LNF Theory Group– July 2013

- Human Capital

7 Ten. Res. [Bellucci, Benfatto, Corcella, Del Duca, Lombardo, Nardi, Isidori]

- Four yrs. ago we were 12 (10 TRs + 2 NTRs)...
- ALL TR above 40
- Two of the above 7 TR are in mobility elsewhere (Isidori at CERN) or are about to go (Del Duca at Rome Sapienza Univ.)

+

5 Postdocs [1 supported by external funds (Fermi Inst.)]

4 Senior Associates

+

7 Associates from outside LNF

~15 frequent visitors from outside LNF, supported by INFN invitation funds: NEW RULES since 2013, Director rather than CSN4!

LNF Theory Group– July 2013

- Research activity

Theory Nat. projects (Iniziative Specifiche) at LNF

I.S.	Loc. (**Nat**.) Spokesperson	FTE	Topics
LF61	**Bellucci**	7.1	[Complex systems] Methods in Cond. Mat. Phys.,
MI12	Bellucci	1.5	[Fields/Strings] Supersymmetry, supergravity, BH
LF21	**Isidori**	1.9	[Phenomenology] Flavor Physics, Physics at LHC
FA51	Nardi	2.5	[Astroparticles] Leptogenesis, neutrino physics
PI11	Lombardo	1.0	[Fields/Strings] Lattice, QCD at finite T

LNF Theory Group–2014

- Research activity

Theory Nat. projects (Iniziative Specifiche) at LNF

I.S.	Loc. (**Nat.**) Spokesperson	FTE	Topics
SEMS	**Bellucci**	9.2	[Complex systems] Methods in Cond. Mat. Phys.,
GSS	Bellucci	5.3	[Fields/Strings] Supersymmetry, supergravity, BH
PHENO-LNF	***Isidori***	*1.9*	*[Phenomenology] Flavor Physics, Physics at LHC*
TASP	*Nardi*	*2.0*	*[Astroparticles] Leptogenesis, neutrino physics*
FTECP	Lombardo	1.0	[Fields/Strings] Lattice, QCD at finite T

Underline: + 1 A.R. in 2014 and 2015

SEMS Spectroscopies, Electron correlations, Modeling-Simulations and low-dimensional systems (ex LF61) - S. Bellucci (nat. spokesperson) + M. Benfatto, M. Cini, K. Hatada, K. Hayakawa, C. Natoli, L. Pierantoni, F. Palumbo,G. Stefanucci

Main research issues

Spectroscopies, Electron correlations, Modeling-Simulations and low-dimensional systems

LNF activities in 2014

The project uses tools from field theory, quantum mechanics, modeling and simulations, to analyze spectroscopies, electron correlations and various properties of low-dimensional systems in condensed matter physics:

* Electron spectroscopy of magnetic systems;
* Magnetic properties of quantum rings;
* NanoElectromagnetics (microwave/RF/photonics);
* Multiple scattering theory for non-local and multichannel potentials;
* Quantum effects in nanoparticles;
* Collective response of low dimensional, many body systems to abrupt perturbations;
* Electronic properties and plasmon excitations in graphene and doped graphene;
* Ab initio simulations and spectroscopy of Graphene/Metal interfaces.

The interdisciplinary and multidisciplinary character of the project ranges from the fusion of classical electrodynamics with novel methods and approaches of condensed matter physics; to methods allowing elucidating local properties of magnetic systems; to understanding the 2D character of the interface collective excitation in the electronic structure of graphene sheets deposited on metal surfaces; to the elaboration of a theoretical framework, providing a unified description of the electronic ground state as well as the excited states of a physical system, taking into account correlation effects, at least at a local level, beyond what can be reached in a description based on Density Functional Theory.

