

Curriculum Vitae

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Informazioni Personali

Cognome: Giaccari

Nome: Stefano Gregorio

Data di Nascita: 17-02-1982

Education

- 2013 PhD in Particelle Elementari
(equipollente al titolo di "Dottore di Ricerca in Fisica")
International School for Advanced Studies (SISSA/ISAS)
Tesi: *Conformal symmetry in String Field Theory
and 4D field theories*
Supervisore: Prof. Lorianò Bonora
- 2008 Laurea Specialistica in Fisica,
punteggio finale:110/110 *cum laude*
Università di Pisa, Dipartimento di Fisica "Enrico Fermi"
Tesi: *Gravitational Anomalies*
Supervisore: Prof. Pietro Menotti
- 2004 Laurea Magistrale in Fisica (BS in Physics),
punteggio finale:110/110 *cum laude*
Università di Pisa, Dipartimento di Fisica "Enrico Fermi"
Tesi: *Lie groups and Special Functions*
Supervisore: Prof. Luciano Bracci

Esperienza di Ricerca

Ricerca Post-dottorato: Department of Sciences, Holon Institute of Technology (HIT)

(referente Prof. Michael Kroyter)

- Teorie di Gravità Modificata
- Teorie di Higher spin
- Teorie di String Fields supersimmetriche
- Fenomeni di Risorgenza in teorie di campo quantistiche perturbative

Ricerca Post-dottorato: Department of Physics, Faculty of Science, University of Zagreb

(referente Prof. Maro Cvitan)

- Teorie di Higher spin
- Teorie di Gravità di Chern-Simons
- Anomalie in gravità con violazione di parità

Ricerca Post-dottorato: Fudan University, Shanghai

(referente Prof. Leonardo Modesto)

- Teorie di gravità non locali super-rinormalizzabili
- Supergravità con derivate di ordine superiore
- Entropia di Entanglement dei Buchi Neri

Ricerca Dottorato: SISSA (Supervisore: Prof. Lorianò Bonora)

- Aspetti formali delle soluzioni di lump per le Dp-brane nella String Field Theory aperta di Witten
- Analisi coomologica delle anomalie di traccia in diverse formulazioni della Supergravità

Ricerca pre-laurea: Dipartimento di Fisica, Università di Pisa (Supervisore: Prof. Pietro Menotti)

- Derivazione della anomalia gravitazionale esatta consistente per campi scalari chirali attraverso la tecnica di Schwinger-DeWitt e analisi coomologica

Interessi di Ricerca

- Teorie di campo di (Super-)gravità, anomalie in teorie di campo supersimmetriche, teorie di campo conformi e di Liouville, teorie di Higher Spin
- Teoria di Stringa, Dp-brane e aspetti non-perturbativi di stringa, dualità gauge/gravità, modelli di stringa effettivi per sistemi di Materia Condensata
- Gravità Quantistica, teorie di Gravità Modificata, teorie di Chern-Simons e fisica dei Buchi Neri

Esperienza Didattica

Assistente in corsi di Teoria Quantistica di Campo e Gravità Generale,

Tutor per studenti di Laurea Magistrale e Specialistica e Dottorato.

Attività editoriali

Peer Reviewer per Symmetry (ISSN 2073-8994)

Universe (ISSN 2218-1997)

Topic Editor per Universe (ISSN 2218-1997)

Altre Competenze Professionali

1. Ottima conoscenza di Linux/Unix, Windows, Macintosh
2. Ottima conoscenza di Mathematica, Matlab, programmazione in C
3. Ottima Conoscenza della Lingua Inglese

