2.a. ICTP South American Institute for Fundamental Research

2.b. Projeto Tematico de Nathan Jacob Berkovits

2.c. IFT-UNESP

2.d. Equipe original:

Daniel Augusto Turolla Vanzella, Pesquisador Associado (4 horas), IFSC/USP
Danilo Rodrigues Ramos, Apoio Tecnico (40 horas), ICTP-SAIFR/UNESP
George Emanuel Avraam Matsas, Pesquisador Associado (4 horas), IFT/UNESP
Lilia Faria, Apoio Tecnico (40 horas), ICTP-SAIFR/UNESP
Nadia Rosa Roque, Apoio Administrativo (40 horas), ICTP-SAIFR/UNESP
Nathan Jacob Berkovits, Pesquisador Responsável (20 horas), IFT/UNESP
Roberto André Kraenkel Pesquisador Associado (4 horas), IFT/UNESP
Rogerio Rosenfeld, Pesquisador Principal (20 horas), IFT/UNESP

Novos membros do equipe:

Carlos Alfonso Ballon Bayona, Postdoc (CAPES), ICTP-SAIFR/UNESP
Chrisostymos Kalousios, Postdoc (FAPESP), ICTP-SAIFR/UNESP
Eduardo Ponton, Professor Visitante, ICTP-SAIFR/UNESP
Elisabete Dal Pino, Pesquisador Associado (4 horas), IAG/USP
Gastão Krein, Pesquisador Associado (4 horas), IFT/UNESP
Gustavo Burdman, Pesquisador Associado (4 horas), IF/USP
Hilda Cerdeira, Pesquisador Associado (4 horas), IFT/USP
Oscar Chacaltana, Postdoc (CAPES), ICTP-SAIFR/UNESP
Raul Abramo, Pesquisador Associado (4 horas), IF/USP
Riccardo Sturani, Jovem Pesquisador (FAPESP), ICTP-SAIFR/UNESP
Victor Rivelles, Pesquisador Associado (4 horas), IF/USP

Mudanças em 2013 no equipe do projeto temático ICTP-SAIFR:

Os novos membros do equipe incluem 3 posdoutores, 1 jovem pesquisador, 1 professor visitante, e 6 pesquisadores associados que vão organizar atividades em 2013 no ICTP-SAIFR. Estamos solicitando a inclusão de benefícios complementares para o pesquisador principal Rogério Rosenfeld que acabou de voltar para o Brasil e que é o vice-diretor do ICTP-SAIFR.

2.e. Processo 2011/11973-4

2.f. 1/12/2011 -30/11/2016

2.g Período 1/12/2011 - 30/12/2012

3. Resumo dos objetivos do projeto proposto

Fundamental research in theoretical physics has historically led to developments in all areas of science. In addition to producing technological applications coming from a better understanding of the physical laws of the universe, fundamental research in theoretical physics has led to new methods of problem-solving which has revolutionized areas of mathematics, biology, computer science, economics, and other areas of study.

Throughout the world, the importance of fundamental research has led to the creation of theoretical physics institutes which focus on research, on the training of graduate students and post-docs, and on the organization of schools and workshops. Although these theoretical physics institutes have different structures and many are connected with public universities, they are all disconnected from undergraduate physics departments and have independent hiring policies and academic responsibilities from the rest of the university. Because of this autonomy, these theoretical physics institutes are able to attract the best researchers to their faculty. And because of the prestigious faculty and the organization of schools and workshops, these institutes are able to attract highly qualified graduate students and post-docs. As a result, the academic and research programs at these autonomous theoretical physics institutes increase the international impact of their host universities.

The establishment of a viable South American institute devoted to the fundamental aspects of theoretical physics is an urgent priority. One of the main roles of the International Center for Theoretical Physics (ICTP) in Italy is to promote scientific research in developing countries, and the establishment of such a Center in South America has been promoted for several years by the ICTP leadership. In addition to promoting theoretical physics research in Brasil, this Center would also have the responsibility of promoting research in less-developed countries of South America by hosting workshops and schools and having an active visiting program for students and researchers from other South American countries. In other words, this regional Center would play the role of a mini-ICTP. In 2010, the new management of ICTP made the establishment of this South American regional Center a high priority with the direct participation of the ICTP and named it the "ICTP South American Institute for Fundamental Research".

The association of the São Paulo State University (UNESP) with the International Center for Theoretical Physics (ICTP) to establish the ICTP South American Institute for Fundamental Research in São Paulo with funding from FAPESP has grown from the desire of UNESP to increase its international visibility and the ICTP desire to employ its expertise in the organization and running of this new South American regional Center for theoretical physics.

The long-term goal for this new institute is to become a South American center of excellence in theoretical physics which will be comparable to theoretical physics institutes in the rest of the world and at the same level as the highly prestigious mathematics institute Instituto Nacional de Matemática Pura e Aplicada (IMPA)

in Rio de Janeiro. Through an active visiting program involving schools and workshops, this center of excellence will elevate the level of theoretical physics research in all of South America. With the assistance of the three institutions of the ICTP, UNESP and FAPESP, the Steering Committee and Scientiific Council and director will accomplish this mission through the following steps:

· Hiring five new permanent researchers with a reduced teaching load who will assist in the organization of schools and workshops;
· Hiring a trained secretarial staff which will handle all non-scientific aspects;
· Supporting an active visiting program for South American students and researchers;
· Offering prestigious postdoctoral positions to highly qualified researchers;
· Organizing schools and workshops on focused topics thoughout the year for South American students and researchers.

4. Realizações no período:

The activities of ICTP-SAIFR in 2012 will be described below including (a) research related to publications, (b) research related to visitors, and (c) organization of schools, workshops, minicourses, outreach activities, meetings and seminars.

a. Research related to publications

The research conducted at ICTP-SAIFR include diverse areas of theoretical physics, as indicated by the publications in list 8 which include the subjects of string theory, general relativity, mathematical biology, particle physics, and statistical mechanics. These publications involved research performed by associated researchers of ICTP-SAIFR and by visitors to ICTP-SAIFR through the visiting program.

In the subject of string theory, publication 1 describes the use of twistors to explain covariant quantization in the pure spinor formalism. Starting with a classical action whose matter variables are a d=10 spacetime vector and a pure spinor, the pure spinor formalism for the superstring is obtained by gauge-fixing the twistor-like constraint. The fermionic variables are Faddeev-Popov ghosts coming from this gauge-fixing and replace the usual (b,c) ghosts coming from gauge-fixing the Virasoro constraint. After twisting the ghost-number such that theta has ghost-number zero and lambda has ghost-number one, the BRST cohomology describes the usual spacetime supersymmetric states of the superstring.

