1 Classical mechanics

The book [2] by Arnold is an introduction to mathematical methods of classical mechanics. Among other which can be recommended as an introductory reference is the book by Ana Cannas da Silva [1].

More advanced references on classical mechanics are [3], [4].

2 Quantum mechanics

For the deformation quantization of Poisson manifolds see [28][29].

For geometric quantization see, for example [7]

Among standard mathematically minded textbooks on quantum mechanics are [13] [6], see also [9][8] for detailed discussion of states in quantum mechanics .

3 Quantum Field Theory

For mathematical exposition of basic ideas of quantum field theory oriented towards constructive quantum field theory point of view see for example [11]. There is no discussion of field theories with fermions in this book.

Many aspects of quantum and classical field theory and explained and reinterpreted in the collection of lectures given during the special year on quantum field theory at the Advanced Study Institute at Princeton [**?**].

Standard references in quantum field theory when it is taught to theory students at a physics department are [17][10][15][14][15].

The perturabation theory, matrix integrals and many interesting applications can found in P. Etingof's lecture notes:

http://ocw.mit.edu/OcwWeb/Mathematics/18-238Fall2002/LectureNotes/index.htm

4 Quantization of gauge theories

The book [**?**] contains a lot of material on quantization of gauge theories.

An extensive treatment of BRST and of BV quantization of gauge theories oriented for physicists with mathematical interests can be found in [18].

A concise exposition of BRST and BV quantization is given in [19] and [27]. A wonderful example of the BV quantization is the perturbative quantization of the Poisson sigma-model [**?**]. This also gives the TQFT interpretation of Kontsevich's deofrmation quantization of Poisson manifolds.

5 Conformal Field Theories

The book [12] can be recommended as a reference book on conformal field theory.

The basics ideas are well captured in the original paper [20].

6 Topological quantum field theory

The path integral approach to quantum topological field theories produced a collection of invariants of 3-manifolds obtained by perturbation theory. They are integrals of forms over configuration spaces and are parameterized by Feynmann diagrams.

Path integral formulation of the Chern-Simons theory was developed by Witten in [33]. For the geometric construction of perturbative invariants of 3-manifolds in this theory see [28][21][22] [23][24].

These reults were developed into the theory of universal finite type invariants of 3-manifolds in [32][31].

A combinatorial topological quantum field theory was defined in [35]. This construction uses certain categories and grew up from the combinatorial construction of invariants of ribbon graphs given in [34]. Examples of such categories are provided by the represenmtation theory of quantized universal enveloping algebras at roots of unity. The construction uses surgery and Kirby caluclus of 3-manifolds. Another combinatorial construction based on triangulations of 3-manifolds was given in [36].

References

[1] Ana Cannas da Silva. *Introduction to symplectic and Hamiltonian geometry.* Publicações Matemáticas do IMPA. [IMPA Mathematical Publications]. Instituto de Matemática Pura e Aplicada (IMPA), Rio de Janeiro, 2003.

[2] V. Arnold, *Mathematical methods of classical mechanics*, Graduate Texts in Mathematics, v. 60, Springer-Verlag, New York, 1989.

[3] V. Arnold, V. Kozlov, and A. Neishtadt, *Mathematical aspects of classical and celestial mechanics* Springer-Verlag, 1997.

[4] V. Arnold, and A. Givental, *Symplectic geometry*, Dynamical systems IV, Encyclopedia of Mathematical Sciences, vol. 4, Springer-Verlag, Berlin, 1990, pp. 1-136.

[5] F. Berezin, and M. Shubin, *The Schrodinger equation* Mathematics and its applications, vol. 66, Kluwer Academic Publishers Groups, Dordrecht, 1991.

[6] G. Mackey, *Mathematical foundations of quantum mechanics*, Dover Publications Inc., Mineola, NY, 2004.

[7] N.M. J. Woodhouse, *Geometric quantization*, Oxford University Press, 1997.

[8] F. Strocchi, *An introduction to the mathematical structure of quantum mechanics. A short course for mathenmaticians.* Advanced series in mathematical physics, vol. 27, World Scientific Publishing, London-Singapore, 2005.

[9] N. Landsman, *Mathematical Topics Between Classical and Quantum Mechanics.*

[10] C. Itzykson, J. B. Zuber, *Quantum field theory.* Dover publications.

