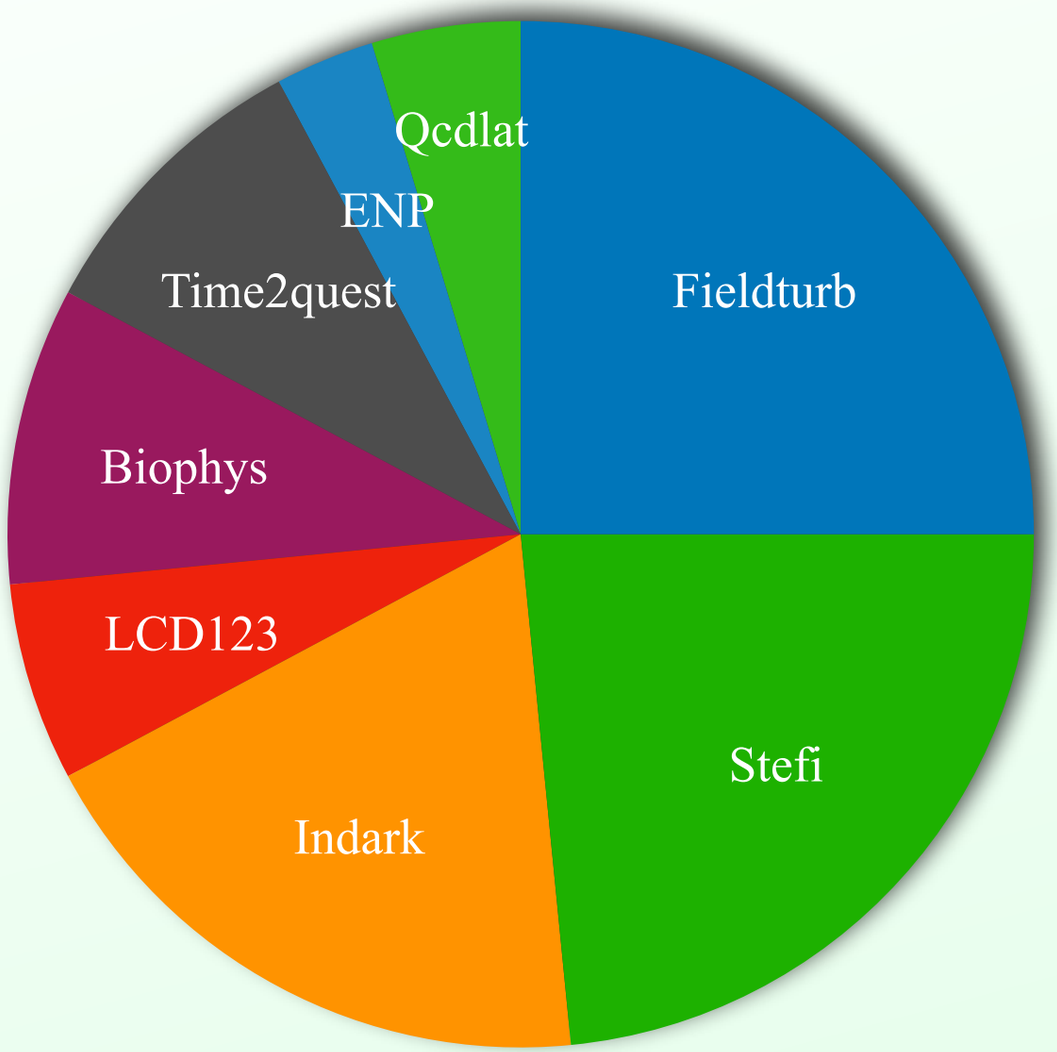
Istituto Nazionale di Fisica Nucleare
SEZIONE DI ROMA TOR VERGATA

Preventivi 2024

Gruppo IV

Iniziative Specifiche

- FTE:



