1. Academic profile

Responsible for the organization of Doctoral Courses, University of Parma, 2004-
Member of the Steering group for the reform of Academic curricula, responsible for the Math-Phys-Informatics sector, leading to the present law about University Classes (1998-99).
Dean of the Faculty if Science, University of Parma, 1995–1999
Full Professor in Theoretical Physics, Univ. of Parma, 1990-
Full Professor in Theoretical Physics, Univ. of Trento, 1986–1989
Summer visitor at CERN (1986, 2003), Fermi Nat'l Accel. Lab. (1987, 1992, 1995, 2003), Brookhaven Nat'l Lab. (1989, 1995), Université de Montpellier II, LPTA (2001–2002, 2004–2006)
Associate Professor, University of Parma, 1983–1986
Fellow at CERN, Theory Division (1981–1982)
Visiting Fellow, Dept. of Physics, Princeton University (Nov.1975–Sept.1976)
Assistant Professor, University of Parma, (1970–1980)
Degree in Physics cum laude, University of Parma, Italy (1968).

2. Scientific Research

The dominant theme in E.O.'s research has been the application of modern mathematical methods (Differential Geometry, Group Theory, Topology, Functional Analysis, Numerical Analysis, Discrete Mathematics) to various branches of Theoretical Physics. For the most part his scientific production is a result of collaboration with other scientists, notably **V. Fateev, J. R. Klauder, G. Marchesini, P. Menotti, M. Pauri, G. Veneziano, M. Virasoro** and many others, among whom some of his former students, **C. Destri, F. Di Renzo, G. Burgio, R. De Pietri, L. Scorzato** and others. The following is a sketchy presentation of topics and results, with the most relevant papers. *A full list of publications is presented separately.*

2.1. **Coherent States and Geometric Quantization.** E.O. has presented in a simple way the connection between Geometrical Quantization and the existence of a Coherent States basis; his main contribution ([63]) is cited in the literature among the papers of Perelomov and Kirillov (see Klauder and Skagerstam, "Coherent States", World Sci. 1985). In a subsequent paper with J. Klauder [37] it was shown how Geometric Quantization is deeply connected to the Path Integral formulation of quantum mechanics in phase space, through a mechanism very similar to the emergence of Landau levels in two dimensional electron films in a magnetic field. The main idea behind the 1989 paper is that the whole machinery of Geometric Quantization (the construction of a line bundle over phase space) can be reduced to the standard qpproach of quantization of gauge theories when one realizes the path integral in phase space by a *Wiener regularization* as suggested by Klauder. Coherent state techniques have been applied to the problem of Berry's phase, both Abelian and non-Abelian [36, 35]. The recent paper [12] addresses the question of defining canonical operators starting from a compact phase space: the way out of the difficulty (a finite dimensional Hilbert space cannot host canonical operators) is found in a rather surprising result: the $U(1)^2$ symmetry of the torus at the classical level is broken to $Z_N \times Z_N$ by quantum effects, where N^2 is the volume of phase space in $\hbar$ units.

2.2. $1/N$ **expansion.** The interest in the "topological expansion" of Veneziano and 't Hooft brought to a series of papers where the quantum mechanical model introduced by Brezin et al was studied beyond the $U(N)$ invariant sector [57, 56]. The adjoint sector was solved in the limit of large N; the singular integral equation which was found in this study was subsequently useful in many other problems (see e.g. J.P. Rodrigues, JHEP, (2005), 0512, 043). The excited states problem in the large N limit was also studied in the collective field method introduced by Jevicki and Sakita (see [54]). A model similar to 't Hooft two dimensional QCD in the large N limit but dealing with baryons was studied in [55].

Only recently, E.O. came back to the study of the $1/N$ expansion following a paper of Veneziano and Wosiek where the large N limit was considered for supersymmetric quantum mechanics. The enumeration of independent strings of operators of the form $\mathrm{Tr}(a_1^\dagger a_2^\dagger \ldots a_n^\dagger)$ where a_i are $N \times N$ matrices with entries given by bosonic or fermionic operators, e.g. $\mathrm{Tr}(b^\dagger f^\dagger f^\dagger b^\dagger b^\dagger b^\dagger f^\dagger f^\dagger b^\dagger f^\dagger)$ was presented in [2]. The anticommutation properties of fermionic operators make the enumeration of non vanishing strings (words) a rather subtle combinatorial problem. Our solution gives an extension of Mac-Mahon and Polya formulae in a non commuting context.

