal bundle of embeddings of a non compact smooth manifold*, Cah. Topologie Géom. Differ. **21** (1980b), 325–337.
- Michor, P.W., *Manifolds of differentiable mappings*, Shiva, Orpington, 1980c.
- Michor, P.W., *The manifold of embeddings of a non compact manifold*, Appendix to: E. Binz, H.R. Fischer: The manifold of embeddings of a closed manifold, Proc. Differential geometric methods in theoretical physics, Clausthal 1978, Lecture Notes in Physics 139, Springer-Verlag, 1981.

- Michor, P.W., *Manifolds of smooth mappings IV: Theorem of De Rham*, Cah. Topologie Géom. Differ. **24** (1983), 57–86.
- Michor, P.W., *A convenient setting for differential geometry and global analysis I, II*, Cah. Topologie Géom. Differ. **25** (1984a), 63–109, 113–178..
- Michor, P.W., *Applications of Hamilton's inverse function theorem to manifolds of mappings*, Proc. Convergence structures and applications II, Schwerin 1983, Akademie Verlag, Berlin, 1984b, pp. 159–162.
- Michor, P.W., *The cohomology of the diffeomorphism group is a Gelfand-Fuks cohomology*, Rend. Circ. Mat. Palermo, Suppl. **14** (1987a), 235–246.
- Michor, P.W., *Remarks on the Frölicher-Nijenhuis bracket*, Proc. Conference Differential Geometry and its Applications, Brno 1986, D. Reidel, 1987b, pp. 197–220.
- Michor, P.W., *Gauge theory for the diffeomorphism group*, Proc. Conf. Differential Geometric Methods in Theoretical Physics, Como 1987, K. Bleuler and M. Werner (eds), Kluwer, Dordrecht, 1988, pp. 345–371.
- Michor, P.W., *Knit products of graded Lie algebras and groups*, Rend. Circ. Mat. Palermo, Suppl. **22** (1989), 171–175.
- Michor, P.W., *The moment mapping for a unitary representation*, Ann. Global Anal. Geom. **8**, No **3** (1990), 299–313.
- Michor, P.W., *Gauge theory for fiber bundles*, Monographs and Textbooks in Physical Sciences, Lecture Notes 19, Bibliopolis, Napoli, 1991, pp. 107.
- Michor, P.W., *All unitary representations admit moment mappings*, Colloquia Mathematica Societatis János Bolyai, 56. Differential Geometry, Eger (Hungary), 1989 (J. Szenthe, L. Tamássy, eds.), János Bolyai Math. Soc. and Elsevier, Budapest and Amsterdam, 1992, pp. 477–489.
- Michor, P.W.; Ratiu, T., *Curvature of the Virasoro-Bott group*, Preprint (1997).
- Michor, P.W.; Schichl, H., *No slices on the space of generalized connections*, Preprint (1997).
- Michor, P.W.; Vanžura, J., *Characterizing algebras of smooth functions on manifolds*, Commentat. Math. Univ. Carol. **37**,**3** (1996), 519–521.
- Michor, P.W.; Vizman, C., *n-transitivity of certain diffeomorphism groups*, Acta Math. Univ. Comenianae **63** (1994), 4.
- Mikusinski, J., *Distributions à valeurs dans le réunions d'espaces de Banach*, Stud. Math. **19** (1960), 251–285.
- Milnor, J., *Topology from the differentiable viewpoint*, University Press of Virginia, Charlottesville, 1965.
- Milnor, J., *Remarks on infinite dimensional Lie groups*, Relativity, Groups, and Topology II, Les Houches, 1983, B.S. DeWitt, R. Stora, Eds., Elsevier, Amsterdam, 1984.
- Milnor, J.; Stasheff, J., *Characteristic classes*, Annals of Math. Studies 76, Princeton University Press, Princeton, 1974.
- Moerdijk, I.; Reyes, G.E., *Models for smooth infinitesimal analysis*, Springer-Verlag, Heidelberg, Berlin, 1991.