And publication 2 describes a new approach to string field theory in which the fields and antifields form a constrained quantum-mechanical system. In the conventional BV description of string field theory, the string field Phi is split as Phi = Psi+Psi* where Psi includes all states with ghost number less than or equal to G and describes the spacetime fields, and Psi* includes all states with ghost number >G and describes the spacetime antifields. A new approach is proposed

here in which separate string fields Psi and Psi* of unrestricted ghost number describe the spacetime fields and antifields. The string antifield Psi* is constrained to satisfy Psi* = dL/d(Q Psi) where L is the BV Lagrangian and Q is the worldsheet BRST operator. Dirac antibrackets are defined using this constraint, and the resulting description is equivalent to the conventional BV description for open and closed bosonic string field theory. For open superstring field theory, this constrained BV description is much simpler than the conventional BV description and allows the BV action to be expressed in the same WZW-like form as the classical action.

In the subject of general relativity, publication 3 describes instabilities from quantum effects in relativistic stars. Dense enough compact objects were recently shown to lead to an exponentially fast increase of the vacuum energy density for some free scalar fields properly coupled to the spacetime curvature as a consequence of a tachyonic-like instability. Once the effect is triggered, the star energy density would be overwhelmed by the vacuum energy density in a few milliseconds. This demands that eventually geometry and field evolve to a new configuration to bring the vacuum back to a stationary regime. Here, it is shown that the vacuum fluctuations built up during the unstable epoch lead to particle creation in the final stationary state when the tachyonic instability ceases. The amount of created particles depends mostly on the duration of the unstable epoch and final stationary configuration, which are open issues at this point. It is emphasized that the particle creation coming from the tachyonic instability will occur even in the adiabatic limit, where the spacetime geometry changes arbitrarily slowly, and therefore is quite distinct from the usual particle creation due to the change in the background geometry.

And publication 4 describes the use of integrable methods and symmetries to study the Dirac equation in curved backgrounds. The Eisenhart-Duval lift allows embedding non-relativistic theories into a Lorentzian geometrical setting. In this paper the lift is studied from the point of view of the Dirac equation and its hidden symmetries. It is shown that dimensional reduction of the Dirac equation for the Eisenhart-Duval metric in general gives rise to the non-relativistic Levy-Leblond equation in lower dimension. It is studied in detail in which specific cases the lower dimensional limit is given by the Dirac equation, with scalar and vector flux, and the relation between lift, reduction and the hidden symmetries of the Dirac equation. While there is a precise correspondence in the case of the lower dimensional massive Dirac equation with no flux, it is found that for generic fluxes it is not possible to lift or reduce all solutions and hidden symmetries. As a by-product of this analysis new Lorentzian metrics are constructed with special tensors by lifting Killing-Yano and Closed Conformal Killing-Yano tensors and the general Conformal Killing-Yano tensor of the Eisenhart-Duval lift metrics are described in terms of lower dimensional forms. Lastly, it is shown how dimensionally reducing the higher dimensional operators of the massless Dirac equation that are associated to shared hidden symmetries it is possible to recover hidden symmetry operators for the Dirac equation with flux.

In the subject of mathematical biology, publications 5-10 describe the dynamics

of ecological systems with predators and prey using various mathematical models. For example, publication 8 discusses a common situation observed in fragmented habitats is that species densities diminish within smaller fragments. Some species, however, do show an opposite tendency. It is argued that release of competition between a strong competitor and a weak one is a plausible explanation for these different sensitivities to area reduction. A quantitative model is provided for competitive release caused by habitat limitation, solely based on the balance of diffusion and growth of the species. It is shown that in small habitat patches the stronger competitor has its density diminished, as opposite to the weaker competitor who, in a certain area range, has its density increased. Field data are examined from an ecological experiment in Amazonia (BDFFP) which measured densities of two Amazonian rodents who showed opposite sensitivity to area reduction and we argue that our model explains the observations accurately. This implies that (i) area reduction is a strong factor determining densities of species in patches of habitat, regardless of considerations on degradation or edge effects and (ii) that species interactions have to be taken into account to explain sensitivity to size of the patches in ecological communities. Alternative explanations are also discussed, such as predator release and effects due to imperfect isolation. Moreover, it is stressed the conceptual and mathematical simplicity of the model, which, nevertheless explains a phenomenon not yet well understood.

Publication 9 involves a collaboration formed during the ICTP-SAIFR Summer-School on Mathematical Biology. It is a tenet of ecological theory that two competing consumers cannot stably coexist on a single limiting resource in a homogeneous environment. Many mechanisms and processes have since been evoked and studied, empirically and theoretically, to explain species coexistence and the observed biological diversity. Facilitative interactions clearly have the potential to enhance coexistence. Yet, even though mutual facilitation between species of the same guild is widely documented empirically, the subject has received very little theoretical attention. Here, one form of intraguild mutualism is studied in the simplest possibly community module of one resource and two consumers. Mutualism is incorporated as enhanced consumption in the presence of the other consumers. It is found that intraguild mutualism can (a) significantly enhance coexistence of consumers, (b) induce cyclic dynamics, and (c) give rise to a bi-stability (a 'joint' Allee effect) and potentially catastrophic collapse of both consumer species.

In the subject of particle physics, publication 11 describes restrictions on models involving exotic scalars and the Higgs boson using recent data from the LHC. The radion, a scalar particle associated with the radius of a compact warped extra dimension, may be the lightest new particle in this class of models. Its couplings to SM particles are proportional to the their masses, similar to the usual Higgs boson, but suppressed by a scale Lambda_r, the radion vacuum expectation value. The main differences are the coupling to massless gauge bosons that receives contribution from the trace anomaly of the energy-momentum tensor due to the the nonvanishing beta functions and the mixing with the Higgs boson arising from a nonminimal coupling to gravity parametrized by a dimensionless coefficient xi. In particular, these differences

can result in significant modifications of the radion phenomenology. Current LHC data on Higgs searches is used to find exclusion regions on the parameters of a radion model, Lambda_r, xi and the radion mass m_r. It is found that, even for low values of Lambda_r, the radion can still have a mass in the region where the Standard Model Higgs has been excluded, for a narrow range of values for the mixing parameter. Some signals at the LHC for this scenario are discussed. It is also found that it is possible to hide the Higgs boson in the current searches in this model, due to a suppression of its couplings.