Lista delle Pubblicazioni

- [1] M. Cvitan, P. Dominis Prester, S. Giaccari, M. Paulišić and I. Vuković, *Gauging the higher-spin-like symmetries by the Moyal product*, [arXiv:2102.09254 [hep-th]].
- [2] L. Bonora and S. Giaccari, *Supersymmetric HS Yang-Mills-like models*, Universe **6**, no.12, special issue “Supersymmetric Quantum Theory”, (2020) doi:10.3390/universe6120245 [arXiv:2011.00734 [hep-th]].
- [3] P. Jizba, L. Rachwał, S. G. Giaccari and J. Knap, *Dark side of Weyl gravity*, Universe **6**, no.8, 123 (2020) doi:10.3390/universe6080123 [arXiv:2006.15596 [hep-th]].
- [4] L. Bonora, M. Cvitan, P. Dominis Prester, S. Giaccari and T. Štemberga, *HS in flat spacetime. YM-like models*, [arXiv:1812.05030 [hep-th]].
- [5] L. Bonora, M. Cvitan, P. Dominis Prester, S. Giaccari and T. Štemberga, *HS in flat spacetime. The effective action method*, Eur. Phys. J. C **79**, no.3, 258 (2019) doi:10.1140/epjc/s10052-019-6660-4 [arXiv:1811.04847 [hep-th]].
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 - [9] L. Bonora, M. Cvitan, P. Dominis Prester, S. Giaccari, M. Paulišić and T. Štemberga, *Worldline quantization of field theory, effective actions and L_∞ structure*, JHEP **04**, 095 (2018) doi:10.1007/JHEP04(2018)095 [arXiv:1802.02968 [hep-th]].
 - [10] L. Bonora, M. Cvitan, P. Dominis Prester, S. Giaccari and T. Štemberga, *One-loop effective actions and higher spins. Part II*, JHEP **1801**, 080 (2018) doi:10.1007/JHEP01(2018)080 [arXiv:1709.01738 [hep-th]].
 - [11] L. Bonora, M. Cvitan, P. Dominis Prester, A. Duarte Pereira, S. Giaccari and T. Štemberga, *Axial gravity, massless fermions and trace anomalies*, Eur. Phys. J. C **77**, no. 8, 511 (2017) doi:10.1140/epjc/s10052-017-5071-7 [arXiv:1703.10473 [hep-th]].
 - [12] L. Bonora, M. Cvitan, P. Dominis Prester, S. Giaccari, B. Lima de Souza and T. Štemberga, *One-loop effective actions and higher spins*, JHEP **612**, 084 (2016) doi:10.1007/JHEP12(2016)084 [arXiv:1609.02088 [hep-th]].
 - [13] S. Giaccari and J. Nian, *Dark Solitons, D-branes and Noncommutative Tachyon Field Theory*, Int. J. Mod. Phys. A **32**, 1750201 (2017) doi:10.1142/S0217751X17502013 [arXiv:1608.07262 [hep-th]].
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 - [15] P. Donà, S. Giaccari, L. Modesto, L. Rachwał and Y. Zhu, *Scattering amplitudes in super-renormalizable gravity*, JHEP **1508**, 038 (2015) doi:10.1007/JHEP08(2015)038 [arXiv:1506.04589 [hep-th]].
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 - [17] L. Bonora and S. Giaccari, *Weyl transformations and trace anomalies in $N=1$, $D=4$ supergravities*, JHEP **1308**, 116 (2013) doi:10.1007/JHEP08(2013)116 [arXiv:1305.7116 [hep-th]].
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- [22] S. Giaccari and P. Menotti, *Consistent gravitational anomalies for chiral bosons*, Phys. Rev. D **79**, 065015 (2009), [arXiv:0812.2810 [hep-th]].