- Moreau, J.J., *Proximité et dualité dans un espace hilbertien*, Bull. Soc. Math. Fr. **93** (1965), 273–299.
- Morrow, J., *The denseness of complete Riemannian metrics*, J. Differ. Geo. **4** (1970), 225–226.
- Moser, J., *A new technique for the construction of solutions of nonlinear differential equations*, Proc. Natl. Acad. Sci. USA **47** (1961), 1824–1831.
- Moser, J., *A rapidly convergent iteration method and non-linear partial differential equations I, II*, Ann. Sc. Norm. Super. Pisa **20** (1966), 265–315, 499–535.
- Namioka, I.; Phelps, R.R., *Banach spaces which are Asplund spaces*, Duke Math. J. **42** (1975), 735–749.
- Nash, J., *The embedding problem for Riemannian manifolds*, Ann. Math. **63** (1956), 20–63.
- Natarajan, L.; Rodríguez-Carrington, E.; Wolf, J.A., *Differentiable structures for direct limit groups*, Lett. Math. Phys. **23** (1991), 99–109.
- Natarajan, L.; Rodríguez-Carrington, E.; Wolf, J.A., *New classes of infinite dimensional Lie groups*, Proceedings of the 1991 Am. Math. Soc. Summer Research Institute ‘Algebraic groups and their generalizations’, to appear.
- Natarajan, L.; Rodríguez-Carrington, E.; Wolf, J.A., *Locally convex Lie groups*, Preprint.
- Negrepontis, S., *Banach spaces and topology*, Handbook of set theoretic topology (K. Kunen and J.E. Vaughan, eds.), North-Holland, 1984.

- Neuwirth, M., *A family of pseudo metrics on the space of all pseudo metrics*, Diplomarbeit, Universität Wien, 1990.
- Neuwirth, M., *Submanifold geometry and Hessians on the Pseudoriemannian manifold of metrics*, Dr. rer. nat. Dissertation, Universität Wien, 1992.
- Neuwirth, M., *Submanifold geometry and Hessians on the Pseudoriemannian manifold of metrics*, Acta Math. Univ. Comenianae **62** (1993), 51–85.
- Nijenhuis, A., *On a class of common properties of some different types of algebras I, II*, Nieuw Arch. Wiskd. **17** (1969), 17–46, 87–108.
- Nijenhuis, A.; Richardson, R., *Cohomology and deformations in graded Lie algebras*, Bull. Am. Math. Soc. **72** (1966), 1–29.
- Nijenhuis, A.; Richardson, R., *Deformation of Lie algebra structures*, J. Math. Mech. **17** (1967), 89–105.
- Nomizu, K.; Ozeki, H., *The existence of complete Riemannian metrics*, Proc. Am. Math. Soc. **12** (1961), 889–891.
- Omori, H., *Infinite dimensional Lie transformation groups*, Lecture Notes in Math. 427, Springer-Verlag, Berlin, 1974.
- Omori, H., *Theory of infinite dimensional Lie groups*, Kinokuniya, 1978a. (Japanese)
- Omori, H., *On Banach Lie groups acting on finite dimensional manifolds*, Tôhoku Math. J. **30** (1978b), 223–250.
- Omori, H.; de la Harpe, P., *About interactions between Banach Lie groups and finite dimensional manifolds*, J. Math. Kyoto Univ. **12** (1972), 543–570.
- Omori, H.; Maeda, Y.; Yoshioka, A., *On regular Fréchet Lie groups I. Some differential geometric expressions of Fourier integral operators on a Riemannian manifold*, Tokyo J. Math. **3** (1980), 353–390.
- Omori, H.; Maeda, Y.; Yoshioka, A., *On regular Fréchet Lie groups II. Composition rules of Fourier Integral operators on a Riemannian manifold*, Tokyo J. Math. **4** (1981a), 221–253.
- Omori, H.; Maeda, Y.; Yoshioka, A., *On regular Fréchet Lie groups III*, Tokyo J. Math. **4** (1981b), 255–277.