In the subject of statistical mechanics, publication 12 describes noncommutative fluids which may play a role in the quantum Hall effect. In this paper, it is constructed for the first time the non-commutative fluid with the deformed Poincare invariance. To this end, the realization formalism of the noncommutative spaces is employed and the results are particularized to the Snyder space. The non-commutative fluid generalizes the fluid model in the action functional formulation to the noncommutative space. The fluid equations of motion and the conserved energy-momentum tensor are obtained.

b. Research related to visitors

During 2012, the ICTP-SAIFR hosted 66 short-term visitors who stayed less than two weeks and 16 long-term visitors who stayed more than two weeks. The complete list of short-term and long-term visitors to ICTP-SAIFR can be found on the webpage http://www.ictp-saifr.org/?page_id=1819 and is

Long-Term

Visitor	Home Institution	Period of Visit	Room Number	Telephone
Riccardo Sturani	University of Urbino, Italy	Nov. 28 – Dec. 24	105	3393-7850
Rafael Porto	IAS, Princeton	Nov. 25 – Dec. 8	111	3393-7842
Alireza Tavanfar	CERN	Oct. 20 – Nov. 27	105	3393-7850
Carlos Alfonso Ballon Bayona	Durham University	Oct. 1 – Dec. 15	107	3393-7887
Carlos Cardona	Univ. de Buenos Aires	Sept. 1 – Oct. 15	106	3393-7834
Derek Frydel	Univ. Fed. Rio Grande do Sul	Sept. 1 – Sept. 14	105	3393-7850
Boris Malomed	Tel Aviv University	July 21 – August 24	111	3393-7842
Antonio Enea Romano	Universidad de Antioquia	June 24- August 22	106	3393-7834

Ion Vasile Vancea	U.F. Rural do Rio de Janeiro	June 5- June 20	112	3393-7846
Hiroshi de Sandes Kimura	IPhT- CEA-Saclay	June 5- December 31	112	3393-7846
Eduardo Ponton	Columbia University	May 13- May 29	112	3393-7846
Marco Cariglia	Univ. Fed. de Ouro Preto	Jan. 28 – Feb. 26	105	3393-7850
Oscar Chacaltana	Univ. of Texas	Jan. 12 – Feb. 29	107	3393-7887
Dionisio Bazeia	Univ. Fed. de Joao Pessoa	Jan. 3 – Jan. 20	111	3393-7842
Niclas Wyllard	Univ. of Gotenborg	Jan. 2 – Feb. 25	112	3393-7846

Short-Term

Visitor	Home Institution	Period of Visit
Francis Halzen	University of Wisconsin at Madison	December 19
Keith Olive	University of Minnesota	December 18
Benjamin Grinstein	University of California at San Diego	December 13
Jeronimo Peralta	Univ. of Buenos Aires	December 6-19
Per Sundin	University of Cape Town	November 19-23
Gregory Korchemsky	IPT, Saclay	November 10-17
Romuald Janik	Jagellonian Univ., Krakow	November 5-14
Jason Harris	Wolfram Research, Illinois	November 4-14
Nikolay Gromov	King's College, London	November 4-11
Konstantin Zarembo	Nordita, Stockholm	November 4-11
Pedro Vieira	Perimeter, Waterloo	November 4-17
Boris Kayser	Fermilab	October 18-23
Reimundo Heluani	IMPA	October 1-2
Joseph Minahan	Uppsala University and MIT	September 1-5
Pavel Wiegmann	University of Chicago	August 29
Norihiro Iizuka	CERN	July 26-August 5
John Friedman	Univ. of Wisconsin at Milwaukee	July 19-27
Marcelo Gleiser	Dartmouth College	July 18
Robert Caldwell	Dartmouth College	July 15-29
Raul Abramo	Univ. de São Paulo	July 15-21
Jolien Creighton	Univ. of Wisconsin at Milwaukee	July 15-21

Alessandro Melchiorri	Univ. of Roma, La Sapienza	July 1-6
Pavel Fileviez Perez	New York University	June 24-30
Gero Gersdorff	Ecole Polytechnique, Palaiseau	June 9-16
Patricia Tissera	Univ. de Buenos Aires	May 28-June 1
Matthew Johnson	Perimeter Institute, Waterloo	May 28-June 1
Ben Bakker	Vrije Universiteit, Amsterdam	May 19-25
Peter Ouyang	Purdue University	May 8-20
Rob Myers	Perimeter Institute, Waterloo	May 8-10
Gerardo Aldazabal	CNEA, Bariloche	May 7-10
Max Bañados	Univ. Católica de Chile, Santiago	May 7-10
Claudio Bunster	CECS, Valdivia	May 7-9
Anamaria Font	Univ. Central de Venezuela, Caracas	May 7-10
Carlos Mafra	Cambridge Univ., UK	May 7-9
Viatcheslav Mukhanov	LMU, Munich	May 7-9
Carmen Núñez	IAFE, Buenos Aires	May 7-9
Ashoke Sen	Harish-Chandra Research Institute, Allahabad	May 7-9
Jorge Zanelli	CECS, Valdivia	May 7-11
David Wilson	Argonne National Laboratory, USA	May 6-8
Craig D. Roberts	Argonne National Laboratory, USA	May 6-8
Wolfgang Bietenholz	UNAM, Mexico	May 6-8
Peter Tandy	Kent State Univ., USA	May 6-8
Ian Cloët	Univ. Adelaide, Australia	May 6-8
Ubirajara van Kolck	Univ. of Arizona	May 6-8
Anthony W. Thomas	Univ. Adelaide, Australia	May 6-8
Amit Sever	Institute for Advanced Study, Princeton	May 6-11
Riccardo Sturani	University of Urbino, Italy	May 1-9
Emil Akhmedov	ITEP, Moscow	April 22-25
Lincoln Carr	Colorado School of Mines	Mar. 8
Ion Vasile Vancea	Univ. Fed. Rural do Rio de Janeiro	Feb. 27 – Mar. 9
Yuri Aisaka	DESY Hamburg	Feb. 7 – Feb. 11

