



Universiteit
Leiden
The Netherlands

Statistical physics and information theory for systems with local constraints

Zhang, Q.

Citation

Zhang, Q. (2021, December 1). *Statistical physics and information theory for systems with local constraints*. Casimir PhD Series. Retrieved from <https://hdl.handle.net/1887/3244220>

Version: Publisher's Version

[Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

License: <https://hdl.handle.net/1887/3244220>

Note: To cite this publication please use the final published version (if applicable).

Bibliography

- [1] JW Gibbs. Elementary principles in statistical physics. *The Collected Works of JW Gibbs (Yale University, New Haven, CT, 1957)*, 2, 1902.
- [2] Sergey V Buldyrev, Roni Parshani, Gerald Paul, H Eugene Stanley, and Shlomo Havlin. Catastrophic cascade of failures in interdependent networks. *Nature*, 464(7291):1025–1028, 2010.
- [3] Stefano Battiston, J Doyne Farmer, Andreas Flache, Diego Garlaschelli, Andrew G Haldane, Hans Heesterbeek, Cars Hommes, Carlo Jaeger, Robert May, and Marten Scheffer. Complexity theory and financial regulation. *Science*, 351(6275):818–819, 2016.
- [4] Aniello Lampo, Javier Borge-Holthoefer, Sergio Gómez, and Albert Solé-Ribalta. Multiple abrupt phase transitions in urban transport congestion. *Physical Review Research*, 3(1):013267, 2021.
- [5] Tiziano Squartini, Joey de Mol, Frank den Hollander, and Diego Garlaschelli. Breaking of ensemble equivalence in networks. *Physical review letters*, 115(26):268701, 2015.
- [6] F den Hollander, M Mandjes, A Roccaverde, and NJ Starreveld. Breaking of ensemble equivalence for perturbed erdos\{o\} renyi random graphs. *arXiv preprint arXiv:1807.07750*, 2018.
- [7] Diego Garlaschelli, Frank den Hollander, and Andrea Roccaverde. Covariance structure behind breaking of ensemble equivalence in random graphs. *Journal of Statistical Physics*, 173(3-4):644–662, 2018.
- [8] Hugo Touchette. Equivalence and nonequivalence of ensembles: Thermodynamic, macrostate, and measure levels. *Journal of Statistical Physics*, 159(5):987–1016, 2015.
- [9] Elad Schneidman, Michael J Berry, Ronen Segev, and William Bialek. Weak pairwise correlations imply strongly correlated network states in a neural population. *Nature*, 440(7087):1007–1012, 2006.
- [10] Ludwig Boltzmann. *Lectures on gas theory*. Courier Corporation, 2012.
- [11] James Clerk Maxwell. Ii. illustrations of the dynamical theory of gases. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, 20(130):21–37, 1860.
- [12] Mark Newman. *Networks*. Oxford university press, 2018.

- [13] Alessandro Campa, Thierry Dauxois, and Stefano Ruffo. Statistical mechanics and dynamics of solvable models with long_range interactions. *Physics Reports*, 480(3):57–159, 2009.
- [14] Giulio Cimini, Tiziano Squartini, Fabio Saracco, Diego Garlaschelli, Andrea Gabrielli, and Guido Caldarelli. The statistical physics of real-world networks. *Nature Reviews Physics*, 1(1):58, 2019.
- [15] Edwin T Jaynes. Information theory and statistical mechanics. *Physical review*, 106(4):620, 1957.
- [16] Mark EJ Newman. Analysis of weighted networks. *Physical review E*, 70(5):056131, 2004.
- [17] Mark Ed Newman, Albert-László Ed Barabási, and Duncan J Watts. *The structure and dynamics of networks*. Princeton university press, 2006.
- [18] Diego Garlaschelli and Maria I Loffredo. Maximum likelihood: Extracting unbiased information from complex networks. *Physical Review E*, 78(1):015101, 2008.
- [19] Diego Garlaschelli and Maria I Loffredo. Generalized bose-fermi statistics and structural correlations in weighted networks. *Physical review letters*, 102(3):038701, 2009.
- [20] Diego Garlaschelli, Sebastian E Ahnert, Thomas Fink, and Guido Caldarelli. Low-temperature behaviour of social and economic networks. *Entropy*, 15(8):3148–3169, 2013.
- [21] Richard S Ellis, Kyle Haven, and Bruce Turkington. Nonequivalent statistical equilibrium ensembles and refined stability theorems for most probable flows. *Nonlinearity*, 15(2):239, 2002.
- [22] Richard S Ellis, Kyle Haven, and Bruce Turkington. Large deviation principles and complete equivalence and nonequivalence results for pure and mixed ensembles. *Journal of Statistical Physics*, 101(5-6):999–1064, 2000.
- [23] Richard S Ellis, Hugo Touchette, and Bruce Turkington. Thermodynamic versus statistical nonequivalence of ensembles for the mean-field blume–emery–griffiths model. *Physica A: Statistical Mechanics and its Applications*, 335(3-4):518–538, 2004.
- [24] Donald Lynden-Bell. Negative specific heat in astronomy, physics and chemistry. *Physica A: Statistical Mechanics and its Applications*, 263(1-4):293–304, 1999.
- [25] Pierre-Henri Chavanis. Gravitational instability of isothermal and polytropic spheres. *Astronomy & Astrophysics*, 401(1):15–42, 2003.