- Omori, H.; Maeda, Y.; Yoshioka, A., *On regular Fréchet Lie groups IV. Definitions and fundamental theorems*, Tokyo J. Math. **5** (1982), 365–398.
- Omori, H.; Maeda, Y.; Yoshioka, A., *On regular Fréchet Lie groups V. Several basic properties*, Tokyo J. Math. **6** (1983), 39–64.
- Omori, H.; Maeda, Y.; Yoshioka, A.; Kobayashi, O., *On regular Fréchet Lie groups VI. Infinite dimensional Lie groups which appear in general relativity*, Tokyo J. Math. **6** (1983), 217–246.
- Onishchik, A.L., *On the classification of fiber spaces*, Sov. Math. Dokl. **2** (1961), 1561–1564.
- Onishchik, A.L., *Connections with zero curvature and the de Rham theorem*, Sov. Math. Dokl. **5** (1964), 1654–1657.
- Onishchik, A.L., *Some concepts and applications of non-abelian cohomology theory*, Trans. Mosc. Math. Soc. **17** (1967), 49–98.
- Orihuela, J.; Valdivia, M., *Projective generators and resolutions of identity in Banach spaces*, Rev. Mat. Univ. Complutense Madrid **2** (1989), 179–199.
- Ovsienko, V.Y.; Khesin, B.A., *Korteweg-de Vries superequations as an Euler equation*, Funct. Anal. Appl. **21** (1987), 329–331.
- Palais, R., *Foundations of global non-linear analysis*, Benjamin, New York, 1968.
- Palais, R.S.; Terng, C.L., *Critical point theory and submanifold geometry*, Lecture Notes in Mathematics 1353, Springer-Verlag, Berlin, 1988.
- Helps, R.R., *Convex functions, monotone operators and differentiability*, Lecture Notes in Math. 1364, Springer-Verlag, New York, 1989.
- Pierpont, J., *Theory of functions of real variables*, Vol. 1, Boston, 1905.
- Pisanelli, D., *Applications analytiques en dimension infinie*, C. R. Acad. Sci. Paris **274** (1972a), 760–762.
- Pisanelli, D., *Applications analytiques en dimension infinie*, Bull. Sci. Math. **96** (1972b), 181–191.
- Preiss, D., *Gâteaux differentiable functions are somewhere Fréchet differentiable*, Rend. Circ. Mat. Pal. **33** (1984), 122–133.
- Preiss, D., *Differentiability of Lipschitz functions on Banach spaces*, J. Funct. Anal. **91** (1990), 312–345.
- Pressley, A.; Segal, G., *Loop groups*, Oxford Mathematical Monographs, Oxford University Press, 1986.

- Procesi, C., *Positive symmetric functions*, Adv. Math. **29** (1978), 219–225.
- Quinn, F., *Ends III*, J. Differ. Geo. **17** (1982), 503–521.
- Rademacher, H., *Über partielle und totale Differenzierbarkeit von Funktionen mehrerer Variablen und über die Transformation der Doppelintegrale*, Math. Ann. **79** (1919).
- Ramadas, T.R., *On the space of maps inducing isomorphic connections*, Ann. Inst. Fourier **32** (1982), 263–276.
- Rao, M.M., *Characterisation of Hilbert spaces by smoothness*, Nederl. Akad. v. W. **71** (1967), 132–135.
- Ratiu, T.; Schmid, R., *The differentiable structure of three remarkable diffeomorphism groups*, Math. Z. **177** (1981), 81–100.
- Rellich, F., *Störungstheorie der Spektralzerlegung, I*, Math. Ann. **113** (1937), 600–619.
- Rellich, F., *Störungstheorie der Spektralzerlegung, V*, Math. Ann. **118** (1940), 462–484.
- Rellich, F., *Perturbation theory of eigenvalue problems*, Lecture Notes, New York University, 1953; Gordon and Breach, New York, London, Paris, 1969.
- Restrepo, G., *Differentiable norms in Banach spaces*, Bull. Am. Math. Soc. **70** (1964), 413–414.
- Restrepo, G., *Differentiable norms*, Bol. Soc. Mat. Mex. **10** (1965), 47–55.