SEMS - S. Bellucci (nat. spokesperson) + M. Benfatto, M. Cini, K. Hatada, K. Hayakawa, C. Natoli, L. Pierantoni, F. Palumbo, G. Stefanucci

LNF collaborations in 2014

- - University of Lorraine, and Belarus State University, Institute for Nuclear Problems, through the 7th FRAMEWORK PROGRAMME, International Research Staff Exchange Scheme "Nano-thin and micro-sized carbons: Toward electromagnetic compatibility application (NAmiceMC)", Proposal Number: 610875, Grant Agreement Number: PIRSES-GA-2013, 2013-2017.
- - CNRS Université de Rennes, Ludwig-Maximilians-Universität München, Université de Bourgogne, Institute of Physics in Prague of the Academy of Sciences of the Czech Republic, Southern Federal University at Rostov-on-Don, University of Science and Technology of China of the Chinese Academy of Sciences, Chiba University in Japan, Birla Institute of Technology and Science at Pilani in India, through the 7° FP International Research Staff Exchange Scheme "A Multiple Scattering Computing Platform For (Nano) Materials (MSNano)", Grant Agreement Number: 2012-317554, 2012-2016.
- - Laboratory for Solid State Physics at the Department of Physics of matter and radiations University of Namur, Nanostructures Department from the Research Institute for Technical Physics and Materials Science of the Hungarian Academy of Sciences in Budapest, Institute for Biochemical Physics at the Russian Academy of Sciences in Moscow, Institute of Physics of the National Academy of Sciences of Ukraine in Kiev, Department of Radiophysics of the Faculty of Physics in Vilnius University, and Belarus State University, Institute for Nuclear Problems, through the 7th FP International Research Staff Exchange Scheme "Fundamental and Applied Electromagnetics Of Nanocarbon (FAEMCAR)", Proposal Number: 318617, Grant Agreement Number: PIRSES-GA-2012, 2012-2015.

SEMS - S. Bellucci (nat. spokesperson) + M. Benfatto, M. Cini, K. Hatada, K. Hayakawa, C. Natoli, L. Pierantoni, F. Palumbo, G. Stefanucci

LNF collaborations in 2013

- - Institut für Festkörperphysik at Technische Universität Berlin, Central Laboratory of Physico-Chemical Mechanics at the Bulgarian Academy of Sciences in Sofia, Institute of Electronic Structure and Laser in Heraklion Crete, Science & Technology Park "Metolit" at Belarusian National Technical University, and Belarus State University, Institute for Nuclear Problems, through the SEVENTH FRAMEWORK PROGRAMME THE PEOPLE PROGRAMME Coordination and support actions Work programme FP7-INCO-2010-6 "Institutional Development of Applied Nanoelectromagnetics: Belarus in ERA Widening (BY-NanoERA)", Grant Agreement Number: 266529, 2010-2013.
- - Yerevan State University, Armenia, through EMERGING SECURITY CHALLENGES DIVISION SCIENCE FOR PEACE AND SECURITY (SPS) PROGRAMME PROJECT PROPOSAL - Multi-Year Science for Peace (SfP)
"Development of Biosensors using Carbon Nanotubes", NATO Grant SPS EAP SFP 984537 (2013). PREPROPOSAL. Full Proposal 2014-2016, invited by NATO in Sept. 2013.

SEMS - S. Bellucci (nat. spokesperson) + M. Benfatto, M. Cini, K. Hatada, K. Hayakawa, C. Natoli, L. Pierantoni, F. Palumbo, G. Stefanucci

Publications in 2013

Characterizing epoxy composites filled with carbonaceous nanoparticles from dc to microwave
D Bychanok, P Kuzhir, S Maksimenko, S Bellucci, C Brosseau Journal of Applied Physics 113 (12), 124103-124103-6

Broadband dielectric/electric properties of epoxy thin films filled with multiwalled carbon nanotubes
J Macutkevic, PP Kuzhir, AG Paddubskaya, J Banys, SA Maksimenko, E ...Journal of Nanophotonics 7 (1), 073593

Pumping through a Luttinger liquid ring threaded by a time-varying magnetic field
E Perfetto, M Cini, S Bellucci Physical Review B 87 (3), 035412

Intrinsic geometric analysis of the network reliability and voltage stability
N Gupta, BN Tiwari, S Bellucci International Journal of Electrical Power & Energy Systems 44 (1), 872-879