- FIELDTURB: Sistemi complessi, turbolenza
  Massimo Cencini, ricercatori: 17, FTE 16
- STEFI: Teoria di stringa, gauge e gravita
  Raffaele Savelli ricercatori: 16, FTE 14.75
- LQCD123: Teorie di gauge sul reticolo
  Nazario Tantalo ricercatori: 5, FTE 3.5
- BIOPHYS: Biofisica
  Velia Minicozzi ricercatori: 8, FTE 5.75
- INDARK: Cosmologia
  Marina Migliaccio ricercatori: 15, FTE 11.6
- Time2quest: Struttura della materia
  Gianluca Stefanucci ricercatori: 10, FTE 6.4
- ENP: Fisica standard model e beyond
  Alberto Salvio ricercatori: 3, FTE 1.55
- QCDLAT: QCD sul reticolo
  Giulia De Divitis ricercatori: 4, FTE 3.5

FieldTurb

Responsabile locale: Massimo Cencini
Nazionale: Giuseppe Gonnella (Bari)

1 Benzi Roberto PO 100
2 Biferale Luca PO 100
3 Bonaccorso Fabio PHD 100
4 Buzzicotti Michele RTDA 100
5 Calascibetta Chiara PHD 100
6 Capocci Damiano PHD 100
7 Cencini Massimo CNR 50
8 Cimini Giulio RTDB 100
9 Guglietta Fabio RTDA 100
10 Heinonen Robin AR 100
11 Li Tianyi AR 100
12 Marra Rossana PO 100
13 Piro Lorenzo AR 100
14 Puglisi Andrea Dirigente ricerca CNR 50
15 Sbragaglia Mauro PO 100
16 Taglienti Diego PHD 100
17 Simeonni Daniele AR 100

Numero Totale Ricercatori 17 FTE: 16

Attivita':

The activity of the FieldTurb team has been focused on the following topics:
Eulerian aspects of complex flows: We have used techniques of machine learning (ML) for the reconstruction of convective flows by using only information on the temperature field and for reconstructing the component of the velocity fields in rotating turbulent flows. Moreover, we have written a review on the use of ML for the reconstruction of complex flows. We also derived new exact relations for turbulent flows.
Lagrangian aspects of complex flows: we have used reinforcement learning techniques to devise policies for the control of the dispersion of particles with limited swimming abilities, and developed optimal control and heuristic techniques for letting swimming particles to track and possibly capture targets (tracers) advected by a turbulent flow. In collaboration with the unit of Torino we have also studied the alignment of microswimmers swimming in non-homogeneous flows and their trapping in flows generated by surface waves. We developed optimal policies for the localization of a source of odors/chemicals (modeled as transported particles) in turbulence. Moreover, we studied the breakup statistics of aggregates of light and heavy particles transported by turbulent flows. We also build TURB-Lagr. A database of 3d Lagrangian trajectories in homogeneous and isotropic turbulence. We devised a new method for trapping sperms in microstructures.
Complex fluids: We studied the heat transfer fluctuations in the Rayleigh-Bènard convection of concentrated emulsions with finite-size droplets, developed a continuum model for soft glassy materials under shear and developed reduced models for droplet dynamics in shear flows at finite capillary numbers. Introduced a new regularized Lattice Boltzmann scheme for simulating soft matter. We also characterized droplet dynamics and statistics in concentrated emulsions via AI tools based on graph neural networks (GNN). We derived thermodynamic bounds for diffusion in nonequilibrium systems with applications to vibrofluidized granular medium.
Richiesta: 45 KE

STEFI

Responsabile Nazionale: Marialuisa Frau (Torino)
Responsabile Locale: Raffaele Savelli

Anagrafica:
1. Massimo Bianchi, PO, Dip. Fisica, Universita' di Roma "Tor Vergata" (100%)
2. Valentina Bevilacqua, PhD, Universita' di Roma "Tor Vergata" (100%)
3. Andrea Cipriani, PhD, Universita' di Roma "Tor Vergata" (100%)
4. Giuseppe D'Appollonio, RTI, Dip. Fisica , Universita' di Cagliari (100%)
5. Giuseppe Dibitetto, RTDB, Dip. Fisica, Universita' di Roma "Tor Vergata" (100%)
6. Giorgo di Russo, PhD, Universita' di Roma "Tor Vergata" (100%)
7. Francesco Fucito, DdR INFN, Sezione di Roma "Tor Vergata" (100%)
8. Carlo Iazeolla, PA, Universita' G. Marconi (100%)
9. Francisco Morales, PR INFN, Sezione di Roma "Tor Vergata" (100%)
10. Gianfranco Pradisi, PA, Dip. Fisica, Universita' di Roma "Tor Vergata" (100%)
11. Fabio Riccioni, Dip. Fisica, Universita' di Roma "Sapienza" (50%)
12. Alejandro Ruiperez, PhD, Universita' di Roma "Tor Vergata" (100%)
13. Alberto Salvio, RTD B, Dip. Fisica, Universita' di Roma "Tor Vergata" (25%)
14. Raffaele Savelli, PA, Dip. Fisica, Universita' di Roma "Tor Vergata" (100%)
15. Giuseppe Sudano, PhD, Universita' di Roma "Tor Vergata" (100%)
16. Gianluca Zoccarato, RTDB, Dip. Fisica, Universita' di Roma "Tor Vergata" (100%)