Brenno Carlini Vallilo	Universidad Andres Bello, Santiago Chile	Feb. 7 – Feb. 18
Luiz Davidovich	UFRJ	Feb. 7 – Feb. 8
Daniel Sudarsky	UNAM	Feb. 6 – Feb. 8
Barton Zwiebach	MIT	Feb. 6 – Feb. 8
Marcela Carena	Fermilab	Feb. 6 – Feb. 8
Arnulfo Zepeda	Univ. Chiapas, Mexico	Feb. 5 – Feb. 9
Juan Maldacena	IAS Princeton	Feb. 5 – Feb. 7
Fernando Quevedo	ICTP	Feb. 5 – Feb. 10
Matias Zaldarriaga	IAS	Feb. 5 – Feb. 8
Marcel Clerc	Univ. de Chile	Feb. 5 – Feb. 9
Peter Goddard	IAS Princeton	Feb. 5 – Feb. 8
Seifallah Randjbar-Daemi	ICTP	Feb. 4 – Feb. 10
Frithjof Lutscher	Univ. of Ottawa	Jan. 23- Jan. 28
Vittoria Colizza	Univ. Pierre et Marie Curie, Paris	Jan. 23- Jan. 28
Priyanga Amarasekare	Univ. of California at Los Angeles	Jan. 22- Jan. 27

The research of some of these visitors is described below:

Niclas Wyllard (mathematical physics) 2/1 – 25/2:
During my visit to ICTP-SAIFR I continued my studies of the relations of "AGT-type" between 4d N=2 supersymmetric gauge theories and 2d conformal field theories. In particular, I focused on cases where surface operators are present in the gauge theory. The paper(s) containing the results will appear within the next few months.

Marco Cariglia (general relativity) 28/1-26/2:
1)I discussed with prof. George Matsas possible applications of the theory of hidden symmetries to a) effective general relativistic metrics like those of sonic/dumb holes, b) non gravitational systems and the description of their hidden symmetries in terms of invariance of the Hamiltonian function in phase space 2) I started putting the basis of a possible, not yet confirmed review work on hidden symmetries to be published on a review journal in collaboration 3) I have performed research on the relation between hidden symmetries and the Eisenhart lift procedure, which is a process of geometrisation of interactions in the style of Kaluza-Klein but that actually describes a wave propagating in spacetime 4) I have started performing research on the Unruh effect that might be applied to quantum information theory 5) I have kept working on an existing project related to the spinning particle motion in Kerr-NUT-(A)dS spacetimes

Oscar Chacaltana (mathematical physics) 12/1 – 29/2:

In collaboration with Jacques Distler and Yuji Tachikawa, I studied the general problem of understanding the local properties of punctures in Gaiotto duality. This duality is concerned with the compactification of 6D N=(2,0) theories on a Riemann surface; the 6D theories may incorporate codimension-2 defects, that in the compactification wrap flat 4D spacetime and look as punctures on the Riemann surface. The 6D theories obey an A-D-E classification. Accordingly, there is a classification of possible defects, or punctures, for every choice of 6D theory. Also, one may incorporate twist lines on the cycles of the Riemann surface, which amount to twists by outer automorphisms of the corresponding A-D-E Dynkin diagram. These lead to a additional sectors of punctures. We were successful in finding algorithms to compute tables of properties of punctures for any choice of A-D-E 6D theory and twist lines. We are currently studying the global properties of the 4D theories that arise from the inclusion of these general punctures and twist lines.

Íon Vancea (statistical mechanics) 27/2-9/3 and 5/6-20/6:
During my visit at ICTP-SAIFR, I worked on the generalization of the relativistic ideal fluid to noncommutative spaces with deformed Poincaré symmetry, in particular to the Snyder space, by using field theory methods. My collaborators in this project are: Maria Cristina Batoni Abdalla Ribeiro (IFT), Luiz Holender (UFRRJ) and Marco Antonio dos Santos (UFES). During my stay, I had daily meetings with M. C. B. A. Ribeiro in which we tried to understand how the deformed Poincaré structure is represented in terms of fluid degrees of freedom. In our meetings we have developed our noncommutative fluid model and obtained the equations that govern its dynamics. In particular, we succeded to prove the conservation of the energy-momentum tensor. In a previous visit, earlier this year, we understood the formalism of the realizations of the deformed Poincaré group which we have used extensively in our work. Also, I have worked on the properties of the strings near the singularity of space-time, more specifically on determining its correlation functions and the Boltzmann equation. However, this study has not been concluded yet.

Boris Malomed (Bose-Einstein condensation) 21/7-24/8:
My work during the visit was focused on the collaboration with two scientists from Sao Paulo: Prof. Sadhan Adhikari at IFT, and Prof. Arnaldo Gammal at USP. The main project on which we have been working with S. Adhikari is dealing with solitons and solitary vortices in the model of a dipolar atomic Bose-Einstein condensate (BEC), assuming that the trapping in the transverse plane (perpendicular to the direction of the dipoles) is provided by the strength of the local repulsive contact interaction growing from the center to periphery, while the longitudinal trapping is provided by a usual harmonic-oscillator potential. The trapping provided by the growing local self-repulsion was recently introduced in my works with colleagues from ICFO (Barcelona), but it was not applied to dipolar condensates. This project involves a student from India currently visiting ITF, Kishor Ramavarmaraja. Drafting and submitting a paper reporting the results is planned. The work with A. Gammal is focused on a project which is relevant to nonlinear optics, namely, the creation of two-dimensional solitary vortices in media featuring the three-wave interaction supported by the quadratic nonlinearity. Our objective is to build objects with

the "hidden vorticity", namely, topological charges +1 and -1 in two components of the fundamental-frequency component, and zero charge in the second-harmonic wave, so that the total vorticity is zero. Such states were studied before, but were found to be always unstable. Our intention is to stabilize the vortex by means of an external harmonic-oscillator trapping potential. The project involves Dr. Marijana Brtka from the ABC Federal University. A publication of a paper reporting the results of the project is planned. In addition, a project was started aimed at searching for solitons in the model of the dipolar BEC with a periodically modulated local orientation of the dipoles.

Antonio Romano (cosmology) 24/6-22/8:
During the visit at ICTP SAIFR I have established a collaboration on the use of LTB solutions to study not linear structure formation in presence of pressure. The set of necessary differential equations have been derived and are now being solved numerically assuming different initial density profiles. During the cosmology school I have also discussed some other research projects with the lecturers, involving the fitting of cosmological data with LTB solutions with and without cosmological constant. These research projects are now under more concrete preparation and implementation. During my visit I have also finished some previously started research on the effects of inhomogeneities on the comic acceleration, and corrections to the cosmological constant due to large scale structure.