- [26] Diego Garlaschelli, Frank Den Hollander, and Andrea Roccaverde. Ensemble nonequivalence in random graphs with modular structure. *Journal of Physics A: Mathematical and Theoretical*, 50(1):015001, 2016.
- [27] Qi Zhang and Diego Garlaschelli. Strong ensemble nonequivalence in systems with local constraints. *arXiv preprint arXiv:2107.04920*, 2021.
- [28] Qi Zhang and Diego Garlaschelli. Ensemble nonequivalence and bose-einstein condensation in weighted networks. *arXiv preprint arXiv:2012.09998*, 2020.
- [29] Thomas M Cover and Joy A Thomas. *Elements of information theory*. John Wiley & Sons, 2012.
- [30] Abbas El Gamal and Young-Han Kim. *Network information theory*. Cambridge university press, 2011.
- [31] Harry Nyquist. Certain factors affecting telegraph speed. *Transactions of the American Institute of Electrical Engineers*, 43:412–422, 1924.
- [32] Ralph VL Hartley. Transmission of information. *Bell System technical journal*, 7(3):535–563, 1928.
- [33] Claude Elwood Shannon. A mathematical theory of communication. *Bell system technical journal*, 27(3):379–423, 1948.
- [34] Stephen F Altschul, Warren Gish, Webb Miller, Eugene W Myers, and David J Lipman. Basic local alignment search tool. *Journal of molecular biology*, 215(3):403–410, 1990.
- [35] Ricard Solé. Using information theory to decode network coevolution. *Science*, 368(6497):1315–1316, 2020.
- [36] Gema Bello-Orgaz, Jason J Jung, and David Camacho. Social big data: Recent achievements and new challenges. *Information Fusion*, 28:45–59, 2016.
- [37] Tiziano Squartini and Diego Garlaschelli. Reconnecting statistical physics and combinatorics beyond ensemble equivalence. *arXiv preprint arXiv:1710.11422*, 2017.
- [38] M Blume, VJ Emery, and Robert B Griffiths. Ising model for the λ transition and phase separation in he 3-he 4 mixtures. *Physical review A*, 4(3):1071, 1971.
- [39] Julien Barré, David Mukamel, and Stefano Ruffo. Inequivalence of ensembles in a system with long-range interactions. *Physical Review Letters*, 87(3):030601, 2001.
- [40] M d’Agostino, F Gulminelli, Ph Chomaz, M Bruno, F Cannata, R Bougault, F Gramegna, I Iori, N Le Neindre, GV Margagliotti, et al. Negative heat capacity in the critical region of nuclear fragmentation: an experimental evidence of the liquid-gas phase transition. *Physics Letters B*, 473(3-4):219–225, 2000.

- [41] Julien Barré and Bruno Gonçalves. Ensemble inequivalence in random graphs. *Physica A: Statistical Mechanics and its Applications*, 386(1):212–218, 2007.
- [42] Charles Radin and Lorenzo Sadun. Phase transitions in a complex network. *Journal of Physics A: Mathematical and Theoretical*, 46(30):305002, 2013.
- [43] Michael Kastner. Nonequivalence of ensembles for long-range quantum spin systems in optical lattices. *Physical review letters*, 104(24):240403, 2010.
- [44] Tiziano Squartini and Diego Garlaschelli. *Maximum-Entropy Networks: Pattern Detection, Network Reconstruction and Graph Combinatorics*. Springer, 2017.
- [45] Andrea Roccaverde. Is breaking of ensemble equivalence monotone in the number of constraints? *Indagationes Mathematicae*, 30(1):7–25, 2019.
- [46] Juyong Park and Mark EJ Newman. Statistical mechanics of networks. *Physical Review E*, 70(6):066117, 2004.
- [47] Ginestra Bianconi and Albert-László Barabási. Bose-einstein condensation in complex networks. *Physical review letters*, 86(24):5632, 2001.
- [48] M Ángeles Serrano, Marián Boguñá, and Romualdo Pastor-Satorras. Correlations in weighted networks. *Physical Review E*, 74(5):055101, 2006.
- [49] Tiziano Squartini, Rossana Mastrandrea, and Diego Garlaschelli. Unbiased sampling of network ensembles. *New Journal of Physics*, 17(2):023052, 2015.
- [50] <https://it.mathworks.com/matlabcentral/fileexchange/46912-max-sampling-package-zip>.
- [51] <https://meh.imtlucca.it>.
- [52] Solomon Kullback and Richard A Leibler. On information and sufficiency. *The annals of mathematical statistics*, 22(1):79–86, 1951.
- [53] Albert Einstein. Quantentheorie des einatomigen idealen gases. *Königliche Preußische Akademie der Wissenschaften.*, 261–267, 1924.
- [54] Patrick Navez, Dmitri Bitouk, Mariusz Gajda, Zbigniew Idziaszek, and Kazimierz Rzazewski. Fourth statistical ensemble for the bose-einstein condensate. *Physical review letters*, 79(10):1789, 1997.
- [55] Martin Holthaus, Eva Kalinowski, and Klaus Kirsten. Condensate fluctuations in trapped bose gases: Canonical vs. microcanonical ensemble. *Annals of Physics*, 270(1):198–230, 1998.
- [56] WJ Mullin and JP Fernandez. Bose-einstein condensation, fluctuations, and recurrence relations in statistical mechanics. *American Journal of Physics*, 71(7):661–669, 2003.