An extension of the results of Veneziano and Wosiek to the whole subspace of $U(N)$ invariant states for susy quantum mechanics was recently produced [1].

2.3. **CERN 1981–82.** As fellow at CERN, EO collaborated with several people (M. Virasoro, V. Fateev, P. Menotti, G. Marchesini). His interest was attracted by Lattice Gauge Theory and by the formulation of string theory introduced by Polyakov. The main achievement was the introduction of a special variation of the lattice action for any choice of gauge group, known as the "Heat kernel action" [52]. Following a study of Polyakov string theory with Virasoro [48], EO looked for an estimate which could prove the boundedness from below of Polyakov–Liouville action. The Moser–Trudinger inequality was indeed the right tool, but the result required to find the best constant in the inequality, which was not known: the inequality with the best possible constant is now known as Moser–Trudinger–Onofri inequality in the mathematical literature (see e.g. "google scholar: Moser Trudinger"). Other papers in this period cover some new results in the calculation of multidimensional integrals [53] and a variant of Villain's action in the non–abelian case [46] where algebraic identities were introduced which were subsequently rediscovered under various names, but essentially reduce to the modified canonical commutation relations $A\,A^\dagger - q^2 A^\dagger A = 1 - q^2$.

2.4. **Computational Physics.** Starting with the years spent at Trento University, EO shifted his main interest to problems requiring heavy use of numerical analysis and symbolic calculus on the computer. His main interest has been focus on Lattice Gauge Theory. The main achievement in this field ahs been the introduction of a numerical technique to compute lattice observables in weak coupling perturbation theory, which is well known to be rather hard in the more standard diagrammatic approach. The method is now applied by many other groups and it is known as "Numerical stochastic perturbation theory". With this method, which is based on Parisi–Wu stochastic quantization, high orders in perturbation theory can be reached in the simplest cases; it was also applied to the calculation of renormalization constants, and to beta function coefficients [26]-[26].

2.5. **Conformal field theory.** Starting in 1992, a fruitful collaboration with V. A. Fateev was born, which led to a series of papers dealing with exact results in the field of integrable systems. In this activity, EO's main task consists in providing computing support (both numerical and symbolic) while, admittedly, the physical ideas stem from the experience and original ideas and conjectures of V.A.F. [25, 22, 29, 8, 7, 6]. Highlights in this collaboration are given by the study of the renormalization flow of the non–linear sigma model, boundary one-point functions and classical solutions in Toda theories.

The paper [3] contains an exact solution of the so–called Marchesini–Muller equation, which was partly conjectured on the basis of a perturbative treatment in [4]. See also [5] where algorithmic details are reported.

3. Planning and Deploying computing facilities

Prompted by requirements of computing facilities for his research, EO started to devote part of his time to the development of parallel computers at his home institution. Various achievements include 1) the acquisition of a prototype APE100 computer (1993), 2) the collaboration of his group to the development of APE1000, 3) the acquisition of a first PC cluster devoted to numerical relativity (Albert100, 2002), and 4) its upgrade to a modern fast–communication cluster with 32 AMD Opteron processors (Albert2, 2004). In the last 20 years he collaborated with INFN's IVth commission (theoretical Physics) on the problem of optimizing the computer resources in the 20+ INFN sites.

4. Teaching

EO has taught several courses, both at graduate and undergraduate level, in Parma, Trento and Milano: *Mathematical methods for physicists, Introductory theoretical Physics, Advanced Quantum Mechanics, Computational methods for Physicists, Monte Carlo techniques, Analytical Mechanics, Computational physics laboratory*. Since 1991 he acts as Director of the "Parma School of Theoretical Physics" which organizes each year a two–weeks seminar for post–graduates (see *http://www.pr.infn.it/snft*). He is co-author with C. Destri of a graduate-level book "Istituzioni di Fisica Teorica" adopted by many Italian Universities (3000 copies sold) [21]. Another book "Lezioni sulla Teoria degli Operatori Lineari" (now out of print) [42] has been adopted also at the University of Roma Tor Vergata. He wrote the article on "Schrodinger equation" for the Treccani Encyclopedia (1986). Recent contributions, freely distributed to students at the University of Parma, "Lezioni sul Momento Angolare in Meccanica Quantistica", "Metodi Probabilistici della Fisica", available on line through CampusNet (*http://www.fis.unipr.it*). In the last three years he has supervised two students for the second level degree and two students for the first degree diploma.

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