

- Attivita' di fenomenologia, reticolo ed astroparticelle

Iniziative Specifiche (con FTE > 0) di Gruppo IV ai LNF:

Sigla	Resp. Loc.	FTE (dip. LNF)	Argomento
LF61	Bellucci	13.0 (1.3)	[Sistemi complessi] Spettroscopia X, Nanotubi,...
MI12	Bellucci	7.7 (0.7)	[Campi/Stringhe] Supersymmetry, quantum gravity,...
LF21	Isidori	4.0 (3.0)	[Pheno] Fisica del sapore, fisica di LHC,...
M11	Lombardo	2.0 (1.0)	[Reticolo] Lattice, QCD a T finita
FA51	Nardi	1.0 (1.0)	[Astroparticelle] Leptogenesi, fisica dei neutrini

2 IS grandi + 1 media + 2 IS piu' piccole (ma non per questo meno importanti: vitale mantenere diversificazione, anche in vista delle varie attivita' sperim. ai LNF)

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Fenomenologia [LF21]

Gruppo LNF (2011):

Dip. LNF: Corcella, Del Duca, Isidori [*Resp. Naz.*],

Borsisti: Jones-Perez [*postdoc INFN*]

Sebbene il gruppo sia piccolo, l'attività e' ad ampio spettro:

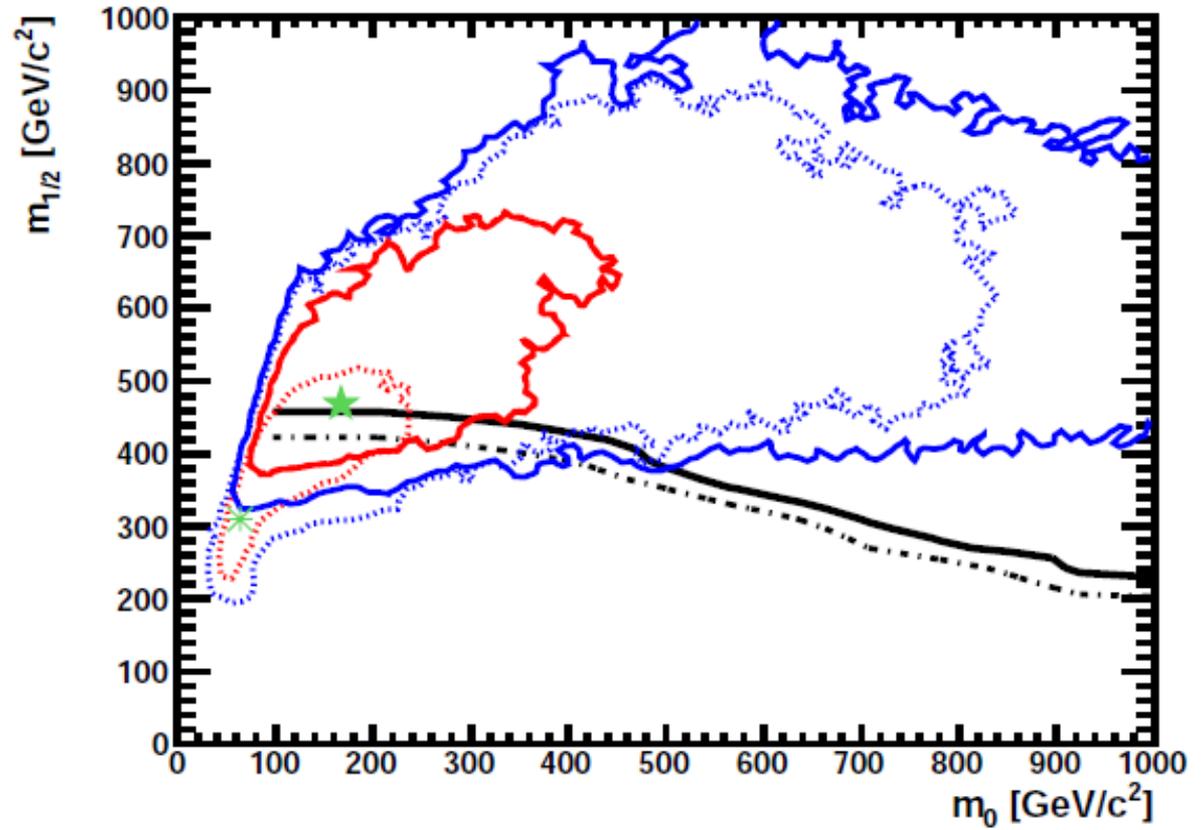
- Modelli di Nuova Fisica
- Stime di precisione in fisica del sapore [*Fisica dei K e B*]
- Sviluppi formali in QCD
- Calcoli di precisione e simulazioni Montecarlo per l'LHC
- QCD a basse energie [*Teoria Chirale*]

