Quantum-like approach to complex systems

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The course is a brief introduction to the analysis of some macroscopic systems through operators and other quantum ideas, and it is organized as follows:

1. **lesson 1:**– Preliminaries: ladder operators; quantum dynamics for closed and open systems; (H, ρ)-dynamics. A first application to love affairs.
2. **lesson 2:**– Population dynamics: migration, escape strategies and pre-agricultural cultures;
3. **lesson 3:**– Decision making: political alliances, the role of the information, compatible and incompatible questions.

The course is mainly based on the following books and papers:

1. F. Bagarello, *Quantum dynamics for classical systems: with applications of the Number operator*, Wiley (2012)
2. F. Bagarello, *Quantum Concepts in the Social, Ecological and Biological Sciences*, Cambridge University Press, 2019
3. F. Bagarello, *An operatorial approach to stock markets*, J. Phys. A, **39**, 6823-6840 (2006)
4. F. Bagarello, *Stock markets and quantum dynamics: a second quantized description*, Physica A, **386**, 283-302 (2007)
5. F. Bagarello, *A quantum statistical approach to simplified stock markets*, Physica A, **388**, 4397-4406 (2009)
6. F. Bagarello, F. Oliveri, *An operator-like description of love affairs*, SIAM Jour. Appl. Math., **70**, No. 8, 3235-3251 (2010)
7. F. Bagarello, *Damping in quantum love affairs*, Physica A, **390**, 2803-2811 (2011)
8. F. Bagarello, F. Oliveri, *A phenomenological operator description of interactions between populations with applications to migration*, Math. Mod. and Meth. in Appl. Sci., **23**, No. 3, 471-492, (2013)
9. F. Bagarello, F. Gargano, F. Oliveri, *A phenomenological operator description of dynamics of crowds: escape strategies*, Appl. Math. Model., **39**, Issue 8, 2276-2294 (2015)

10. F. Bagarello, E. Haven, *The role of information in a two-traders market*, Physica A, **404**, 224-233 (2014)

11. F. Bagarello, *An operator view on alliances in politics*, SIAM J. Appl. Math., **75**, 564-584 (2015)

12. F. Bagarello, E. Haven, *First results on applying a non-linear effect formalism to alliances between political parties and buy and sell dynamics*, Physica A, **444**, 403-414 (2016)

13. F. Bagarello, E. Haven, A. Khrennikov, *A model of adaptive decision making from representation of information environment by quantum fields*, Philosophical Transactions A, **375**, 20170162 (2017).

14. F. Bagarello, G. Bravo, F. Gargano, L. Tamburino, *Large-scale effects of migration and conflict in pre-agricultural human groups: Insights from a dynamic model*, PLOS ONE, DOI:10.1371/journal.pone.0172262 (2017)

15. F. Bagarello, F. Gargano, *Modeling interactions between political parties and electors*, Phys. A, dx.doi.org/10.1016/j.physa.2017.04.035

16. F. Bagarello, I. Basieva, A. Khrennikov, *Quantum field inspired model of decision making: Asymptotic stabilization of the belief state via interaction with surrounding mental environment*, Jour. Math. Psych., **82**, 159-168 (2018)

17. F. Bagarello, I. Basieva, A. Khrennikov, E. Pothos *Quantum like modeling of decision making: quantifying uncertainty with the aid of Heisenberg-Robinson inequality*, Journal of Mathematical Psychology, **84**, 49-56 (2018)

18. F. Bagarello, *A dynamical approach to compatible and incompatible questions*, Physica A, **527**, 121282 (2019)

19. F. Bagarello, *One-directional quantum mechanical dynamics and an application to decision making*, Physica A, **537**, 122739, (2020)

20. F. Bagarello, F. Gargano, F. Roccati, *Modeling epidemics through ladder operators*, Chaos, Solitons and Fractals, **140**, 110193 (2020)

21. F. Bagarello, F. Gargano, F. Oliveri, *Spreading of competing information in a network*, Entropy 2020, **22** (10), 1169