Atti di Conferenze

1. L. Bonora and S. Giaccari, *HS Yang-Mills-like models: a review*, Annals of the University of Craiova Physics AUC (ISSN - 1223 - 6039), volume 30 (part II), 2020
2. S. Giaccari and L. Modesto, *Causality in Nonlocal Gravity*, Contribution to: 10th MATHEMATICAL PHYSICS MEETING, 121-136 School and Conference on Modern Mathematical Physics 9 - 14 September 2019, Belgrade, Serbia
3. L. Bonora, M. Cvitan, P. D. Prester, A. D. Pereira, S. Giaccari and T. Štemberga, *Pontryagin trace anomaly*, EPJ Web Conf. **182**, 02100 (2018)
4. P. Dominis Prester, L. Bonora, M. Cvitan, S. Giaccari and T. Štemberga, *Induced actions for higher spin fields*, J. Phys. Conf. Ser. **1051**, no.1, 012008 (2018)
5. L. Bonora, M. Cvitan, P. D. Prester, S. Giaccari and T. Štemberga, *Higher Spins from One-Loop Effective Actions*, Springer Proc. Math. Stat. **255**, 17-30 (2017)
6. L. Bonora, M. Cvitan, P. Dominis Prester, S. Giaccari, B. Lima de Souza and T. Štemberga, *Massive Dirac field in 3D and induced equations for higher spin fields*,
7. L. Bonora, S. Giaccari and B. L. D. Souza, *Revisiting Trace Anomalies in Chiral Theories*, Springer Proc. Math. Stat. **111**, 3 (2014).
8. L. Bonora, S. Giaccari and B. Lima de Souza, *Revisiting Trace Anomalies in Chiral Theories*, Bled Workshops Phys. **14**, no. 2, 22 (2013).
9. L. Bonora, S. Giaccari and D. D. Tolla, *Mathematical problem with exact lump solutions in SFT*, PoS ICMP **2012**, 004 (2012).

PhD thesis

S. G. Giaccari, *Conformal symmetry in String Field Theory and 4D Field Theories*.

All my papers are available at the link

<https://inspirehep.net/authors/1060685>

List of recent talks

- Israel Physical Society 65th Annual Meeting, Weizman institute of science, 17 February 2020
Title: Pseudo-Democratic Superstring Field Theory
- XV AVOGADRO MEETING on Strings, Supergravity and Gauge Theories, INFN & University of Naples “Federico II”, 18-20 December 2019
Title: Pseudo-Democratic Superstring Field Theory
- APCTP-KHU Workshop “Higher Spin Gravity: Chaotic, Conformal and Algebraic Aspects” , Pohang (South Korea), 23 September - 2 October 2019
Title: An effective action approach to higher spin theories in flat spacetime
- 10th MATHEMATICAL PHYSICS MEETING: School and Conference on Modern Mathematical Physics, 9 - 14 September 2019, Belgrade, Serbia
Title: Causality in nonlocal gravity
- Avenues of Quantum Field Theory in Curved Spacetime, Dipartimento di Scienze Fisiche, Informatiche e Matematiche, Università degli Studi di Modena e Reggio Emilia, 9-10 September 2019
Title: A worldline quantization approach to higher spin theories
- Israel Physical Society 64th Annual Meeting, Hebrew University of Jerusalem, 9 December 2018
Title: Higher spin theories from the effective action method

Research activity

My past research activity has mainly focused on string theory and quantum gravity. In particular, String field theory (SFT) plays a crucial role in our understanding of string theory at non-perturbative level. My initial work [1, 2, 3, 4] has mainly concerned a class of proposed solutions associated with the endpoint of Renormalization Group (RG) flows triggered by relevant boundary deformations on the string worldsheet. This work has contributed to enlighten how D-branes are encoded in solutions of Witten's Cubic Open String Field Theory (COSFT) defined on a worldsheet endowed with a fixed Boundary Conformal Field Theory (BCFT). More recently, I have worked on a novel formulation of superstring field theory introduced a few years ago [5]. The main characteristic of this approach is the elimination of the picture redundancy in string vertices not by an explicit choice but rather by an extended gauge symmetry, thus providing a natural unification of the Neveu-Schwarz and Ramond sectors. Whereas the original formulation of the theory involved unphysical singularities due the insertion of Picture Changing Operators (PCOs) in the vertex midpoint, my research has concerned several ways of introducing PCOs as line integrals in order to regularize the unphysical singularities while still keeping explicit gauge invariance, following a strategy similar to the one used to incorporate the Ramond sector in SFT [6].

