CURRICULUM VITAE

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Education:

Ph. D. thesis
Scientific advisor: Prof. dr. Constantin Bizdadea
Title: Coomological aspects of $N = 1$, $D = 11$ SUGRA

Abstract: **1**. In this paper we construct all consistent interactions in $D = 11$ that can be added to a free theory describing a Pauli-Fierz graviton, a massless Rarita-Schwinger gravitino, and an Abelian three-form gauge field from the deformation of the 'free' solution to the master equation. By 'consistent' we mean that the interacting theory preserves both the field content and the number of independent gauge symmetries of the free one. The analysis is performed such that the interactions satisfy some general and quite natural assumptions: smoothness in the coupling constant, locality, Lorentz covariance, Poincaré invariance, and preservation of the number of derivatives on each field (derivative order assumption). We compute all these couplings by using local cohomological techniques in the framework of the BRST formalism. One of the final outcomes of this procedure will be the quest for the uniqueness of $D = 11$, $N = 1$ SUGRA

University education

- October 1995 to September 1999: University of Craiova, Faculty of Physics. Diploma work: "Second class constrained systems approach without the Poisson bracket" under Prof. dr. C. Bizdadea's supervision.

- October 2000 to June 2001: University of Craiova, Faculty of Physics, M.Sc. in Quantum Field Theory. Graduation work: "Hamiltonian Stückelberg Coupling between 2- and 3-form Gauge Fields" under the supervision of Prof. dr. Constantin Bizdadea

High school education
September 1991 - July 1993: High School "Elena Cuza", Craiova, Romania
September 1993 - July 1995: High School "Nicolae Balcescu", Craiova, Romania

Employment
October 2004 till present: Ph. D student in Physics at the University of Craiova, Faculty of Physics.
Supervisor: Professor Constantin Bizdadea

Brief summary of the research activity held in the last years
Field of study: Mathematical Physics and High Energy Physics.
Research themes: Quantum Field Theory, BRST cuantification of the gauge theories
Subjects:
- The study of consistent Hamiltonian interactions among gauge theories using the BRST deformation procedure.

- We investigate the Hamiltonian Stueckelberg coupling between p- and $(p + 1)$-form gauge fields, in the framework of the Hamiltonian BRST formalism. The models involving p-forms gauge fields are interesting especially from the point of view of string and superstring theories, supergravity and the gauge theory of gravity, being well-known the inclusions of these fields within the multiplets of supergravity in 10 or 11 dimensions.

- The study of consistent Lagrangian interactions among gauge theories using the BRST deformation methods and techniques.
Results:

- We have investigated the couplings between a single spin-two field or a collection of such fields (described in the free limit by a sum of Pauli-Fierz actions) and a massless p-form using the powerful setting based on local BRST cohomology. We found two complementary situations. One submits to the well-known prescriptions of General Relativity, but the other situation discloses some new type of couplings in $(p + 2)$ space-time dimensions, which only modify the gauge symmetries of the p-form. It is remarkable that these $(p + 2)$-dimensional cross-couplings comply with the derivative order assumption, unlike other situations from the literature. Unfortunately, in the case of a collection of spin-two fields none of these coupled theories allows for (indirect) cross-couplings between different gravitons.

- The derivation of cross-interactions between an Abelian three-form gauge field and a Pauli-Fierz graviton in eleven-dimensional Minkowski space-time. We employ the method of constructing consistent interactions based on the deformation of the solution to the master equation associated to the 'free' theory. The starting model is

invariant under an Abelian and second-stage 'off-shell' reducible set of gauge symmetries. Making use of the vielbein formulation of spin-two field theory, it turns out that the interacting Lagrangian follows the General Relativity prescriptions and the gauge algebra remains 'off-shell' second-stage reducible. Consequently, we show the uniqueness of interaction

- The analysis of the the consistent eleven-dimensional interactions that can be introduced between a massless Rarita-Schwinger field and an Abelian three-form gauge field. Our main result is that under the working hypotheses there are neither cross-couplings nor self-interactions for the gravitino in $D = 11$. The only possible term that can be added to the deformed solution to the master equation is nothing but a generalized Chern-Simons term for the three-form gauge field, which brings contributions to the deformed Lagrangian, but does not modify the original, Abelian gauge transformations.

- The investigations of the consistent couplings that can be introduced between a massless spin-two field (described in the free limit by the Pauli-Fierz action) and a massless Rarita-Schwinger spinor in eleven space-time dimensions. In this case we prove that in $D = 11$ there are no cross-interactions between the graviton and the massless gravitino and also no self-interactions among the gravitino. Furthermore, we comment on the absence of self-interactions among the gravitino in $D = 11$ and argue that this result does not contradict the presence in the Lagrangian of $D = 11$, $N = 1$ SUGRA of a quartic gravitino vertex. We also make the comparison with the case $D = 4$, where gravitini are known to allow self-interactions in the presence of a graviton, such that their 'mass' constant becomes related to the cosmological one.