Geometrical Methods for Power Network Analysis, S Bellucci, BN Tiwari, N Gupta Springer Book

Fermionic current from topology and boundaries with applications to higher-dimensional models and nanophysics
S Bellucci, AA Saharian Physical Review D 87 (2), 025005

Origin of incommensurate satellite reflections on TbMnO3 by resonant x-ray scattering
V Cuartero, J García, G Subías, J Herrero-Martín, J Blasco and C R Natoli, J. Phys.: Conf. Ser. 430 012101

Nonequilibrium Many-Body Theory of Quantum Systems: A Modern Introduction,
G Stefanucci, R van Leeuwen Cambridge University Press

Equilibrium and nonequilibrium many-body perturbation theory: a unified framework based on the Martin-Schwinger Hierarchy, R van Leeuwen, G Stefanucci Journal of Physics: Conference Series 427 (1), 012001

Time-dependent Landauer–Büttiker formula for transient dynamics
R Tuovinen, R van Leeuwen, E Perfetto, G Stefanucci Journal of Physics: Conference Series 427 (1), 012014

GSS Gauge Theories, Supergravity and String Theory (ex MI12) - S. Bellucci (loc. spokesperson) + S. Ferrara (ass.), A. Yeranyan (Fermi Inst. PostDoc)

Main research issues

I) String Theory, Supergravity.
II) Perturbative and non perturbative properties of Gauge Theories.

String Theory seems the best candidate to describe in one framework both Quantum Gravity and the usual Quantum Field Theory models of the Fundamental Interactions. Because of this, String Theory has become an efficient theoretical laboratory to explore the limits of our understanding of the fundamental forces. Indeed, the most plausible models for new physics beyond the Standard Model have been inspired by ideas developed in the context of String Theory.

Supergravity emerges as the low energy limit of String Theory. The study of Supergravity in its many forms is crucial for understanding the perturbative and non-perturbative dynamics of String Theory, the landscape of vacua, compactifications and the issue of supersymmetry breaking. It is also important for a better understanding of black holes and their microstates, which is is a central problem in Quantum Gravity.

In the last decades a considerable progress has been obtained in the investigation of non perturbative properties and different dualities between strong and weak coupling regimes in Gauge and String Theory. Integrability and a better understanding of the structure of scattering amplitudes has shed new light on the quantum properties of certain gauge theories.

GSS - S. Bellucci (loc. spokesperson) + S. Ferrara (ass.), A. Yeranyan (Fermi Inst. PostDoc)

Main research issues (continued)

A major role as a candidate bridge between line I and line II is played by D-branes, extended objects in String Theory, whose low energy dynamics is described by supersymmetric gauge theories. Analysis of D-brane configurations therefore provides non- perturbative information on gauge theories and leads to a framework that unifies string theory, supergravity and gauge theory. An analogous role is played by the AdS/CFT duality, which, emerged from string theory, has been centered on the analysis of strongly interacting gauge field theories by mapping them to classical gravity and it has been recently extended to the description of the quark-gluon plasma and to condensed matter.

Important and acknowledged results. The IS includes internationally known experts in gauge theories, supergravity, D-branes, compactifications and the AdS/CFT correspondence whose competences are naturally complementary. Many collaborations are active with international Institutions. The future research activity will be devoted to the study of some of the main open problems in the fields of:

1) The AdS/CFT correspondence, with an eye to three, four and possibly higher dimensional theories, the relation with integrability and the holographic description of realistic systems.
2) Supergravity and Black Holes, with attention to the classical and quantum properties of supergravity and the properties of BPS and non-BPS black-holes and their microstates.
3) Properties of supersymmetric Gauge Theories, with attention to integrability and the properties of scattering amplitudes, the study of protected quantities in various dimensions, topological theories and the (brane) instantonic calculus.
4) String Theory, compactifications and string vacua, with an eye to the most tractable vacua, the supersymmetric ones, and to the deepening of our knowledge of semi-phenomenological models.