Ed e' fortemente collegata alle varie attività di GR.I dei LNF

LF21- Highlights-1
[New Physics]

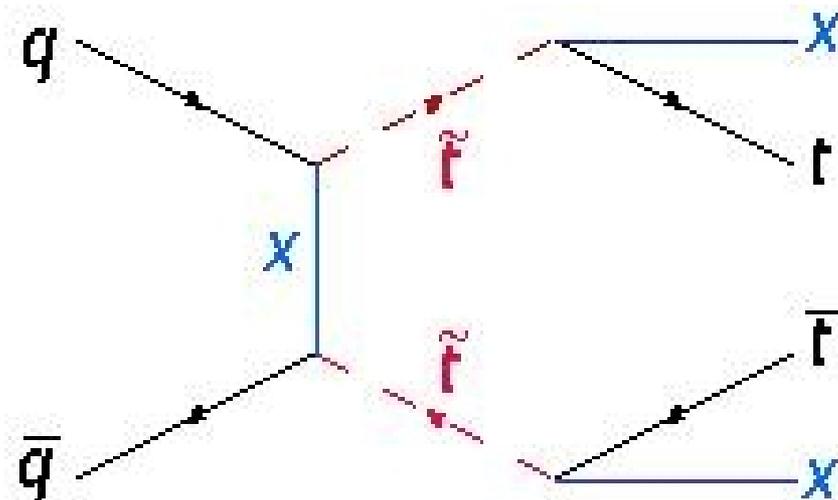
Analysis of the spectrum
of the constrained MSSM
using indirect constraints
+ first LHC results

[collab. of G.Isidori with Ellis et al.]



Exotic SUSY model proposed
to explain the AFB top-antitop
anomaly observed by CDF

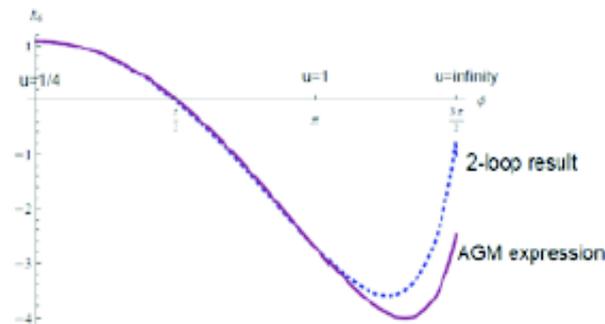
[Isidori, Kamenik]



LF21- Highlights-2 [QCD & N=4 Super YM Theory]

It is believed that N=4 Super Yang-Mills (MSYM) be a completely integrable gauge field theory. Furthermore, MSYM is conformal invariant, thus it provides an example of the AdS/CFT duality (Maldacena 1997), which relates the large-coupling limit of a 4-dimensional Conformal Field Theory to a weakly-coupled string theory.

Recently, a remarkable relation has been found between the scattering amplitudes of MSYM in the 't-Hooft planar limit and Wilson loops defined on a contour of null segments (Alday Maldacena 2007). Accordingly, a lot of research has been dedicated to understand amplitudes/Wilson loops at strong coupling (Alday Gaiotto Maldacena 2009), and two-loop amplitudes/Wilson loops at weak coupling (Arkani-Hamed Bourjaily Cachazo Trnka 2010).

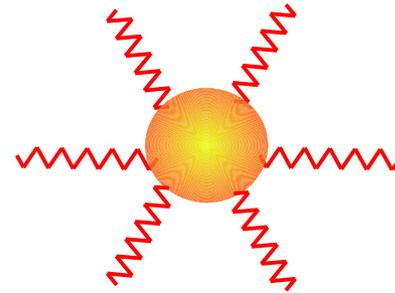


We (Del Duca Duhr Smirnov 2009) have performed the first analytic calculation of a two-loop six-point Wilson loop in arbitrary kinematics, which has allowed the first comparison between such a quantity and a Wilson loop computed at strong coupling (Alday Gaiotto Maldacena 2009).