Numero ricercatori: 16, FTE: 14.75

Attivita' di Ricerca:

The activity of the String Theory group has been focussed on the following topics:

- Application of localization techniques to the study of N=2 supersymmetric gauge theories and black hole physics. Computation of instanton corrections in four and eight dimensional gauge theories and correlators in strongly interacting superconformal theories. Study of the gravitational wave response of black hole and fuzzballs, their spectrum of QNMs, the multipolar structure and echo signals. Study of aspects of beyond-the-Standard-Model physics and its relation with gravity and cosmology. In particular: the study of inflation in modified gravity models, metric-affine theories of gravity and axion-flavour connections.

- In the framework of N=2 supersymmetric gauge theories, computation of the OPE coefficients for conformal theories which are called of the Argyres-Douglas type. This computation was done keeping only the first two gravitational corrections and the results were shown to be in very good agreement with the conformal bootstrap.
- Determination of the field theory living on probe D3-branes of general 7-brane stacks wrapped on Abelian orbifolds;
- Determination of certain flux-dependent 8-derivative couplings in 10-dimensional Type IIB supergravity.
- Computation of loop amplitudes containing gravitons.
- Investigation of fuzz-ball phenomenology by exploiting the connection between BH, D-brane and fuzz-ball perturbation theory and N=2 SYM theories in the Nekrasov-Shatasvili approach.
- Study of generalised Couch-Torrence inversions, stringy memories, absorption cross-sections, (near) super-radiant modes and tidal Love numbers.
- Investigation of holography-inspired models for meson and glue-ball scattering.
- Computation of higher derivative corrections in N=6 supergravity from strings on asymmetric orbifolds.
- Study of non-perturbative aspects of gauge theories on curved manifolds.
- Study of the leptogenesis in post-inflationary models with additional dominating scalar fields.
- Study of Metric-Affine theories of gravity with dynamical torsion. The case of Weyl gauging. Study of generalized symmetries in gauge theories and applications to phenomenology.

Richiesta: 24 KE

INDARK

Title: Inflation, Dark Matter and the Large-Scale Structure of the Universe

Responsabile Nazionale: Massimiliano Lattanzi (INFN Ferrara)
Responsabile Locale: Marina Migliaccio
Anagrafica:

1) Hervé Bourdin (RTD-B UniRM2) 50%
2) Pasquale Mazzotta (PO UniRM2) 50%
3) Marina Migliaccio (Coord., RTD-B UniRM2) 50%
4) Nicola Vittorio (PO UniRM2) 50%
5) Avinash Anand, Ph.D. student, CSN II 40%
6) Giampaolo Benevento, post-doc, CSN IV 100%
7)Alessandro Carones, post-doc, CSN II 40%
8) Viviana Cuozzo, Ph.D. student, CSN IV 100%
9) Federico De Luca, post-doc, CSN IV 100%
10) Marco Faltelli, Tecnologo, CSN IV 100%
11) Arianna Favale, Ph.D. student, CSN IV 100%
12) Guglielmo Frittoli, Ph.D student, CSN IV 100%
13) Giacomo Galloni, Ph.D student, CSN IV 70%
14) Anto Idicherian Lonappan, post-doc, CSN II 40%
15) Giulia Piccirilli, Ph.D student, CSN IV 70%
15) Javier Carron-Duque, Postdoc, CSN IV 100%
Ricercatori 15, FTE 11.6