GSS - S. Bellucci (loc. spokesperson) + S. Ferrara (ass.), A. Yeranyan (Fermi Inst. PostDoc)

External fundings & 2013 Workshop

Research also supported by the ERC Grant SUPERFIELDS Supersymmetry, Quantum Gravity and Gauge Fields, P.I. S. Ferrara, Participants: CERN and INFN), ends mid 2014.

Inspired by the AdS/CFT success, one could try to involve another far reaching idea partially already present in the AdS/CFT correspondence. This idea is a duality which generalizes the notion of electromagnetic duality in Maxwell theory. Combined with supersymmetry, it leads to intriguing developments. In order to discuss topics related to the cancellation of ultraviolet divergences in extendedsupergravity and Born Infeld like actions, we organized:
Breaking of supersymmetry and Ultraviolet Divergences in extended Supergravity, Workshop
25 to 28 March 2013, LNF, http://www.lnf.infn.it/theory/buds
Sponsored by INFN, ESF Holograv, ERC Superfields Grant

The Workshop will be repeated in 2014, when further progress is expected especially concerning higher orders in the AdS/CFT correspondence, due to higher-derivative terms.

GSS - S. Bellucci (loc. spokesperson) + S. Ferrara (ass.), A. Yeranyan (Fermi Inst. PostDoc)

Publications in 2013

Conjecture on hidden superconformal symmetry of N=4 supergravity
Sergio Ferrara, Renata Kallosh, and Antoine Van Proeyen Phys. Rev. D 87, 025004 (2013) [13 pages]

Supersymmetric Gravity and Black Holes
Proceedings of the INFN-Laboratori Nazionali di Frascati School on the Attractor Mechanism 2009
Springer Proceedings in Physics Volume 142, 2013, S. Bellucci ed.

Black Objects in Supergravity
Proceedings of the INFN-Laboratori Nazionali di Frascati School 2011
Springer Proceedings in Physics, Vol. 144, 2013, S. Bellucci ed.

d-geometries revisited, Anna Ceresole, Sergio Ferrara, Alessandra Gnecchi, Alessio Marrani
Journal of High Energy Physics February 2013, 2013:59

Isospin particle systems on quaternionic projective spaces
S Bellucci, S Krivonos, A Nersessian, V Yeghikyan Physical Review D 87 (4), 045005

Dual multiplets in N= 4 superconformal mechanics
S Bellucci, S Krivonos, A Sutulin Journal of Physics A: Mathematical and Theoretical 46 (3), 035401

On the road to N= 2 supersymmetric Born-Infeld action
S Bellucci, S Krivonos, A Shcherbakov, A Sutulin Physics Letters B 721 (2013) 353–357

Symmetries of N= 4 supersymmetric CP(n) mechanics
S Bellucci, N Kozyrev, S Krivonos, A Sutulin Journal of Physics A: Mathematical and Theoretical 46 (27), 275305

PHENO LNF (ex LF21) - G. Isidori (nat. spokesperson) + G. Corcella, V. Del Duca (? $\Rightarrow$ RM1), G. Pancheri

Main research issues

1) Higgs mass implications on the stability of the electroweak vacuum
2) U(2) and Minimal Flavour Violation in Supersymmetry
3) A toy-model to explain the large t-tbar FB asymmetry observed at Tevatron
4) The one-loop six-dimensional hexagon integral with three massive corners
5) Investigation of the infrared structure of gauge theory amplitudes in the high-energy limit

PHENO LNF (ex LF21) - G. Isidori (nat. spokesperson) + G. Corcella, V. Del Duca (? $\Rightarrow$ RM1), G. Pancheri

External fundings

LHCPhenoNet, an Initial Training Network (ITN) supported by the 7th Framework Programme of the European Commission. Network Contract PITN-GA-2010-264564 2011-2014.
12 teams from 28 European Universities and Research Institutes, including INFN-LNF, the University of Buenos Aires, CERN, and 3 partners from the industrial sector.
http://www.lhcphenonet.eu/

FA51 - E. Nardi (loc. spokesperson) + E. Peinado (pdoc) + 1 A.R.