In addition, we (Del Duca Duhr Smirnov 2010) have performed the first analytic calculation of a two-loop eight-point Wilson loop in a 2-dimensional space-time, and compared it to the same quantity computed at strong coupling (Alday Maldacena 2009).

LF21- Highlights-2 [*QCD & N=4 Super YM Theory*]

Six-gluon amplitudes beyond lowest-order in QCD, using constraints from N=4 Super Yang Mills



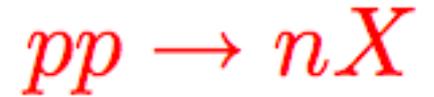
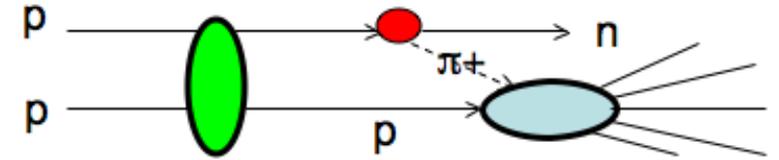
Quantities in N=4 Super Yang-Mills (*MSYM*) are polynomials of uniform transcendental weight, where a log has weight $w=1$, a dilog has $w=2$, π has $w=1$, a Riemann zeta function ζ_3 has $w=3$, etc. Two-loop amplitudes/Wilson loops are given as polynomials of weight 4.

Recently, we ([Del Duca Duhr Smirnov 2011](#), [Del Duca Dixon Drummond Duhr Henn Smirnov 2011](#)) have found that one-loop six-point integrals in six space-time dimensions are computable as polynomials of weight 3 with the same functional form as the polynomials which characterise the two-loop amplitudes/Wilson loops in four dimensions. However, they are simpler because of the lower weight. Thus, they can be considered as proto-structures which allow us to study the analytic environment of the two-loop amplitudes/Wilson loops in four dimensions.