Attività' scientifiche:
The InDark project aims to investigate crucial aspects of the standard cosmological model and its extensions, together with their connection with particle physics. The main contributions of the Roma2 RU include:

i) Late-time Cosmology. Constrain models of Dark Energy and Modified Gravity with current cosmological datasets and derive forecasts for the combination of future observations of the Cosmic Microwave Background (from LiteBIRD, Simons Observatory, CMB-S4) and the Large-Scale Structure (LSS) of the Universe (from the Euclid galaxy survey whose launch is expected at the beginning of July 2023). Explore viable solutions to the Hubble constant tension following several approaches: a) assess the impact of data analysis methodological choices and approximations, also performing model-independent tests of data consistency; b) explore extensions to the ΛCDM model; and c) develop novel approaches that use galaxy clusters observations to get an independent measurement of the Universe expansion rate.

ii) Dark Matter. Develop estimators for measuring the correlation of CMB lensing with other tracers of the LSS, such as galaxy counts, cosmic shear and cosmic filaments, in order to map the distribution of Dark Matter in the Universe and constrain models of galaxy bias and growth of cosmic structures.

iii) Inflation and the primordial universe. Improve component separation techniques to mitigate foreground emissions in future CMB polarization measurements. Evaluate the capability to constrain parameters of non-standard inflationary models using both future CMB polarization data and Gravitational Wave observations.

Richiesta in KE: 24 KE

Jose F. Morales (INFN, Tor Vergata, Roma) Preventivi

LQCD123

Phenomenology with Lattice QCD in Roma123

Responsabile nazionale: Vittorio Lubicz (Roma Tre)
Responsabile locale: Nazario Tantalo

Anagrafica

1) Roberto Frezzotti (PO) 50%
2) Marco Guagnelli (R INFN) 100%
3) Nazario Tantalo (PA) 100%
4) Alessandro de Santis (PhD, D) 100%
5) Evangelista Antonio 60%

Ricercatori: 5, FTE: 3.5

Attività' scientifica

L'attività da noi svolta nel periodo 05/2022 -- 05/2023, limitandosi ai soli lavori peer-reviewed, è di seguito brevemente riassunta:

• abbiamo calcolato da principi primi il contributo adronico leading di polarizzazione del vuoto, nelle così dette short- e intermediate- windows, al momento magnetico anomalo del muone. I nostri risultati, allo stato dell'arte, hanno evidenziato una discrepanza dell'ordine di 4 deviazioni standard con i dati ottenuti da analisi dispersive dei dati sperimentali per il rapporto R (vedi sotto). • abbiamo validato un innovativo metodo da noi proposto (noto come metodo HLT) che permette di estrarre densità spettrali adroniche da correlatori euclidei calcolati sul reticolo facendo simulazioni numeriche di una teoria integrabile, il modello O(3) sigma non lineare in 1+1 dimensioni e confrontando, con successo, i risultati numerici con le espressioni note analiticamente. • abbiamo usato il su menzionato metodo HLT per calcolare da principi primi il rapporto R delle sezioni d'urto e+e-->adroni e e+e-->muoni, in bin di energia gaussiani di larghezze O(500) MeV, e confrontato i nostri risultati con quelli sperimentali osservando una tensione significativa (3 deviazioni standard) nei bins attorno al picco della risonanza rho. • sempre utilizzando il metodo HLT abbiamo studiato i decadimenti semileptonici inclusivi dei mesoni pesanti, H-->Xlnu, per masse dei quark pesanti nella regione del charm e confrontato i risultati non-perturbativi ottenuti da principi primi con quelli ottenuti mediante tecniche di OPE. • abbiamo studiato la dinamica non-perturbativa di modelli di Higgs composto con una interazione forte SU(4) con particolare attenzione al regime chirale e alla struttura dello spettro che abbiamo indagato usando il metodo HLT. • abbiamo effettuato simulazioni da principi primi di QCD+QED nella formulazione basata sull'utilizzo di condizioni al bordo C-periodiche e ottenuto, senza fissare una gauge e in una teoria completamente locale, i primi risulati per le masse dei pioni, dei kaoni, dei mesoni D(s) nonchè dei barioni sia di spin 1/2 che di spin 3/2 tenendo di conto non-perturbativamente gli effetti di isospin-breaking forte ed elettromagnetici. • abbiamo studiato i decadimenti P-->l nu l+ l- dei mesoni pseudoscalari leggeri dimostrando la possibilità di estrarre i necessari fattori di forma adronici da simulazioni di QCD sul reticolo. • utilizzando la formulazione da noi recentemente proposta della teoria isosimmetrica a passo reticolare fissato (rotated Twisted Mass) e il metodo RM123 per il calcolo degli effetti di isospinbreaking partendo da simulazioni di QCD isosimmetrica, abbiamo calcolato la differenza di massa dei pioni neutri e carichi all ordine alpha_em. • abbiamo dato un importante contributo alla stesura della review del Flavour Lattice Average Group (FLAG)
Nel corso del 2024 ci proponiamo di • estendere i nostri studi da principi primi del rapporto R e dei contributi adronici al g-2 del muone includendo gli effetti di isospin-breaking forte ed elettromagnetico e aumentando sostanzialmente la precisione sui contributi isosimmetrici. Questo ci permetterà nel caso del rapporto R di stringere i bins di energia Gaussiani e di meglio localizzare in energia la significativa discrepanza con gli esperimenti già evidenziata dai nostri precedenti studi da principi primi; • di calcolare con la precisione richiesta per poter effettuare stringenti test fenomenologici, i decadimenti radiativi P-->l nu gamma e P-->l nu l+l- sia nel caso dei mesoni leggeri (pi,K) che nel caso dei mesoni charmati (D,Ds).