Main research issues

The Theoretical Astroparticle Physics (TAsP) research network is being proposed by a well-established scientific community formed by 13 INFN nodes, with a strong tradition of common scientific interests, research programs and integrated activities in the field of astroparticle physics. The goal of TAsP is to undertake a vast and diversified research program at the crossroad of particle physics, astrophysics and cosmology, where deeper levels of theoretical understanding are clearly demanded by a number of phenomena, including neutrino masses and mixings, the puzzles of dark matter and dark energy, the observed baryon asymmetry of the universe, as well as the origin and spectra of high-energy cosmic rays and gamma rays.

Planned activities

(1) Neutrino Physics;
(2) Dark Matter;
(3) Astrophysical Sources of Radiation;
(4) Cosmology;
(5) Interplay with Particle Physics.

FTECP (ex PI11) - M.P. Lombardo (loc. spokesperson) + F. Palumbo

Main research issues

Lattice Field Theories and Computational Particle Physics.

Link with the Center for Mathematics and Theoretical Physics (CMTP)

http://cmtp.uniroma2.it/index.php

LNF theory group, assessment report. Report preparato dal Comitato Teorici (Prof. A. Lerda, Dr. M. Mangano, Prof. A. Masiero) relativo al gruppo IV dei LNF – Giugno 2013

Considerazioni generali

Il livello scientifico di ogni membro del gruppo e' eccellente. Sebbene in ambiti diversi, tutti i membri del gruppo godono di stima a livello internazionale, come riconosciuto dalle loro responsabilita' di leadership (ruolo di convener in workshops, appartenenza a comitati internazionali, assegnazioni di grants europei, etc). La diversita' dei loro profili e' un elemento positivo, che permette di coprire quasi ogni aspetto del programma di ricerca dei gruppi sperimentali del laboratorio. Dalla discussione con i Rappresentanti degli esperimenti e' emerso chiaramente che tutti i colleghi teorici hanno contribuito, ovviamente a diversi livello di coinvolgimento e di intensita', ad arricchire le loro attivita'. La varieta‘ del programma sperimentale del laboratorio suggerisce che la diversita‘ dei profili espressi dai membri del gruppo teorico venga mantenuta. Il disagio espresso da alcuni teorici relativamente al loro isolamento, e le difficolta' a livello di relazioni personali o di condivisione dei fondi comuni di gruppo IV, non sembrano avere impatto sull'eccellenza dei contributi che, individualmente, essi hanno dato sia al Progresso scientifico nei rispettivi campi di specializzazione e nel panorama internazionale, sia alle attivita' del laboratorio, quando ne sia emersa la necessita' o l'opportunita'.

Raccomandazione #1:

Il Direttore dovrebbe inviare un forte messaggio di apprezzamento e riconoscimento al gruppo, meglio ancora se fatto a livello individuale, anche come misura per assopire le esistenti tensioni, e come rassicurazione che la valutazione di questa review e' totalmente positiva per quanto riguarda il loro lavoro. Una verifica periodica (per esempio un colloquio annuale) con i singoli individui, potrebbe aiutare a farli sentire maggiormente integrati nell'attivita' del laboratorio, dare un'opportunita‘ di esporre il loro programma di ricerca ed i loro successi personali, ed aiutarvi assieme ad identificare sinergie fra il loro lavoro e le attivita' del laboratorio.

LNF theory group, assessment report. Report preparato dal Comitato Teorici (Prof. A. Lerda, Dr. M. Mangano, Prof. A. Masiero) relativo al gruppo IV dei LNF – Giugno 2013

Rafforzamento di indirizzi strategici:

Le attivita' sperimentali del laboratorio coprono un ampio range; ciononostante, il laboratorio riconosce l'esistenza di aree strategiche, in cui focalizzare al massimo i propri sforzi ed in cui pretendere assoluta leadership. Ovvi esempi sono i programmi relativi all'uso di Dafne, e la partecipazione agli esperimenti LHC. E' dunque ragionevole che, seppur salvaguardando la varieta' di temi attualmente coperti dal gruppo teorico, ma vista l'impossibilita' di espandere e rinforzare il gruppo in maniera uniforme, vengano assegnate risorse per potenziarne alcuni temi specifici.