- The construction of all possible interactions in $D = 11$ among a graviton, a massless Majorana spin-3/2 field, and a three-form gauge field. First, we put all the fields together and investigate if there are consistent interactions vertices *at order one* in the coupling constant involving *all* of them. We prove that the answer is negative, such that the first-order deformation of the solution to the master equation is completely known from the couplings involving only two types of fields. Second, we analyze the consistency of the first-order deformation at order two in the coupling constant. and find that there are only two types of solutions, but only one is interesting from the point of view of interactions (the other allows at most the interactions between a graviton and a 3-form). Third, we analyze this solution and observe that it systematically reproduces the Lagrangian formulation of $D = 11$, $N = 1$ SUGRA. Therefore, we can state that all consistent interactions in $D = 11$ among a spin-2 field, a massless Majorana spin-3/2 field, and a three-form that comply with our working hypotheses are uniquely described by $D = 11$, $N = 1$ SUGRA.

International schools
I attended the following international activities (schools and workshops):

- "The 4th School and Workshop on Quantum Field Theory and Hamiltonian Systems", Calimanesti, Romania, October 16-21, 2004;

- "The RTN Winter School on Strings, Supergravity and Gauge Theories", CERN, January 16-20, 2006;

- "The 5th School and Workshop on Quantum Field Theory and Hamiltonian Systems", Calimanesti, Romania, May 20-26, 2006;

- "The International School on Modern Trends in Mathematical Physics", Sofia, Bulgaria, September 24-30, 2006;

- The 2nd Workshop of the Marie Curie Research Training Network "Constituents, Fundamental Forces and Symmetries of the Universe", Napoli, Italy, October 9-13, 2006

- "The RTN Winter School on Strings, Supergravity and Gauge Theories", CERN, January 15-19, 2007

- "The XXIII International Symposium on Lepton and Photon Interactions at High Energy", August 13-18, 2007, Daegu, Korea

- "3rd RTN workshop on Constituents, Fundamental forces and Symmetries of the Universe" October 1-5, 2007, Valencia, Spain

- "The RTN Winter School on Strings, Supergravity and Gauge Theories", CERN, January 21-25, 2008

- "The 6th Spring School and Workshop on QFT & Hamiltonian Systems", 6-11 May 2008, Calimanesti, Romania

- "4-th EU RTN Workshop", 11-17 September 2008, Varna, Bulgaria

Language Skills

- Romanian, English

Publication record

[1] E. Diaconu, Physica Scripta **68** (2003) 337

[2] E. M. Cioroianu, E. Diaconu, S. C. Sararu, On the uniqueness of $D = 11$ interactions among a graviton, a massless gravitino and a three-form. I: Pauli-Fierz and three-form, Int. J. Mod. Phys. **A 23** (2008) 4721-4755

[3] E. M. Cioroianu, E. Diaconu, S. C. Sararu, On the uniqueness of $D = 11$ interactions among a graviton, a massless gravitino and a three-form. II: Three-form and gravitini, Int. J. Mod. Phys. **A 23** (2008) 4841-4859

[4] E. M. Cioroianu, E. Diaconu, S. C. Sararu, On the uniqueness of $D = 11$ interactions among a graviton, a massless gravitino and a three-form. III: Graviton and gravitini, Int. J. Mod. Phys. **A 23** (2008) 4861-4875

[5] E. M. Cioroianu, E. Diaconu, S. C. Sararu, On the uniqueness of $D = 11$ interactions among a graviton, a massless gravitino and a three-form. IV: Putting things together, Int. J. Mod. Phys. **A 23** (2008) 4877-4923

[6] E.M. Cioroianu, E. Diaconu, S.C. Sararu, Couplings among Pauli-Fierz theory and an abelian three-form in D=11, Proceedings, "Physics Conference TIM-05" Timisoara, November 25-26, 2005, Analele Universitatii de Vest din Timisoara, Vol. **46** (2005) 87-92, Seria Fizica

[7] E.M. Cioroianu, E. Diaconu, S.C. Sararu, A note on the uniqueness of interactions between Pauli-Fierz and an Abelian three-form gauge fields in eleven spacetime dimensions, Annals of the University of Craiova, Physics AUC **16** (part I) (2006) 103-126

[8] E.M. Cioroianu, E. Diaconu, S.C. Sararu, Consistent couplings between an Abelian three-form gauge field and a non-massive Rarita-Schwinger field in D=11, Proceedings, "The Spring School in Quantum Field Theory and Hamiltonian Systems", 20-26 May 2006, Calimanesti, Romania

[9] E.M. Cioroianu, E. Diaconu, S.C. Sararu, 11-dimensional Supergravity as an interacting theory on Minkowski space, Proceedings, "The 6th International Spring School and workshop on Quantum Field Theory and Hamiltonian Systems", 6-11 May 2008, Calimanesti, Romania, Physics AUC - Vol **18** (2008) 219-229

[10] E.M. Cioroianu, E. Diaconu, S.C. Sararu, On the cohomological derivation of D=11, N=1 SUGRA, Proceedings, "Third National Conference on Theoretical Physics", Busteni, Romania, June 10-13, 2008, Romanian Journal of Physics volume **53**, No. 9-10 (2008) 87

[11] E.M. Cioroianu, E. Diaconu, S.C. Sararu, On the consistent interactions in D=11 among a graviton, a massless gravitino and a three-form, To appear in the proceedings of "4-th EU RTN Workshop", 11-17 September 2008, Varna, Bulgaria