Carlos Cardona (string theory) 1/9-15/10:
During the month and a half that I spent at the institute I was mainly working in two projects. On one hand, I have been interested in the computation of correlation functions of large spin operators in N=4 SYM. Some progress was done during my stay in ICTP-SAIFR concerning to the two- and three- point functions. I expect to be able to release some preliminar results on this work in a couple of months. On the other hand, I have been working in the computation of correlation functions of string vertex operators in Warped-AdS3 in order to apply this results to non-local dipole theories, but the work is still in a early stage..

Derek Frydel (statistical mechanics) 1/9-14/9:
During my visit I have been reviewing the literature on the field-theoretical methods with view to apply these methods to electrostatics of soft matter systems. Since the people in the institute are mathematically oriented and since my field of research is very different, I felt that this would keep me connected with others. I have given a talk where I have presented some of my ideas how the field-theoretical methods could be implemented to treat electrostatics. The comments I have received I found very helpful.

Riccardo Sturani (gravitational waves) 1/5-9/5 and 28/11-24/12:
My research is about the effective field description of General Relativity in gravitationally bound, two body systems. The phenomenological impact of these systems is related to existing gravitational wave observatories and during my visit at ICTP I could exchange ideas and discuss with other researchers involved in the field as well as researcher from other fields. This has allowed me to

understand and push further my research about non-local terms that describe the interaction of gravitational waves with matters.

Carlos Alfonso Ballon Bayona (AdS-CFT applications) 1/10-15/12:
I have been working on three projects during my visit at ICTP-SAIFR. The first one is on a final stage and deals with the DBI equations in holographic backgrounds with applications in condensed matter. The second project is on a initial stage and deals with a holographic description of magnetic field effects in hadron physics, particularly the deconfinement transition. The third project is also on a initial stage and deals with meson loop effects in the electromagnetic scattering of baryons. My visit at the ICTP-SAIFR has been very important to the development of these projects. I had several meetings in Sao Paulo and Rio de Janeiro with collaborators that are involved in these projects. In particular, I have been visiting professors in University of Sao Paulo (USP) and Rio de Janeiro Federal University (UFRJ) that are participating actively on the second and third project described above. I have also given seminars at ICTP-SAIFR, USP, UFRJ and UNICAMP. Finally, I have met some researchers at ICTP-SAIFR that are interested in collaborating with me in future projects.

c. Organization of activities

During the year of 2012, the ICTP-SAIFR organized three São Paulo International Schools for Theoretical Physics, three workshops, three minicourses, two outreach events, the annual meeting of the steering committee and scientific council, and weekly seminars and colloquia. The complete list of 2012 activities is on the webpage http://www.ictp-saifr.org/?page_id=1098 , and the list of weekly seminars and colloquia is on the webpage http://www.ictp-saifr.org/?page_id=1814 . Many of the activities were filmed using equipment donated by the ICTP in Trieste and the vídeos are available online on the associated webpages.

c.1. São Paulo International Schools

The three São Paulo International Schools each lasted two weeks and were on the subjects of Mathematical Biology (January 16-29), Relativistic Astrophysics and Cosmology (July 16-27), and Symbolic Computation (November 5-16). The schools were for mostly masters and PhD students, and those students not from São Paulo where housed in a "pousada" in shared rooms. The students were asked to anonymously evaluate the schools, and the links to view their evaluations are http://www.ictp-saifr.org/sis/viewAvaliacao.php , http://www.ictp-saifr.org/sis/viewAvaliacaoGR.php and http://www.ictp-saifr.org/sis/viewAvaliacaoGR.php . All lectures of the schools except the first one were filmed and the videos are available online on the school webapge.

The International School on Mathematical Biology is described on the webpage http://www.ictp-saifr.org/?page_id=1073 and involved 4 lecturers and 63 students from the countries of Brasil, Argentina, Colômbia, Equador, Paraguai, Uruguai, Venezuela, Canada, USA, England and Portugal. This school is aimed at graduate students in Physics, Mathematics, Ecology an Epidemiology, having at

least a basic knowledge of calculus and differential equations. The first week was a basic course on population biology, which also includes modelling exercises. The second week was an advanced school on up-to-date topics in ecology and epidemiology.

During the first week, mornings were devoted to lectures and afternoons were devoted to group projects. During the second week, mornings and afternoons were devoted to lectures, seminars, and discussion sessions. The seminars were

- Renata Pardini: Diversity in Fragmented Landscapes
- Claudia Codeço: Population dynamics of *Aedes aegypti*,vector of Dengue Fever
- Thomas Lewinsohn: Spandrels, hubris and the baroque of nature

The subjects of the lectures were
R. Kraenkel – IFT- UNESP (São Paulo) - **Introduction to Population Biology**
P. Amarasekare – Univ. of California (Los Angeles) - **Population and Community Dynamics**
V. Colizza - Univ. Pierre et Marie Curie (Paris), ISI Foundation (Turin) - **Epidemics on Networks**
F. Lutscher – Univ. of Ottawa (Canada) - **Mathematical Models of Spatial Ecology**
The student evaluations of this school are on the webpage http://www.ictp-saifr.org/sis/viewAvaliacao.php

The International School on Relativistic Astrophysics and Cosmology is described on the webpage http://www.ictp-saifr.org/?page id=1076 and involved 4 lecturers and 67 students from the countries of Brasil, USA, Argentina, Chile, Colombia, Cuba, Mexico, India, and Venezuela. Modern technology is improving our observations of neutron stars, pulsars, black holes, and other compact objects, which only can be understood in the context of general relativity. Moreover, the direct observation of gravitational waves, expected in the next years, should dramatically increase our comprehension of various astrophysical phenomena. At the same time, only a deep understanding of general relativity will enable physicists to grasp the very meaning of precise measurements of some cosmological observations. The aim of the School was to discuss some of the most important modern topics of astrophysics and cosmology in the context of general relativity. Students were expected to have had some previous contact with general relativity.

Each morning and each afternoon consisted of a 90 minute lecture and a 60 minute discussion/exercise session. There were also 2 seminars during the school by
D. Sudarsky (The inflationary origin of the seeds of cosmic structure: quantum theory and the need for novel physics) and
M. Gleiser (Oscillons: Theory and Applications in Symmetry Breaking and Cosmology).