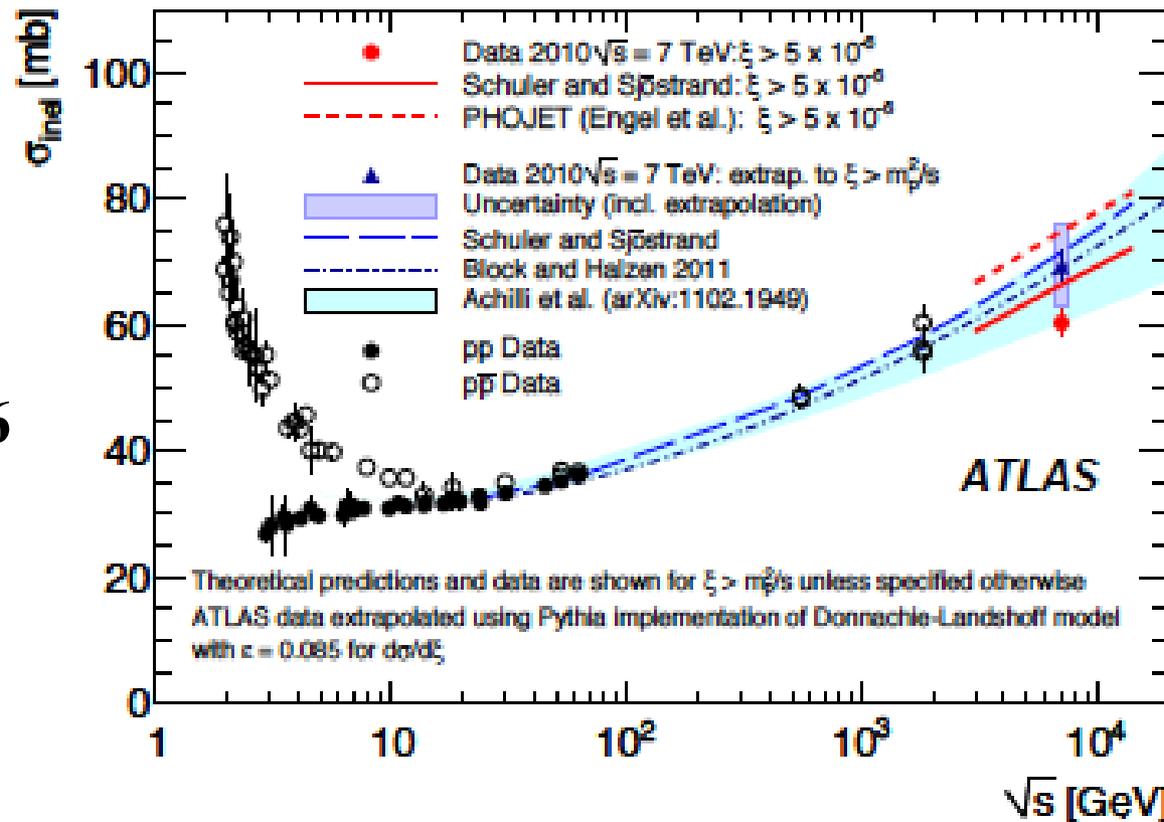
LF21- Highlights-3

[Hadron Physics at LHC]

Predizioni e confronti con dati e altri modelli per le sezioni d'urto totali nella regione del TeV per **pioni** e protoni



Inelastic p-p
cross-section
by ATLAS
arXiv:1104.0326



La **banda blu** nel lavoro di ATLAS corrisponde a Achilli, Godbole, Grau, Pancheri, Srivastava, Shekhovtsova [arxiv-1102.1949](https://arxiv.org/abs/1102.1949)

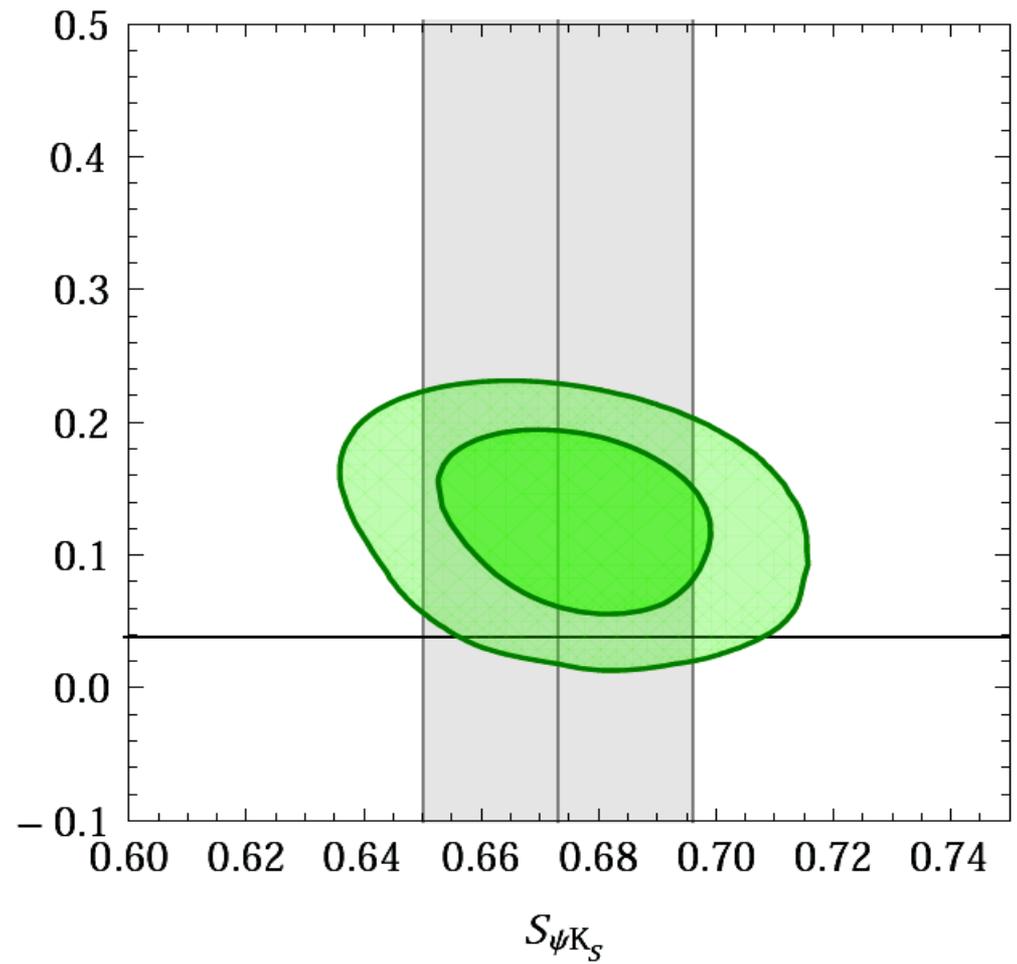
LF21- Highlights-4

[Flavour Physics]

Proposed a SUSY model with $U(2)^3$
Flavour symmetry that

- predicts correct Yukawa structure
- solves existing tensions in CKM fits
- predicts anomalous CPV in B_s
mixing

[collab. of G.Isidori with Barbieri et al.]