Raccomandazione #2:

Il management del laboratorio definisca in modo preciso quale sia l'indirizzo che intende rafforzare all'interno del gruppo teorico, e ne informi il gruppo. Salvo eventuali sviluppi relativi ad un futuro progetto bandiera, tipo IRIDE, siamo unanimi nel ritenere che tale indirizzo debba essere la fenomenologia delle alte energie.

LNF theory group, assessment report. Report preparato dal Comitato Teorici (Prof. A. Lerda, Dr. M. Mangano, Prof. A. Masiero) relativo al gruppo IV dei LNF – Giugno 2013

Possibili strumenti di rafforzamento:

E' chiaro che l'aumento del complemento di staff potra', al piu', essere limitato ad un'occasionale posizione di ricercatore. Il rafforzamento deve dunque manifestarsi attraverso una crescita nelle attivita' del gruppo, che lo porti ad attrarre a Frascati un maggior numero di ricercatori, per attivita' tipo Summer Institutes, Workshops, scuole dedicate a studenti di PhD e giovani ricercatori, o semplici collaborazioni scientifiche. Queste attivita' possono essere ottimizzate e coordinate con i colleghi sperimentali, e dovrebbero avere impatto almeno su scala nazionale. Un esempio di collaborazione e' offerto dall'idea interessante, emersa durante la discussione, di istituire un programma di Summer Students (tipicamente sperimentali), al quale il gruppo teorico puo' contribuire offrendo lezioni. Frascati potrebbe inoltre ambire a diventare punto di riferimento per le attivita' fenomenologiche italiane, con un programma mirato di ospitalita' di ricercatori stranieri, che aiuti ad attrarre colleghi italiani, ed in particolare colleghi di area romana. A questo proposito, uno sforzo aggressivo di potenziare la fenomenologia a Frascati potrebbe ambire a rinforzare il legame con i fenomenologi di area romana, anche attraverso opportunita' di mobilita' interna all'INFN.

Raccomandazione #3:

Il management del laboratorio deve essere pronto a sostenere queste attivita', eventualmente sollecitando Il coinvolgimento diretto dell'ente, proponendo ad esso un programma sistematico di attivita' a beneficio di tutta la comunita' nazionale, sia teorica che sperimentale. I fenomenologi del gruppo teorico, inoltre, dovrebbero attivarsi con forse maggiore impegno ad attrarre risorse europee, attraverso i vari programmi tipo ERC, COST, etc, cosi' come e' fatto con grande successo per sostenere altri indirizzi del gruppo.

LNF theory group, assessment report. Report preparato dal Comitato Teorici (Prof. A. Lerda, Dr. M. Mangano, Prof. A. Masiero) relativo al gruppo IV dei LNF – Giugno 2013

Gestione del gruppo teorico e definizione di un piano di sviluppo:

Per guidare il gruppo teorico a svolgere un ruolo piu' diretto nella strategia scientifica del laboratorio, e' indispensabile che a questo vengano assegnate risorse direttamente dal management del laboratorio, come suggerito al punto #3. Il meccanismo di finanziamento del gruppo teorico, basato sulla competizione all'interno della commissione IV, puo' infatti solo in parte accomodare le necessita' del gruppo di rispondere ai bisogni del laboratorio. La definizione del programma di sviluppo e dell'uso delle risorse, deve essere dunque concordato direttamente fra management del laboratorio e gruppo teorico.

Raccomandazione #4:

Sembra naturale proporre che il management identifichi una leadership di riferimento, all'interno del gruppo teorico, con la quale negoziare un piano, ed alla quale affidarne l'implementazione. Questo processo potrebbe essere formalizzato istituendo il gruppo teorico come divisione o sottodivisione del laboratorio.