At the same time, motivated also by recent investigations in perturbative aspects of SFT [7], I worked in higher derivative theories of gravity, where perturbative unitarity and quantum super-renormalizability or finiteness can be reproduced by the introduction of weakly nonlocal form factors. In order to better understand their relevance for physical observables, I studied the modifications on graviton scattering amplitudes induced by higher derivative terms [8], finding that, in the absence of higher derivative operators quadratic in the Riemann tensor, the amplitudes coincide with the ones found in Einstein gravity. More recently [9] the behavior of scattering amplitudes in the eikonal approximation in a class of weakly nonlocal theories has been shown to be consistent with the notion of causality discussed in [10]. Such a higher derivative theory of gravity as Weyl gravity, where conformal invariance is broken at quantum level, can also provide an interesting model to study the onset of an infrared fixed point by functional renormalization group, with interesting cosmological implications [11]. I have also considered $N = 1$ nonlocal supergravity [12], which makes up a very interesting model where unitarity, consistent with the standard perturbative spectrum of local supergravity, is achieved not just order by order in the derivative expansion, but non-perturbatively in the energy. Moreover, UV finiteness, thanks to improved power-counting in superspace, requires a less restrictive choice of form factors than similar theories in ordinary space. Another line of research in the quantum properties of gravity has addressed an interesting phenomenon of CP violation induced by a Pontryagin density term in the trace anomaly of theories on curved backgrounds [13, 14].

The higher-spin modes that naturally show up in string theory have also received widespread attention over the years, in particular in the tensionless limit where they become massless and the higher spin gauge symmetry plays a crucial role in con-

straining the dynamics. The elusive nature of higher corrections to the symmetry and the lack of an action reproducing Vasiliev's equation of motion has been a motivation to study the effective action of scalar and fermion fields coupled to external higher-spin gauge fields in generic dimension and in the presence of a mass term [15, 16, 17, 13, 18]. This effective action can be interpreted in the light of the proposal [19] that the interacting higher-spin gauge theory in AdS spacetime can be holographically described in terms of N free massless scalar or fermion fields on the boundary and the infinite set of $O(N)$ -singlet Noether currents. Most recently, a supersymmetric higher spin model inspired by this effective action was discussed in [20].

Research interests

In recent years the importance of SFT for enlightening some crucial aspects of superstring perturbation theory has been pointed out [21]. Recent developments in the construction of heterotic and type II string field theories [22, 23] pave the way for interesting applications of this approach. In particular, the corresponding effective actions [24, 25] could be instrumental in achieving a novel understanding of long-standing puzzles in quantum gravity. For example, Weyl gravity (even in its supersymmetric versions), while having interesting quantum behavior, is notoriously affected by the presence of ghost modes in its spectrum. Nevertheless these are expected to disappear once an infinite tower of higher derivative terms are included in the effective action [26]. The construction of an explicit effective action from string field theory would give a very practical way to realize this scenario and to study in detail the picture proposed in [27]. More in general, one can expect to get a useful handle of perturbation theory and to show unexpected nontrivial simplifications at quantum level, coming from the underlying "microscopic" SFT action. This would be in line with recent results showing a surprising delay in the onset of loop divergences in maximal supergravity [28]. In the past some vanishing theorems for multi-loop string amplitudes have been proven by use of the pure spinor formalism where explicit spacetime supersymmetry is preserved [29] and I would be interested in investigating whether similar or even stronger results can be obtained using the new superstring field theories proposed.