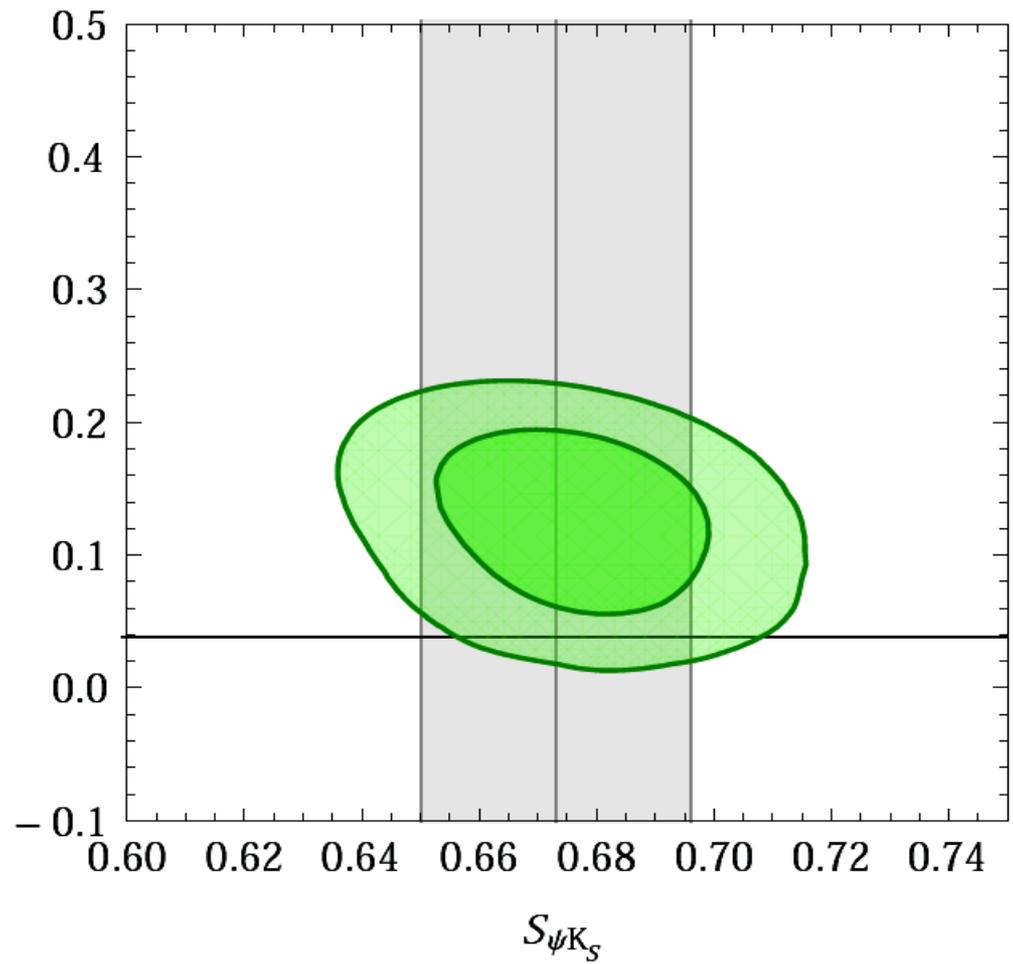
LF21- Highlights-4

[Flavour Physics]

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[collab. of G.Isidori with Barbieri et al.]



