NPQCD

NONPERTURBATIVE PROPERTIES OF QCD

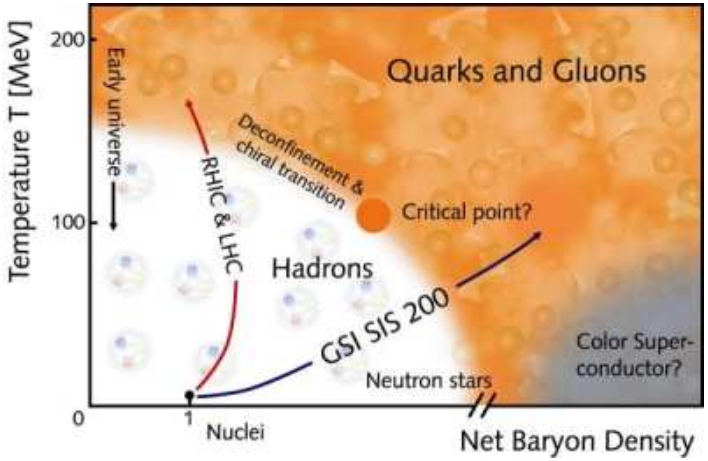
Enrico Meggiolaro

Attività 2019 e preventivi 2020 **Pisa, 4 Luglio 2019**

- **Sezioni partecipanti:** Bari, Cosenza + LNGS, Pisa
- **Responsabile nazionale:** L. Cosmai (Sez. INFN di Bari)
- **Associati presso Pisa:**
  - B. Alles Salom (Ricercatore INFN, 100% NPQCD)
  - A. Athenodorou (borsista *Marie Curie*, 100% NPQCD)
  - C. Bonati (RTDA, 90% NPQCD)
  - M. D'Elia (Prof. Associato, 90% NPQCD)
  - A. Di Giacomo (Prof. Emerito, 100% NPQCD)
  - E. Meggiolaro (Prof. Associato, 100% NPQCD [responsabile locale])
  - F. Negro (Docente, 100% NPQCD)
  - G. Paffuti (Prof. Ordinario, 100% NPQCD)
  - P. Rossi (Prof. Ordinario, 100% NPQCD)
  - D. Vadacchino (Assegnista [HPC-HTC, CIPE], 100% NPQCD [fino a Dic. 2019])
  - C. Bonanno, M. Cardinali, G. Clemente (Dottorandi, 100% NPQCD)

Attività di ricerca

- **Proprietà non-perturbative della QCD: confinamento del colore, simmetrie chirali, proprietà topologiche, etc.**
- **Proprietà delle interazioni forti in condizioni estreme: diagramma di fase della QCD, QCD in campi esterni.**



- **Simulazioni numeriche e teorie efficaci.**
- **Connessioni fenomenologiche: collisioni fra ioni pesanti, scattering adrone-adrone, transizione di QCD cosmologica, fenomenologia dell'assione.**
- **Connessioni tecnologiche: sviluppo di codici su architetture parallele standard ed ibride (CPU+GPU o altro), exascale (legame con progetto HPC-HTC, CIPE).**

Pubblicazioni 2019

1. C. Bonati, E. Calore, M. D'Elia, M. Mesiti, F. Negro, A. Rucci, F. Sanfilippo, F. Schifano, G. Silvi, R. Tripiccione, "Roberge-Weiss endpoint and chiral symmetry restoration in $N_f = 2+1$ QCD", Phys. Rev. D 99, 014502 (2019).

2. C. Bonanno, C. Bonati, M. D'Elia, "Topological properties of CP^{N-1} models in the large-N limit", JHEP 1901 (2019) 003.

3. C. Giannetti, B. Lucini, D. Vadacchino, "Machine Learning as a universal tool for quantitative investigations of phase transitions", Nucl. Phys. B944 (2019) 114639.

4. C. Bonati, P. Rossi, "Topological susceptibility of two-dimensional $U(N)$ gauge theories", Phys. Rev. D 99, 054503 (2019).

5. G. Clemente, M. D'Elia, A. Ferraro, "Spectral Methods and Running Scales in Causal Dynamical Triangulations", Phys. Rev. D 99, 114506 (2019).