Strong constraints on higher derivative corrections to gravity come not only from the need to reconcile renormalizability and perturbative unitarity, but also from the violation of Gao and Wald's notion of causality, which has been recently discussed by Camanho, Edelstein, Maldacena, and Zhiboedov [10] in connection to Shapiro's time delay, which is one of the classical tests of general relativity (GR). Light propagating near a compact object should suffer a time delay compared with the same propagation in flat spacetime. Therefore, if we get a negative time delay, or actually a time advancement, we have a causality violation. Exploiting the relation between the Shapiro time delay and the scattering amplitudes for gravitating particles in the eikonal approximation, the authors of [10] have proven that these causality problems are produced only by the form of the on-shell three-point functions of the theory. The

only consistent classical gravitational S-matrix whose exchange poles are bounded in spin is the Einstein S-matrix so that a generic higher derivative term is related to contributions from the exchange of poles of arbitrarily high spin in the four graviton scattering amplitude. Therefore graviton scattering amplitudes can be used to assess the onset of higher spin modes [30, 31].

An outstanding problem in higher spin gauge theories is to find a satisfactory action principle. The method based on the holographic principle is one of the most promising ones and progress have been made in the construction of cubic and quartic vertices [32]. An interesting generalization would be to build supersymmetric higher spin actions from quantum correlation functions, in particular in cases of extended supersymmetry (e.g. $\mathcal{N} = 2$ in four dimensions) where such models have not yet been constructed [33]. This approach is of course background-dependent and becomes increasingly cumbersome when higher order vertices are considered. An interesting possibility is that these interactions actually organize themselves in the way prescribed by string field theory around a maximally symmetric vacuum as the one expected to correspond to higher-spin gauge spectrum. This approach is actually at the basis of recent progresses in the understanding of the AdS_3/CFT_2 correspondence [34]. A very intriguing case in higher dimensions is in particular the correspondence between Chern-Simons-matter theories in three dimension and higher-spin gravity in AdS_4 . This is also a context where boson-fermion dualities recently considered [35] could be further studied.

Another line of research inspired by [34] and by the developments related to the Sachdev-Ye-Kitaev model [36] is to investigate higher spin holographic duality in the case of the AdS_2/CFT_1 correspondence, using world-sheet methods to study the tensionless limit. This is actually prompted by the fact that the world-sheet CFT description of the background is known [37].

References

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 - [9] S. Giaccari and L. Modesto, Contribution to: 10th MATHEMATICAL PHYSICS MEETING, 121-136
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Teaching statement

Teaching is not merely a process by which an expert tries to transfer some knowledge and expertise to students, but actually a community experience where both the teacher and the students must cooperate in achieving their educational goals. I think this sharing of purpose and commitment is really essential to the success of any course of studies, and I have always tried to achieve it in my teaching activity. In particular, while having a basic idea of what the essential goals of the course should be, I try to understand what the students' expectations and needs are in each specific case and to calibrate my teaching consequently. I think this kind of flexibility is really important not only to increase the profit students can get from classes, but also to make them feel an active part of a unique experience whose final outcome really depends on them.

In particular, during my postdoc in Fudan University, I have taught as an assistant in a Quantum Field Theory course for graduate students and I have found it extremely useful to prepare a list of exercises, divided by topic, from which students could choose the ones to solve. I also let them organize in work groups which could cooperate in the solution of exercises. This strongly stimulated them to discuss their doubts and to ask me a lot of questions and in particular helped less enterprising students to feel more committed in the class and to interact more with their fellow students and with me. During all my postdocs, I also helped mentor PhD students, and therefore I could experience that research and teaching are indeed part of the same knowledge-fostering process that should be pursued by any educational institution.

Over the years I have gained relevant experience in the application for research grants and their management, in organizing workshops and conferences, in tutoring undergraduate, graduate and PhD students and in teaching courses at both undergraduate and graduate levels. I have therefore a strong commitment to teaching and to carrying out to the best of my capabilities any duties of administrative or other kind that the Department of Physics would assign me. Overall, it is very important for me to be an efficient collaborative proactive member of the group I work with and to have positive interactions with my colleagues and superiors. I can ensure my full commitment to the success of the activities of the Department of Physics.

17/03/2021

Holon

 Data

 Luogo