The theoretical activity in flavour and LHC physics is one of the activities which gives more visibility to our Laboratory:

- G. Isidori invited for plenary talks at ICHEP 2010, Planck 2011, ECFA Seminar (CERN, Oct. 2011)
- V. Del Duca coordinates the recently approved FP7 RT Network “QCD pheno Net”

Quark Gluon Plasma and StrongEWSB

Computers:

INFN GRID

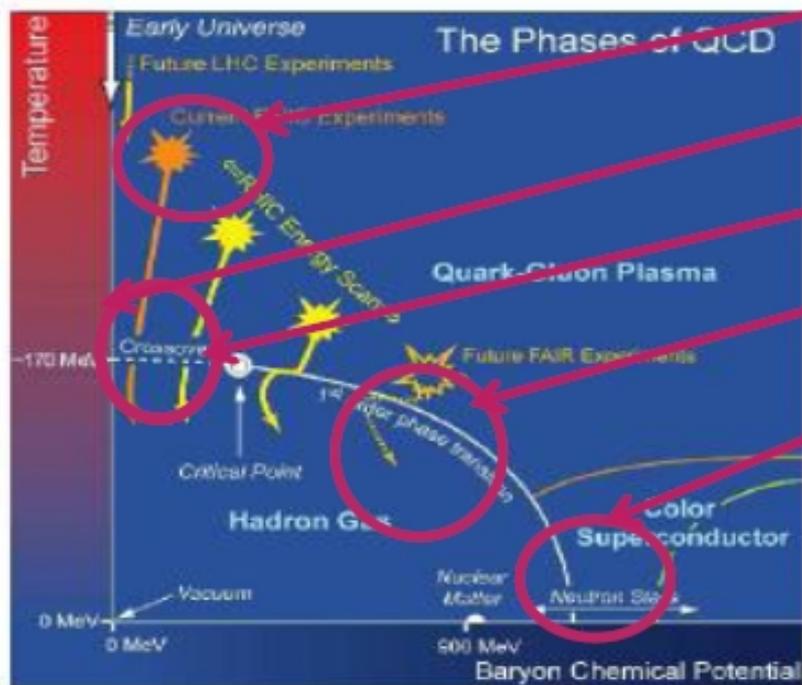
CINECA Pow6 (10Mhours)

ApeNEXT (1 rack)

Kyoto SPS

M.P.Lombardo and K. Miura

Collaborations with: Berlin, Sapporo, Seoul, Argonne, Dublin, Dubna, Frankfurt, Swansea, Copenhagen, Stonybrook, Groningen, Bielefeld, Kyoto



From NSAC

- Bottomonium in the QGP
- Transition temperature
- Shape of the critical line
- Sign Problem of QCD
- Matter at high density

Walking "Technicolor" - Near Conformality



From KMI

Pubblicazioni 2010 -2011

M. D'Elia, F. Di Renzo, M. P. Lombardo, *Strongly interacting quark-gluon plasma and the critical behaviour of QCD at imaginary μ* , Indian J. Phys. **85** (2011) 51-55.

M. P. Lombardo, K. Splittorff, J. J. M. Verbaarschot, *A mesoscopic approach to the QCD phase diagram*, Prog. Theor. Phys. Suppl. **186** (2010) 516-521.

F. Burger, E. -M. Ilgenfritz, M. Kirchner, M. P. Lombardo, M. Muller-Preussker, O. Philipsen, C. Urbach, L. Zeidlewicz, *The thermal QCD transition with two flavours of twisted mass fermions*, [arXiv:1102.4530 [hep-lat]].

A. Deuzeman, E. Pallante, M. P. Lombardo, *The Bulk transition of many-flavour QCD and the search for a UVFP at strong coupling*, PoS **LAT2010** (2010) 067.

A. Deuzeman, M. P. Lombardo, E. Pallante, *Chiral symmetry of QCD with twelve light flavors*, PoS **LAT2010** (2010) 098.

R. Falcone, E. Laermann, M. P. Lombardo, *Study of finite temperature QCD with 2+1 flavors via Taylor expansion and imaginary chemical potential*, PoS **LAT2010** (2010) 183.

A. Ohnishi, K. Miura, T. Z. Nakano, *Another mean field treatment in the strong coupling limit of lattice QCD*, PoS **LAT2010** (2010) 208.

K. Miura, T. Z. Nakano, A. Ohnishi, N. Kawamoto, *Chiral and deconfinement transitions in strong coupling lattice QCD*, PoS **LAT2010** (2010) 202.

T. Z. Nakano, K. Miura, A. Ohnishi, *Effective Potential and Phase Diagram in the Strong-Coupling Lattice QCD with Next-to-Next-to-Leading Order Polyakov Loop Effects*, PoS **LAT2010** (2010) 205.

A. Deuzeman, E. Pallante, M. P. Lombardo, *Phases of QCD from small to large $N(f)$: (Some) lattice results*, Int. J. Mod. Phys. **A25** (2010) 5175-5182.