6. M. Caselle, A. Nada, M. Panero, D. Vadacchino, "Conformal field theory and the hot phase of three-dimensional $U(1)$ gauge theory", JHEP 1905 (2019) 068.

7. N. Battelli, C. Bonati, "Color flux tubes in $SU(3)$ Yang-Mills theory: an investigation with the connected correlator", Phys. Rev. D 99, 114501 (2019).

8. E. Meggiolaro, "Theta dependence of the vacuum energy density in chiral effective Lagrangian models at finite temperature, above T_c", Phys. Rev. D 99, 114009 (2019).

9. G. Landini, E. Meggiolaro, "Study of the interactions of the axion with mesons and photons using a chiral effective Lagrangian model", e-Print: arXiv:1906.03104.

10. B. Alles, J.J. Alonso Pereda, V. Russier, "Phase diagram for ensembles of random close packed Ising-like dipoles as a function of the temperature and texturation", in preparation.

Attività prevista 2020

- We plan to continue our study about the so-called θ dependence in pure-gauge theories and in full QCD, extending our results to temperatures close to 1 GeV, by means of numerical simulations with lattice spacings smaller than 0.04 fm.
- We plan to continue to study (by lattice QCD simulations) how the Quark-Gluon Plasma is influenced by a magnetic background field (which is expected to play a relevant role, especially in the framework of noncentral heavy-ion collisions).
- We will study the nonperturbative properties of Yang-Mills theories with a compactified direction and a trace deformation added to the action which prevents the breaking of the center symmetry, in order to verify how close their properties are to those of standard confining Yang-Mills theories.
- We will continue our numerical study of the so-called Causal Dynamical Triangulations (an approach to quantum gravity on a discretized space-time).
- We plan to extend our study of the QCD flux tubes, considering in particular the breaking of the flux that takes place in pure-gauge theories with static charges in the adjoint representation.

- **The topological properties of the QCD vacuum (and their relationships with chiral symmetries) will be also investigated at finite temperature by means of Chiral Effective Lagrangians with the inclusion of the axion field.**
- **We plan to undertake a detailed study of some particular $U(1)$ axial condensates of the QCD vacuum in terms of the spectral density of the Euclidean Dirac operator and (at finite temperature) by means of the so-called "dilute instanton gas approximation".**
- **Importance sampling of actions with a sign problem has become one of the hardest problems in lattice field theory and statistical mechanics. We are studying it for the $2D$ nonlinear sigma $O(n)$ models by dualization. We are planning to extend the present "technology" to the so far elusive $O(3)$ model with a θ term.**
- **At the same time, we will continue our study regarding the topological properties of CP^{N-1} models, considering in particular their approach to the large-N limit.**
- **The study of nanoparticles' ensembles has relevant technological impacts. We are planning to continue the study of the physical and thermodynamical properties of such systems with arrays of nanoparticles (not random packed) with or without defects, including also the texturation.**

Collaborazioni

1. **ETH, Zurigo, Svizzera (Ph. de Forcrand).**
2. **INFN, Sezione di Roma Tre (F. Sanfilippo).**
3. **Department of Physics, University of Cyprus, Cipro (H. Panagopoulos, A. Todaro, F. Manigrasso).**
4. **JINR, Dubna, Russia (M. Hasegawa, M. Ilgenfritz).**
5. **Institute for Theoretical Physics, Eotvos University, & MTA-ELTE Lattice Gauge Theory Research Group, Budapest, Ungheria (M. Giordano).**
6. **Bogolyubov Institute for Theoretical Physics, Kiev, Ucraina (O. Borisenko).**
7. **Bergische Universität Wuppertal, Germania (S. Calì).**
8. **Swansea University, Gran Bretagna (M. Mesiti, B. Lucini).**
9. **ITEP, NRC "Kurchatov Institute", Mosca, Russia (V. Braguta, A. Kotov, A. Nikolaev).**
10. **Universidad Malaga, Spagna (J.J. Alonso Pereda).**
11. **CNRS, Thiais, Francia (V. Russier).**

Richieste 2020

- *Missioni*: **16 KEuro**