- Riemann, B., *Ueber die Hypothesen, welche der Geometrie zu Grunde liegen*, Habilitationsvortrag 10. Juni 1854, Gesammelte Werke (H. Weber, ed.), Teubner, Leipzig, 1876.
- Schaefers, H.H., *Topological vector spaces*, GTM 3, Springer-Verlag, New York, 1971.
- Schichl, H., *On the existence of slice theorems for moduli spaces on fiber bundles*, Doctoral dissertation, Univ. Wien, 1997.
- Schlafli, R., *Universal connections*, Invent. Math. **59** (1980), 59–65.
- Schmidt, H.-J., *The metric in the superspace of Riemannian metrics and its relation to gravity*, Differential Geometry and its Applications, Brno, Czechoslovakia, 1989, World Scientific, Singapur, 1990, pp. 405–411.
- Sebastião e Silva, J., *As funções analíticas e a análise funcional*, Dissertation, 1948.
- Sebastião e Silva, J., *As funções analíticas e a análise funcional*, Port. Math. **9** (1950a), 1–130.
- Sebastião e Silva, J., *Sobre a topologia dos espaços funcionais analíticos*, Rev. Fac. Cienc. Lisboa, ser. A1 **2** (1950b), 23–102.
- Sebastião e Silva, J., *Sui fondamenti della teoria dei funzionali analitici*, Port. Math. **12** (1953), 1–46.
- Sebastião e Silva, J., *Le calcul différentiel et intégral dans les espaces localement convexes, réels ou complexes, I*, Atti. Acad. Naz. Lincei **20** (1956a), 743–750.
- Sebastião e Silva, J., *Le calcul différentiel et intégral dans les espaces localement convexes, réels ou complexes, II*, Atti. Acad. Naz. Lincei **21** (1956b), 40–46.
- Sebastião e Silva, J., *Conceitos de função diferenciável em espaços localmente convexos*, Publ. do Centro Estudos Math. de Lisboa (1957).
- Sebastião e Silva, J., *Les espaces à bornés et la notion de fonction différentiable*, Colloque sur l'analyse fonctionnelle, Louvain, 1960, CBRM, 1961, pp. 57–63.
- Seeley, R.T., *Extension of  $C^\infty$ -functions defined in a half space*, Proc. Am. Math. Soc. **15** (1964), 625–626.
- Segal, G., *The geometry of the KdV equation*, Int. J. Mod. Phys. A **6** (1991), 2859–2869.
- Seip, U., *Kompakt erzeugte Vektorräume und Analysis*, Lecture Notes in Math. 273, Springer-Verlag, Heidelberg, 1972.
- Seip, U., *Differential calculus and cartesian closedness*, Categorical Topology, Mannheim 1975 (Binz, E., Herrlich, H., eds.), Lecture Notes in Math. 540, Springer-Verlag, Heidelberg, 1976, pp. 578–604.
- Seip, U., *A convenient setting for differential calculus*, J. Pure Appl. Algebra **14** (1979), 73–100.
- Seip, U., *A convenient setting for smooth manifolds*, J. Pure Appl. Algebra **21** (1981), 279–305.
- Shirota, A class of topological spaces, Osaka Math. J. **4** (1952), 23–40.
- Siegl, E., *A free convenient vector space for holomorphic spaces*, Monatsh. Math. **119** (1995), 85–97.
- Siegl, E., *Free convenient vector spaces*, doctoral thesis, Universität Wien, Vienna, 1997.
- Smale, S., *Diffeomorphisms of the 2-sphere*, Proc. Am. Math. Soc. **10** (1959), 621–626.
- Sova, M., *Conditions of differentiability in topological vector spaces*, Czech. Math. J. **16** (1966a), 339–362.
- Sova, M., *General theory of differentiability in linear topological spaces*, Czech. Math. J. **14** (1966b), 485–508.

- Steenrod, N.E., *A convenient category for topological spaces*, Mich. Math. J. **14** (1967), 133–152.  