M. P. Lombardo, K. Splittorff, J. J. M. Verbaarschot, *How the Quark Number fluctuates in QCD at small chemical potential*, PoS **LAT2010** (2010) 216.

G. Aarts, S. Kim, M. P. Lombardo, M. B. Oktay, S. M. Ryan, D. K. Sinclair, J. -I. Skullerud, *Bottomonium above deconfinement in lattice nonrelativistic QCD*, Phys. Rev. Lett. **106** (2011) 061602.

F. Burger *et al.* [tmfT Collaboration], *Thermal transition temperature from twisted mass QCD*, PoS **LAT2010** (2010) 220.

M. P. Lombardo, K. Splittorff, J. J. M. Verbaarschot, *The Fluctuations of the Quark Number and of the Chiral Condensate*, Phys. Rev. **D81** (2010) 045012.

A. Deuzeman, M. P. Lombardo, E. Pallante, *Evidence for a conformal phase in $SU(N)$ gauge theories*, Phys. Rev. **D82** (2010) 074503.

K. Miura, T. Z. Nakano, A. Ohnishi, N. Kawamoto, *Strong-coupling lattice study for QCD phase diagram including both chiral and deconfinement*

T. Z. Nakano, K. Miura, A. Ohnishi, *Chiral and deconfinement transitions in strong coupling lattice QCD with finite coupling and Polyakov loop effects*, Phys. Rev. **D83** (2011) 016014.

T. Z. Nakano, K. Miura, A. Ohnishi, *Effective Potential in the Strong-coupling Lattice QCD with Next-to-Next-to-Leading Order Effects*, Prog. Theor. Phys. **123** (2010) 825-851.

Desideri di calcolo 2012 e oltre

GRID User Interface @ LNF (grazie a Sandro Angius, allo staff Pcsupport ed Elisabetta Vilucchi per l'aiuto fino ad oggi)

Convenzione CINECA - INFN, LNF (sul modello INFM)



LNF Computational Physics Center (for LFTheory)



Attività Principale: studio asimmetria materia/antimateria

Cioé come spiegare: $\eta_B \equiv \frac{n_B - \bar{n}_B}{n_\gamma} = (6.21 \pm 0.16) \times 10^{-10}$

Una teoria convincente: **Leptogenesis** (relaz. $\eta_B \iff$ Fisica neutrini)

Formulazione generale di Teorie Effettive per l' Universo Primordiale

[“Early Universe effective theories ...”, C. S. Fong, M. C. Gonzalez-Garcia, E. Nardi; JCAP 1102, 032 (2011)]

Applicazioni:

- Formulazione rigorosa della **Leptogenesis Supersimmetrica**
[“Supersymmetric Leptogenesis”, C. S. Fong, M. C. Gonzalez-G., EN, J. Racker; JCAP 1012, 013 (2010).]
- Formulazione rigorosa della Leptogenesis da “*soft SUSY breaking*”
e scoperta di una nuova possibilità: **Baryogenesis via R-genesis**
[“... The Soft Leptogenesis and R-Genesis Cases”, C. S. Fong, M. C. Gonzalez-Garcia, E. Nardi; JCAP]

Altri argomenti relazionati con Leptogenesis:

- Leptogenesis "soft" ed effetti di sapore leptonic
["Flavoured soft leptogenesis and natural values of the B term",
C. S. Fong, M. C. Gonzalez-Garcia, E. Nardi and J. Racker; JHEP 1007, 001 (2010)]
- "Leptogenesis from soft supersymmetry breaking" (IJMPA Review Article)
[C. S. Fong, M. C. Gonzalez-Garcia and E. Nardi; To appear]

Altri argomenti:

- Minimal Flavour Violation nel settore leptonic e meccanismo del Seesaw
["Minimal flavour violation extensions of the seesaw",
R. Alonso, G. Isidori, L. Merlo, L. A. Muñoz and E. Nardi; JHEP 1106, 037 (2011)]
- Proposto un nuovo meccanismo per le gerarchie delle masse dei fermioni
["Naturally large Yukawa hierarchies", E. Nardi; arXiv:1105.1770 [hep-ph]]

• Convegni e attività divulgative

- The LNF Spring School “Bruno Touscheck”
Organizzata ogni due anni su tematiche di fenomenologia delle particelle