[11] J. Glimm, and A. Jaffe, *Quantum physics.*

[12] P. di Francesco,P. Mathiew, D. Senechal, *Conformal Field Theory*, Springer, NY, 1997.

[13] John von Neumann, *Mathematical Foundations of quantum mechanics.*

[14] A. Zee, *Quantum Field Theory in a Nutshell*, Princeton University Press.

[15] L. H. Ryder, *Quantum Field Theory*, Cambridge University Press, 1985.

[16] M.E. Peskin, and D.V. Schroeder, *An introduction toquantum field theory*, Addison-Wesley, 1995.

[17] S. Weinberg, *The quantum theory of fields*, Cambridge University Press, v. I, 1995; v. II, 1996.

[18] Henneaux, Marc. *Quantization of gauge systems*, Princeton, N.J., Princeton University Press,1992.

[19] A. Schwarz, Topological quantum field theories, hep-th/0011260.

[20] Belavin, A. A.; Polyakov, A. M.; Zamolodchikov, A. B. Infinite conformal symmetry in two-dimensional quantum field theory. Nuclear Phys. B 241 (1984), no. 2, 333–380.

[21] Axelrod, Scott; Singer, I. M. Chern-Simons perturbation theory. Proceedings of the XXth International Conference on Differential Geometric Methods in Theoretical Physics, Vol. 1, 2 (New York, 1991), 3–45, World Sci. Publ., River Edge, NJ, 1992.

[22] Axelrod, Scott; Singer, I. M. Chern-Simons perturbation theory. II. J. Differential Geom. 39 (1994), no. 1, 173–213.

[23] Bott, Raoul; Cattaneo, Alberto S. Integral invariants of 3-manifolds. J. Differential Geom. 48 (1998), no. 1, 91–133.

[24] Bott, Raoul; Cattaneo, Alberto S. Integral invariants of 3-manifolds. II. J. Differential Geom. 53 (1999), no. 1, 1–13.

[25] Cattaneo, Alberto S.; Felder, Giovanni A path integral approach to the Kontsevich quantization formula. Comm. Math. Phys. 212 (2000), no. 3, 591–611. (Reviewer: Martin Schlichenmaier) 53D55 (58D30 81S40 81T18 81T40 81T45)

[26] Cattaneo, Alberto S. Configuration space integrals and invariants for 3-manifolds and knots. Low-dimensional topology (Funchal, 1998), 153–165, Contemp. Math., 233, Amer. Math. Soc., Providence, RI, 1999.

[27] Kevin J. Costello. Renormalisation and the Batalin-Vilkovisky formalism. arXiv:0706.1533.

[28] Kontsevich, Maxim Feynman diagrams and low-dimensional topology. First European Congress of Mathematics, Vol. II (Paris, 1992), 97–121, Progr. Math., 120, Birkhuser, Basel, 1994.

[29] Kontsevich, Maxim Formality conjecture. Deformation theory and symplectic geometry (Ascona, 1996), 139–156, Math. Phys. Stud., 20, Kluwer Acad. Publ., Dordrecht, 1997.

[30] Kontsevich, Maxim Deformation quantization of Poisson manifolds. Lett. Math. Phys. 66 (2003), no. 3, 157–216.

[31] Le, Thang T. Q.; Murakami, Jun; Ohtsuki, Tomotada On a universal perturbative invariant of 3-manifolds. Topology 37 (1998), no. 3, 539–574.

[32] Ohtsuki, Tomotada Finite type invariants of integral homology 3-spheres. J. Knot Theory Ramifications 5 (1996), no. 1, 101–115.

[33] Witten, Edward Quantum field theory and the Jones polynomial. Comm. Math. Phys. 121 (1989), no. 3, 351–399.

[34] Reshetikhin, N. Yu.; Turaev, V. G. Ribbon graphs and their invariants derived from quantum groups. Comm. Math. Phys. 127 (1990), no. 1, 1–26.

[35] Reshetikhin, N.; Turaev, V. G. Invariants of 3-manifolds via link polynomials and quantum groups. Invent. Math. 103 (1991), no. 3, 547–597.

[36] Turaev, V. G.; Viro, O. Ya. State sum invariants of 3-manifolds and quantum $6j$-symbols. Topology 31 (1992), no. 4, 865–902.