 Stegall, Ch., *The Radon-Nikodym property in conjugate Banach spaces*, Trans. Am. Math. Soc. **206** (1975), 213–223.  
 Stegall, Ch., *The duality between Asplund spaces and spaces with the Radon-Nikodym property*, Isr. J. Math. **29** (1978), 408–412.  
 Stegall, Ch., *The Radon-Nikodym property in conjugate Banach spaces II*, Trans. Am. Math. Soc. **264** (1981), 507–519.  
 Stein, E.M., *Singular integrals and differentiability properties of functions*, Princeton Univ. Press, Princeton, 1970.  
 Stoltz, O., *Grundz"uge der Differential- und Integralrechnung*, Bd. 1, Leipzig, 1893.  
 Sullivan, D., *Infinitesimal computations in topology*, Publ. Math. Inst. Hautes Etud. Sci. **47** (1978), 269–331.  
 Sylvester, J., *On a theory of the syzygetic relations of two rational integral functions, comprising an application to the theory of Sturm's functions, and that of the greatest algebraic common measure*, Philos. Trans. R. Soc. Lond. **143** (1853), 407–548; *Mathematical papers*, Vol. I, At the University Press, Cambridge, 1904, pp. 511ff.  
 Talagrand, M., *Renormages de quelques  $C(K)$* , Isr. J. Math. **54** (1986), 327–334.  
 Thurston, W., *Foliations and groups of diffeomorphisms*, Bull. Am. Math. Soc. **80** (1974), 304–307.  
 Toeplitz, O., *Die linearen vollkommenen Räume der Funktionentheorie*, Comment. Math. Helv. **23** (1949), 222–242.  
 Toruńczyk, H., *Smooth partitions of unity on some non-separable Banach spaces*, Stud. Math. **46** (1973), 43–51.  
 Toruńczyk, H., *Characterizing Hilbert space topology*, Fundam. Math. **111** (1981), 247–262.  
 Toruńczyk, H., *A correction of two papers concerning Hilbert manifolds*, Fundam. Math. **125** (1985), 89–93.  
 Tougeron, J.C., *Idéaux de fonctions différentiables*, Ergebnisse 71, Springer-Verlag, Heidelberg, 1972.  
 Treves, F., *Topological vector spaces, distributions, and kernels*, Academic Press, New York, 1967.  
 Triantafillou, G., *Diffeomorphisms of manifolds with finite fundamental group*, Bull. Am. Math. Soc. **31** (1994), 50–53.  
 Troyanski, S.L., *Equivalent norms in unseparable  $B$ -spaces with an unconditional basis*, Teor. Funkts. Funkts. Anal. Prilozh. **6** (1968), 59–65.  
 Troyanski, S.L., *On locally convex and differentiable norm in certain non-separable Banach spaces*, Stud. Math. **37** (1971), 173–180.  
 Turner, E., *Diffeomorphisms of a product of spheres*, Invent. Math. **8** (1969), 69–82.  
 Tzafriri, L., *Some directions of results in Banach space theory*, Functional analysis, surveys and recent results, North. Holl., 1980, pp. 2–18.  
 Valdivia, M., *Topics in locally convex spaces*, North Holland, 1982.  
 Valdivia, M., *Resolution of identity in certain metrizable locally convex spaces*, Rev. R. Acad. Cienc. Exactas Fis. Nat. Madr. **83** (1989), 75–96.  
 Valdivia, M., *Projective resolution of identity in  $C(K)$  spaces*, Arch. Math. **54** (1990), 493–498.  
 Vanderwerff, J., *Smooth approximations in Banach spaces*, Proc. Am. Math. Soc. **115** (1992), 113–120.  
 Van Est, W.T. ; Korthagen, T.J., *Nonenlargable Lie algebras*, Indag. Math. **26** (1964), 15–31.  
 Van Hove, L., *Topologie des espaces fonctionnels analytiques et de groupes infinis de transformations*, Bull. Cl. Sci., Acad. R. Belg. **38** (1952), 333–351.  
 Varadarajan, V.S., *Harmonic analysis on real reductive groups*, Lecture Notes in Mathematics 576, Springer-Verlag, Berlin, Heidelberg, New York, 1977.  