Mario Antonelli, Diego Aristizabal,
Oscar Catà, Vittorio Del Duca,
Riccardo Faccini, Gino Isidori,
Jernej Kamenik, Enrico Nardi (School Director),
Matteo Palutan, Tommaso Spadaro

- Organizzazione e divulgazione (G. Pancheri)::
 - Gruppo Italiano sul Linear Collider: Trento LC11 12-16 settembre 2011
 - Bruno Touschek Memorial Lectures 2011
 - Preparazione volume **I disegni inediti di Bruno Touschek**
 - Pubblicazione su EPJH dell'articolo con lettere e disegni inediti

Bruno Touschek: Particle Physicist and father

of the e+e- collider di Luisa Bonolis e Giulia Pancheri

MIT-CTP-4212, LNF-11-01(P). Mar 2011. 63 pp. **arXiv:1103.2727**



Le quattro stagioni del

LNF Spring Institute

Gennaio 2010 - Marzo 2011:

**sei mesi uomo su fondi FAI +
partecipanti LNF e area Romana +
ospiti finanziati su altri budget +
generoso appoggio in foresteria =**

**Tre Istituti , una Giornata di Studio,
Collaborazioni, Reciprocita'**



Spring

LNF-2010-1 : Frontiers of Strong Interactions

24 Maggio – 10 Giugno 2010

Resident Guests

Rossella Falcone (Bielefeld) , Marteen Golterman (San Francisco),
Peter A.Lukin (Novosibirsk), Elisabetta Pallante (Groningen), Marco Panero (Zurich),
Ben Svetitsky (Tel Aviv), Tassos Vladikas (Roma)



Autumn

Giornata di Studio Covenor: V. Del Duca

Martedì 28 Settembre 2010.

Aula Conversi, edificio 57, piazzale Einstein, LNF

10:15 A. Banfi (ETH, Zurich)

''Loop lessons from Wilson loops in N=4 SYM''

11:15 V.A. Smirnov (NPI, Moscow State U.)

''Evaluating Feynman integrals analytically to higher orders in the dimensional regularisation parameter''

12:00 C. Duhr (IPPP, Durham)

''Two-loop Wilson loops and scattering amplitudes in N=4 SYM''

14:30 M. Antonelli (LNF)

''W/Z cross sections at LHC in ATLAS''



Winter

Quark Gluon Plasma, and the first LHC results

LNF-2011-1

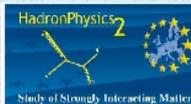
1 March - 8 March 2011

Laboratori Nazionali di Frascati

Introductory Lectures:
Helmut Satz (Bielefeld)

Topical Seminars:
Gennaro Corcella (LNF-TH),
Vittorio Del Duca (LNF-TH),
Pasquale Di Nezza (LNF-EXP),
Daniele Guido (TUV-Mathematics),
Maria Paola Lombardo (LNF-TH),
Gerardo Morsella (TUV-Mathematics),
Giulia Panzeri (LNF-TH),
Bhupendra Nath Tiwari (LNF-TH)

Discussions & Workshopping



Spring

LNF-2011-2

22 – 28 March 2011

Laboratori Nazionali di Frascati

Topics: Technicolor, Strong Dynamics, SUSY

Colloquium Speaker:

Koichi Yamawaki

Kobayashi Maskawa Institute, Nagoya
(in collaboration with LNF 'Seminari Generali')

Topical Seminars by:

Marco Bochicchio

Sapienza Università di Roma

Joel Jones-Perez

LNF

Masafumi Kurachi

Kobayashi Maskawa Institute, Nagoya

Kohtaroh Miura

LNF

Hiroshi Ohki

Kobayashi Maskawa Institute, Nagoya

Discussions & Workshopping



• Considerazioni finali (personali)

Nei 15 anni trascorsi presso i LNF credo di aver contribuito in modo significativo a rafforzare l'attività di ricerca presso questi laboratori (nel campo della fenomenologia, ma non solo).

Negli ultimi 10 anni -con l'aiuto di Vittorio ed altri- ho anche cercato (e sperato) di creare un Gruppo di Fenomenologia ai LNF degno di un grande laboratorio. C'erano tutte le premesse perche' cio' avvenisse.

Purtroppo pero' ho dovuto constatare la quasi totale indifferenza della Dirigenza dell'INFN rispetto a questo programma.

Credo si sia persa una grande opportunità...