The subjects of the lectures were
J. Creighton – University of Wisconsin at Milwaukee – **Relativistic Astrophysics I**
R. Abramo – Universidade de São Paulo – **Modern Cosmology I**

J. Friedman - University of Wisconsin at Milwaukee - **Relativistic Astrophysics II**
R. Caldwell - Dartmouth College - **Modern Cosmology II**
The student evaluations of this school are on the webpage http://www.ictp-saifr.org/sis/viewAvaliacaoGR.php

The International School on Symbolic Computation is described on the webpage http://www.ictp-saifr.org/?page_id=1076 and involved 6 lecturers and 89 students from the countries of Brasil (42), USA (7), Africa do Sul (7), Argentina (5), Russia (4), Chile (4), Canada (4), England (3), Denmark (2), Sweden (1), France (1), Germany (1), Poland (1), Spain (1), Japan (1), Lituania (1), Colombia (1), Venezuela (1), India (1) e China (1). The goal of the school was to bring together theoretical physicists of all levels who want to learn both symbolic computational methods and a selected advanced research topic in theoretical physics. The topic for this year's edition was the Spectrum and Correlation Functions of Supersymmetric Yang-Mills theory and Integrability. The symbolic computational methods were mostly based on the use of Mathematica and focused on examples in this physics topic.

Each morning consisted of 3 lectures and each afternoon consisted of exercise sessions involving applications of symbolic computation to theoretical physics.
The subjects of the lectures were
K. Zarembo – Nordita Institute (Stockholm) – **Introduction to Integrability and super-Yang-Mills**
R. Janik — Jagellonian Univ. (Krakow) — **Integrability and AdS-CFT**
N. Gromov – King's College (London) –
Symbolic Computations in super-Yang-Mills and Integrability I
G. Korchemsky – Inst. de Phys. Theorique (Saclay) – **Correlation Functions in super-Yang-Mills**
P. Vieira — Perimeter Institute (Waterloo) –
Symbolic Computations in super-Yang-Mills and Integrability II
J. Harris – Wolfram Research (Illinois) – **Mathematica**
The student evaluations of this school are on the webpage
http://www.ictp-saifr.org/sis/viewAvaliacaoGR.php

c.2. Workshops

The ICTP-SAIFR organized three workshops in 2012 on the topics of gravity and string theory, non-perturbative QCD, and particle physics.

The workshop on gravity and string theory was a two-day workshop which preceded a school in Natal on the same topic. The webpage of the workshop is http://www.ictp-saifr.org/?page_id=2024 . The program consisted of seminars presented by the following invited speakers:
Gerardo Aldazabal (CNEA, Bariloche) – "U-fluxes, sugra gaugings and moduli fixing"
Max Bañados (Univ. Católica de Chile, Santiago) –

"The action for higher spin black holes in three dimensions"
Claudio Bunster (CECS, Valdivia) – "Comments on electric-magnetic duality"
Anamaria Font (Univ. Central de Venezuela, Caracas) – "Yukawa couplings in 7-brane-models"
Carlos Mafra (Cambridge Univ., UK) – "Tree and one-loop n-point superstring amplitudes in pure spinor superspace"
Viatcheslav Mukhanov (LMU, Munich) – "Asymptotic freedom, confinement and triviality in classical lambda phi^4 theory"
Rob Myers (Perimeter Institute, Waterloo) – "Holographic entanglement entropy"
Carmen Núñez (IAFE, Buenos Aires) – "Effective action of double field theory"
Ashoke Sen (Harish-Chandra Research Institute, Allahabad) – "What can black holes tell us about microstates?"
Amit Sever (Perimeter Institute, Waterloo) – "The quark anti-quark potential and the cusp anomalous dimension"
Riccardo Sturani (Univ. Urbino, Italy) – "Fundamental gravity with gravitational waves"
Jorge Zanelli (CECS, Valdivia) – "Local SUSY without gravitini"

The workshop on non-perturbative QCD was a two-day workshop immediately following a conference in Caraguatatuba on the same topic. The program consisted of seminars presented by the following invited speakers:
1) Anthony W. Thomas, Adelaide (Australia)
2) Jorge Noronha, Univ. of São Paulo (São Paulo)
3) Marcio Woitek Jr., IFT (São Paulo)
4) Ubirajara van Kolck, Paris Sud (France) & Univ. Arizona (USA)
5) Ian Cloët, Univ. Adelaide (Australia)
6) Peter Tandy, Kent State (USA)
7) Bruno El-Bennich, Univ. Cruzeiro do Sul (São Paulo)
8) Wolfgang Bietenholz, UNAM (Mexico)
9) Sergio Novaes, IFT (São Paulo)
10) Sandra Padula, IFT (São Paulo)
11) Craig D. Roberts, Argonne (USA)
12) Ricardo Matheus, IFT (São Paulo)
13) Fernanda M. Steffens, IFT (São Paulo)
14) David Wilson, Argonne (USA)

The workshop on particle physics was a five-day workshop held every two years in a different country of Latin America. This was the 9th version of the workshop called SILAFAE: IX Simpósio Latino Americano de Física de Altas Energias . It was held in the nearby Memorial de America Latina because of the requirement of a large auditorium. The webpage is http://www.ictp-saifr.org/?page_id=1080
The program included several short seminars and 45 minute invited plenary talks by
K. Akiba – LHCb Results
E. Aprile – Dark Matter Experiments
J. Bartels – Non-perturbative QCD
E. de la Cruz Burelo – Tevatron Milestones
A. Djouadi – Higgs Physics

G. Gelmini – Dark Matter Theory
B. Grinstein – Flavor and CP Violation
T. Lasserre – Neutrino Experiments
R. Shellard- Auger Project Results
E. Pontón – Beyond the Standard Model
G. Salam – Perturbative QCD
J. Takahashi – LHC Heavy Ion Results
J. Valle – Neutrino Theory
ATLAS: F. Monticelli – Higgs results
CMS- X. Janssen – Higgs results
ATLAS/CMS- F. Yumiceva – Exotica results
ATLAS/CMS: C. Escobar – Heavy flavor results
ATLAS/CMS- L. Sulak – QCD results
ATLAS/CMS: M. Dova – SUSY results

c.3. Minicourses

In 2012, the ICTP-SAIFR organized three minicourses on the subjects of integrability, particle physics, and gravitational waves.