 Vašák, L., *On one generalization of weakly compactly generated Banach spaces*, Stud. Math. **70** (1981), 11–19.  
 Veblen, O.; Whitehead, J.H.C., *The foundations of differential geometry*, Cambridge University Press, Cambridge, 1932.  
 Ver Eecke, P., *Fondements du calcul différentiel*, Presses Universitaires de France, Paris, 1983.  
 Ver Eecke, P., *Applications du calcul différentiel*, Presses Universitaires de France, Paris, 1985.  
 Verde-Star, L., *Interpolation and Combinatorial Functions*, Stud. Appl. Math. **79** (1988), 65–92.  
 Vogt, R., *Convenient categories of topological spaces for Homotopie theory*, Arch. Math. **22** (1971), 545–555.

- Volterra, V., *Sopra le funzioni che dipendono da altre funzioni, Nota I, II, III*, Rend. Acad. Naz. Lincei **4** (3) (1887), 97–105, 141–146, 153–158.
- Waelbroeck, L., *Études spectrale des algèbres complètes*, Mém. Cl. Sci., Collect., Acad. R. Belg. **31** (1960), 142–.
- Waelbroeck, L., *Some theorems about bounded structures*, J. Funct. Anal. **1** (1967a), 392–408.
- Waelbroeck, L., *Differentiable Mappings in b-spaces*, J. Funct. Anal. **1** (1967b), 409–418.
- Warner, F.W., *Foundations of differentiable manifolds and Lie groups*, Scott Foresman, 1971.
- Warner, G., *Harmonic analysis on semisimple Lie groups, Volume I*, Springer-Verlag, New York, 1972.
- Wegenkittl, K., *Topologien auf Räumen differenzierbarer Funktionen*, Diplomarbeit (1987), Universität Wien, 1–72.
- Wegenkittl, K., *The space of isometric immersions into Euclidean space*, Dissertation (1989), Universität Wien, 1–147.
- Weil, A., *Théorie des points proches sur les variétés différentielles*, Colloque de topologie et géométrie différentielle, Strasbourg, 1953, pp. 111–117.
- Weinstein, A., *Symplectic manifolds and their Lagrangian submanifolds*, Adv. Math. **6** (1971), 329–345.
- Weinstein, A., *Lectures on symplectic manifolds*, Reg. Conf. Ser. Math. **29** (1977), Am. Math. Soc..
- Wells, J.C., *Differentiable functions on Banach spaces with Lipschitz derivatives*, J. Differ. Geo. **8** (1973), 135–152.
- Whitney, H., *Analytic extensions of differentiable functions defined in closed sets*, Trans. Am. Math. Soc. **36** (1934), 63–89.
- Whitney, H., *Differentiable Even Functions*, Duke Math. J. **10** (1943), 159–166.
- Whitney, H.; Bruhat, F., *Quelques propriétés fondamentales des ensembles analytiques-réels*, Comment. Math. Helv. **33** (1959), 132–160.
- Wojtyński, W., *One parameter subgroups and B-C-H formula*, Stud. Math. **111** (1994), 163–185.
- Yamamuro, S., *A theory of differentiation in locally convex spaces*, Mem. Am. Math. Soc. **212** (1979).
- Yamamuro, S., *Notes on the inverse mapping theorem in locally convex spaces*, Bull. Austr. Math. Soc. **21** (1980), 419–461.
- Young, W.H., *The fundamental theorems of differential calculus*, University Press, Cambridge, 1910.
- Zhivkov, N.V., *Generic Gâteaux differentiability of directionally differentiable mappings*, Rev. Roum. Math. Pure. Appl. **32** (1987), 179–188.
- Živkov, N.V., *Generic Gâteaux differentiability of locally Lipschitzian functions*, Constructive Function Theory, 1981, Sofia, 1983, pp. 590–594..
- Zorn, M.A., *Gâteaux-differentiability and essential boundedness*, Duke Math. J. **12** (1945), 579–583.

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