GSS: Gauge theories, supergravity and string theory

Nodes

- Milano Bicocca
- Milano
- Padova
- Torino
- Frascati
- Lecce
- Genova

National coordinator

A. Zaffaroni, Milano Bicocca

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The general theme of the network

The general context of GSS is that String Theory, Quantum Gravity and the non-perturbative dynamics of Supersymmetric Field Theories.

The specific topics that are studied include:

- AdS/CFT correspondence.
- Branes, supersymmetric gauge theories, instanton calculus, integrable systems, topological field theories.
- Supergravity and black holes.

GSS: Genova Node

The Genoa group

- Giuseppe Bandelloni
- Carlo Becchi
- Camillo Imbimbo

The specific theme of the Genoa group

Within this context, Genova node has focused and developed an expertise on topological quantum field theories, topological string theories, higher-spin field theories and their non-perturbative dynamics.

Higher-spin field theories

- Higher-spin field theories are generalizations of Einstein gravity whose gauge symmetries are tensorial extension of the usual reparametrization algebra.
- This topic has been studied by G. Bandelloni which has investigated both the algebraic structures of such gravitational theories with extended metric tensors and their quantum anomalies.

Topological Field Theories and Supersymmetric Theories

- Topological field theories and and topological string theories have been studied by C.M.Becchi and C. Imbimbo.
- Topological (field and string) theories are close “cousins” of supersymmetric theories.
- They are characterized by a special “topological” supersymmetry — the so-called BRST symmetry.
- The BRST symmetry of topological theories is intimately related to the “physical” supersymmetry of the corresponding supersymmetric theories.

Topological Field Theories

- Topological theories have a much simpler dynamics and are much more tractable than their supersymmetric relatives.
- Physical quantities that are computed in topological theories describe certain sub-sectors of supersymmetric theories — the so-called topological or BPS sectors.
- The interesting fact is that these quantities can be often be computed exactly in a non-perturbative way, by exploting the underlying BRST symmetry.

Localization for supersymmetric theories

- A phenomenon which has studied intensely in recent years is the one of localization which occurs for supersymmetric gauge theories on curved space-times.
- By “localization” one refers to the circumstance for which the semi-classical approximation for the partition function or for certain observables turn out to be exact.
- Although it has been known for a long time that topological field theories localize, it was initially thought that localization for “physical” supersymmetric theories was a more general and different phenomenon.

Localization and topological field theories

- In Genova we developed an original approach to localization.
- This approach is based to the coupling of topological gauge theories to external topological gravity.
- Our approach aims to show that localization for physical supersymmetric theories can in fact be brought and understood in the general framework of topological localization.

Localization and topological field theories

- To achieve this we had to introduce a concept which is quite unfamiliar and rather exotic in conventional approaches: the coupling of the topological gauge theory to external classical bosonic backgrounds with non-vanishing ghost number.
- The reason for this is that topological gravity includes, beyond the gravitational metric fields, bosonic fields of even ghost number.

- Our approach has allowed us to characterize — in a way which is considerably more direct and simpler than conventional approaches — the curved space-times for which the phenomenon of localization occurs.
- Moreover it has allowed us to compute the dependence of the physical observables on the geometric parameters charcterizing these manifolds in a complete regularization independent way by solving certain topological anomaly equations.

Ongoing projects and collaborations

- Topological approach to localization of supersymmetric field theories in collaboration with Dario Rosa and Soo-Jong Rey of Seoul National University.
- Formulation of new topological string models, in collaboration with A.Tomasiello of Milano Bicocca University.

Publications 2014-15

- D. Ghoshal, C. Imbimbo and D. Kumar, “Weak Coupling Expansion of Yang-Mills Theory on Recursive Infinite Genus Surfaces,” JHEP **1410**, 181 (2014) [arXiv:1407.6380 [hep-th]].
- C.Imbimbo and D.Rosa, "Topological anomalies for Seifert 3-manifolds,” to appear in JHEP (2015) [arXiv:1411.6635 [hep-th]].
- G. Bandelloni, “A model for massless higher spin field interacting with a geometrical background,” IJMMP 201 [arXiv:1502.00452 [hep-th]].
- C. Becchi, “Slavnov-Taylor and Ward Identities in the Electroweak Theory,” Theor. Math. Phys. **182**, no. 1, 52 (2015) [Teor. Mat. Fiz. **182**, no. 1, 65 (2014)] [arXiv:1407.3960 [hep-th]].