The minicourse on integrability consisted of 3 lectures by Joseph Minahan (Uppsala and MIT) with the title "Integrability in N=4 super_Yang-Mills" and is on the webpage http://www.ictp-saifr.org/?page_id=2707

The minicourse on particle physics consisted of 2 lectures by Boris Keyser (Fermilab) with the title "Major Questions and Issues in Particle Physics" and is on the webpage http://www.ictp-saifr.org/?page_id=2912

The minicourse on gravitational waves consisted of 6 lectures by Rafael Porto (IAS Princeton) with the title "**The effective field theory (EFT) approach to gravitational dynamics: from black holes to cosmology**" and is on the webpage http://www.ictp-saifr.org/?page_id=2925

c.4. Outreach events

The ICTP-SAIFR organized two outreach events in 2012. The first was a public lecture presented in Spanish by Matias Zaldariaga (IAS Princeton) with the title "Explorando los Orígenes del Universo" (Exploring the Origins of the Universe). The webpage is http://www.ictp-saifr.org/?page_id=1947

The second outreach event was a competition for undergraduate physics students in which winners were determined by a 3-hour exam. The title of the competition is Premio IFT-ICTP para Jovens Físicos and the webpage with the names of the 5 winners is http://www.ictp-saifr.org/?page_id=2711

c.5. Annual meeting of ICTP-SAIFR councils

The annual meeting of the ICTP-SAIFR Steering Committee and Scientific Council included closed meetings of the two councils, an opening ceremony, and a discussion session with invited seminars by

- Luis Raul Abramo (Instituto de Fisica, USP)
- Amir Caldeira (Departamento de Fisica, Unicamp)
- Carlos Brito Cruz (Scientific Director of FAPESP)
- Celso Pinto de Melo (President of Brazilian Physics Society)

The webpages of these events are http://www.ictp-saifr.org/?page_id=1896 and http://www.ictp-saifr.org/?page_id=1900

All members of the Steering Committee and Scientific Council were present except for Anthony Zee because of health reasons. The names of the members of these councils are

Members of the Steering Committee:

Fernando Quevedo (chair)
ICTP director
Julio Cezar Durigan
UNESP rector
Carlos Brito Cruz
FAPESP scientific director
Jacob Palis
Brazilian Academy of Science president
Juan Maldacena
Representing South America

Members of the Scientific Council:

Peter Goddard (chair)
IAS Princeton
Seifallah Randjbar-Daemi
ICTP vice-director
Juan Montero
IFT-UNESP director
Marcela Carena
Fermilab, Batavia
Marcel Clerc
Univ. de Chile, Santiago
Luiz Davidovich
UFRJ, Rio de Janeiro
Daniel Sudarsky
UNAM, Mexico City
Matias Zaldarriaga
IAS, Princeton
Anthony Zee
Univ. of California, Santa Barbara

Barton Zwiebach
MIT, Cambridge

c.6. Weekly seminars and colloquia

During 2012, weekly seminars and colloquia were regularly organized on Monday and Wednesday afternoons. There were 101 seminars and colloquia in 2012 and the complete list is on the webpage http://www.ictp-saifr.org/?page_id=1814

5. Descrição e avaliação do apoio institucional recebido no período

The ICTP-SAIFR received generous support from both the Instituto de Física Teórica (IFT) and from the Universidade Estadual Paulista (UNESP).

From the IFT, the ICTP-SAIFR obtained space on the first floor for both its visitor offices and a large discussion room. Using the institutional reserva técnica, the IFT financed reform of the library which opened space for ICTP-SAIFR, purchased several desktop computers for ICTP-SAIFR offices, and is planning to install air-conditioning for all ICTP-SAIFR offices. The IFT auditorium has also been reformed and is available whenever necessary for ICTP-SAIFR activities. Both the professors and secretarial staff of the IFT have been extremely supportive of all ICTP-SAIFR activities.

From UNESP, the university is paying for three ICTP-SAIFR secretaries including our executive secretary, our accountant, and our computer systems manager. Based on the accomplishments of this staff in 2012, UNESP agreed to give them a salary raise beginning in 2013. UNESP has also agreed to hire 5 permanent ICTP-SAIFR researchers within five years and the first such permanent researcher is expected to be hired in 2013.

6. Plano de atividades para o próximo período

In 2013, the ICTP-SAIFR plans to hire its first of five permanent researchers, hire a Young Investigator and several FAPESP postdoctoral feillows, expand its program of visitors, and organize several schools, workshops, minicourses, and seminars.

The first hiring of a permanent researcher is expected to be in the area of Particle Physics and the LHC, and there will be several visitors in 2013 in this field of research. There will also be an increased emphasis on general relativity and cosmology. Riccardo Sturani will be joining the ICTP-SAIFR in February 2013 as a Young Investigator in the area of gravitational waves. And Alessandro Melchiorri from the Univ. of Rome is planning to visit the ICTP-SAIFR beginning in September 2013 as a visiting professor performing research related to the Cosmic Microwave Background. Finally, the research area of complex nonlinear systems will be emphasized, and there are several workshops in the planning stages in this field including a visit of Leo Kadanoff (Chicago) in March 2013.

In 2013, there will be an increased number of collaborations between ICTP-SAIFR researchers and professors at other nearby universities such as USP and UNICAMP. The list of associated researchers at ICTP-SAIFR has been expanded to include several professors at USP (Raul Abramo, Gustavo Burdman, Elisabete Dal Pino, Victor Rivelles) who are expected to be regular visitors to ICTP-SAIFR and will assist in organizing activities.