- [57] Sourav Chatterjee and Persi Diaconis. Fluctuations of the bose-einstein condensate. *Journal of Physics A: Mathematical and Theoretical*, 47(8):085201, 2014.
- [58] SV Tarasov, Vl V Kocharovsky, and VV Kocharovsky. Grand canonical versus canonical ensemble: Universal structure of statistics and thermodynamics in a critical region of bose-einstein condensation of an ideal gas in arbitrary trap. *Journal of Statistical Physics*, 161(4):942–964, 2015.
- [59] A Crisanti, A Sarracino, and M Zannetti. Condensation versus ordering: From the spherical models to bose-einstein condensation in the canonical and grand canonical ensemble. *Physical Review Research*, 1(2):023022, 2019.
- [60] C. Kittel and H. Kroemer. *Thermal Physics*. W.H. Freeman, San Francisco, 1980.
- [61] Pierfrancesco Dionigi, Diego Garlaschelli, Frank den Hollander, and Michel Mandjes. A spectral signature of breaking of ensemble equivalence for constrained random graphs. <https://arxiv.org/abs/2009.05155>, 2020.
- [62] Assaf Almog and Diego Garlaschelli. Binary versus non-binary information in real time series: empirical results and maximum-entropy matrix models. *New journal of physics*, 16(9):093015, 2014.
- [63] Andrea Roccaverde. Is breaking of ensemble equivalence monotone in the number of constraints? *Indagationes Mathematicae*, 30(1):7–25, 2019.
- [64] Stefan Semrau, Johanna E Goldmann, Magali Soumillon, Tarjei S Mikkelsen, Rudolf Jaenisch, and Alexander Van Oudenaarden. Dynamics of lineage commitment revealed by single-cell transcriptomics of differentiating embryonic stem cells. *Nature communications*, 8(1):1096, 2017.
- [65] P. Wang, W. He, and J. Zhao. A tale of three social networks: User activity comparisons across facebook, twitter, and foursquare. *IEEE*, 18(2):10–15, 2013.
- [66] Assaf Almog, M Renate Buijink, Ori Roethler, Stephan Michel, Johanna H Meijer, Jos HT Rohling, and Diego Garlaschelli. Uncovering functional signature in neural systems via random matrix theory. *PLoS computational biology*, 15(5):e1006934, 2019.
- [67] F den Hollander, M Mandjes, A Roccaverde, NJ Starreveld, et al. Ensemble equivalence for dense graphs. *Electronic Journal of Probability*, 23, 2018.
- [68] Silvia Heubach and Toufik Mansour. *Combinatorics of compositions and words*. CRC Press, 2009.
- [69] A Moujahid, A d’Anjou, FJ Torrealdea, and Francisco Torrealdea. Energy and information in hodgkin-huxley neurons. *Physical Review E*, 83(3):031912, 2011.

- [70] Luis E Olmos, Serdar Çolak, Sajjad Shafiei, Meead Saberi, and Marta C González. Macroscopic dynamics and the collapse of urban traffic. *Proceedings of the National Academy of Sciences*, 115(50):12654–12661, 2018.
- [71] René Marois and Jason Ivanoff. Capacity limits of information processing in the brain. *Trends in cognitive sciences*, 9(6):296–305, 2005.
- [72] Milan Studený and Jirina Vejnarová. The multiinformation function as a tool for measuring stochastic dependence. In *Learning in graphical models*, pages 261–297. Springer, 1998.