Five São Paulo International Schools for Theoretical Physics will be organized by the ICTP-SAIFR in 2013 on the subjects of
mathematical biology (http://www.ictp-saifr.org/?page_id=2363),
particle physics (http://www.ictp-saifr.org/?page_id=2365),
non-perturbative QCD (http://www.ictp-saifr.org/?page_id=2368),
quantum gravity (http://www.ictp-saifr.org/?page_id=2371), and
astrophysics (http://www.ictp-saifr.org/?page_id=2373). The organizers and speakers at each of these schools are listed on the webpage of the school. There are also three meetings and one minicourse already set for 2013 and there are several more workshops and minicourses that are still in the planning stage. The present list of 2013 activities is on the webpage http://www.ictp-saifr.org/?page_id=2269 and includes

São Paulo International Schools on Theoretical Physics

II Southern-Summer School on Mathematical Biology
January 21 – February 2, 2013
School on Particle Physics in the LHC Era
April 1-12, 2013
School on Non-Perturbative QCD
May 27- June 7, 2013
School on Approaches to Quantum Gravity
September 2-9, 2013
School on Fundamental Astrophysics
October 7-18, 2013

Meetings and Workshops

2013 Meeting of Steering Committee and Scientific Council
February 17-19, 2013
VI Quantum Gravity Workshop in the Southern Cone
September 11-13, 2013
Workshop on Higher-Spin and Higher-Curvature Gravity
November 4-7, 2013

Minicourses

Corrigan minicourse on classical and quantum integrability
April 15-17, 2013

7. Seção específica com descrição sucinta e justificada da aplicação dos recursos de Reserva Técnica

The Reserva Técnica was used for the following purposes:

1) Reform of ICTP-SAIFR offices on the first floor to include the same structures as offices of IFT professors on the third and fourth floors – total cost of 59.765,20 reais.

2) Purchase of computer equipment for ICTP-SAIFR offices (1 laptop, 6 desktop computers, 2 printers, 2 no-breaks) – total cost of 19.507,60 reais.

3) Publication of advertisement of FAPESP postdoctoral and visiting positions in Physics Today and in Nature Jobs – total cost of 8.395,59 reais.

4) English courses for Equipe Técnico in order to communicate with participants of ICTP-SAIFR activities – total cost of 3.492,00 reais

5) Infrastructure for ICTP-SAIFR secretarial offices (pens, envelopes, pastas, etc.)– total cost of 780,83 reais

6) Maintenance of IFT-ICTP colloquia – total cost of 696,18 reais

8. a. Artigos em revistas científicas indexadas;

1. Pure spinors, twistors, and emergent supersymmetry.
Nathan Berkovits
- **JHEP 1212 (2012) 006**
- DOI: 10.1007/JHEP12(2012)006
- e-Print: arXiv:1105.1147 [hep-th] | PDF

2. Constrained BV Description of String Field Theory.
Nathan Berkovits
- **JHEP 1203 (2012) 012**
- DOI: 10.1007/JHEP03(2012)012
- e-Print: arXiv:1201.1769 [hep-th] | PDF

3. Particle creation due to tachyonic instability in relativistic stars.
A.G.S. Landulfo, W.C.C. Lima , G.E.A. Matsas , D.A.T. Vanzella .
- **Phys.Rev. D86 (2012) 104025**
- DOI: 10.1103/PhysRevD.86.104025
- e-Print: arXiv:1204.3654 [gr-qc] | PDF

4. **Hidden symmetries of Eisenhart lift metrics and the Dirac equation with flux.**
Marco Cariglia .
- **Phys.Rev. D86 (2012) 084050**
- DOI: 10.1103/PhysRevD.86.084050

- e-Print: arXiv:1206.0022 [gr-qc] | PDF

5. Pamplona da Silva, D.J. ; **Kraenkel, R.A.** . Population persistence in weakly-coupled sinks. Physica. A , v. 391, p. 142-146, 2012.

6. Bhuvaneswari, A. ; **Kraenkel, R.A.** ; Senthilvelan, M. . Application of the –lambda- symmetries approach and time independent integral of the modified Emden equation. Nonlinear Analysis: Real World Applications, v. 13, p. 1102-1114, 2012.

7. Coutinho, R.M. ;Godoy, W. A. C. ; **Kraenkel, R. A.** . Integrodifference model for blowfly invasion. Theoretical Ecology, v.5 , p. 363-371, 2012.

8. Azevedo, F. ; **Kraenkel, R.A.** ; Panmplona da Silava D.J.. Competitive release and area effects. Ecological Complexity, v. 11, p. 154-159, 2012.

9. Assaneo, F., Coutinho, R., Lin, Y., Mantilla, C., Lutscher, F, "Dynamics and coexistence in a system with intragulid mutualism", accepted for publication in Ecological Complexity, December 2012.

10. Kraenkel, R.A. ; Manikandan, K. ; Senthilvelan, M. . On certain new exact solutions of a diffusive predator prey system. Communications in Nonlinear Science & Numerical Simulation, v. 18, p. 1269-1274, 2013.

11. Radion-Higgs mixing effects on bounds from LHC Higgs Searches Hiroshi de Sandes and R. Rosenfeld, Phys.Rev. D85 (2012) 053003

12. **Noncommutative fluid dynamics in the Snyder space-time.**
M.C.B. Abdalla , L. Holender, M.A. Santos , I.V. Vancea .
- **Phys.Rev. D86 (2012) 045019**
- DOI: 10.1103/PhysRevD.86.045019
- ICTP-SAIFR-2012-004
- e-Print: arXiv:1206.3982 [hep-th]

9. Para as publicações listadas no item (8), inclua cópias das primeiras páginas.

Veja arquivos anexados.

10. Lista dos trabalhos preparados ou submetidos

Veja arquivos anexados para os artigos

1) A general model for seasonal variation in matrix quality and the consequences for population diffusion and patch connectivity**,**
M.Z. Cardoso, G. Corso, R.M. Coutinho and R.A. Kraenkel

2) Biodiversity Can Help Prevent Malaria Outbreaks in Tropical Forests,
Gabriel Zorello Laporta, Paulo Inácio Knegt Lopez de Prado, Roberto André Kraenkal, Renato Mendes Coutinho, Maria Anice Mureb Sallum

3) Comment on "Trouble with the Lorentz law of force: Incompatibility with special relativity and momentum conservation",
Daniel Vanzella

4) Multi Higgs and Vector boson production beyond the Standard Model,
A. Belyaev, A. C. A. Oliveira, R. Rosenfeld and M. C. Thomas

5) Harmonic Superspace from the AdS5×S5 Pure Spinor Formalism.
Nathan Berkovits and Thiago Fleury

6) Nilpotent orbits and codimension-two defects of 6d N=(2,0) theories,
Oscar Chacaltana, Jacques Distler, Yuji Tachikawa

7) Conditions for low-redshift positive apparent acceleration in smooth inhomogeneous models,
Antonio Enea Romano

8) Inhomogeneities induced low red-shift corrections to the luminosity distance relation,
Antonio Enea Romano, Pisin Chen