• utilizzando il metodi da noi introdotti per studiare la fisica del bottom sul reticolo (ETMC ratio method) e per estrarre densità spettrali da correlatori euclidei di reticolo (HLT), di studiare diversi processi di notevole rilevanza fenomenologica legati a decadimenti dei mesoni B. In particolare ci proponiamo di studiare• i su menzionati decadimenti leptonici radiativi nel caso dei mesoni B; • i decadimenti semileptonici inclusivi B-->X lnu• i decadimenti semileptonici esclusivi B-->D(*)lnu• i decadimenti esclusivi B-->K(*) l+l- includendo con la necessaria precisione non perturbativa i contributi dei così detti charming penguins

• utilizzando il metodo HLT, di completare lo studio già intrapreso dei decadimenti inclusivi adronici del leptone tau, tau-->X nu_tau, nel settore di flavour adronico X_ud e di estendere lo studio al settore X_us particolarmente rilevante per l'estrazione dell'elemento di matrice CKM Vus.

RICHIESTA: 10 KE

Jose F. Morales (INFN, Tor Vergata, Roma) Preventivi

Biophys

Title: Intrinsically disordered proteins: multi-level computational approaches

Responsabile Nazionale: Sebastiano Stramaglia
Responsabile Locale: Velia Minicozzi
Anagrafica:

1) Simone Botticelli, PHD, 100%
2) La Penna Giovanni, PR, 50% 0.25
3) Minicozzi Velia, R 100%
4) Morante Silvia, PO, 100%
5) Cedrix Jurgal Dongmo Foumthuim , postdoc, 100%
6) Rossi Giancarlo, PO
7)Stellato Francesco, PA, 100%
8) Alleva Stefania , PHD, 100% 0.5

Ricercatori 8 FTE 5.75 (totale)

Attività' scientifiche:

The scientific research conducted by the Roma Tor Vergata group is focused on the development and application of computational methods to determine the structure and dynamics of biologically relevant molecules. These methods are used to provide a robust background for the analysis of experimental results obtained through the use of large-scale facilities such as synchrotrons and Free Electron Lasers. To study complex biological molecules such as proteins, a multi-scale approach is necessary due, on the one side, to the large number of atoms involved in these systems, and, on the other side, to the requirement for an *ab initio* quantum-mechanical description of specific aspects, such as the interaction with metal ions. Our group develops multi-level strategies for computational analysis based on non-equilibrium molecular dynamics simulations, which are carried out using the multiple-walkers meta-dynamics method on high-performance computing (HPC) platforms. At present, our group is focused on: i) a challenging investigation involving the prediction of the structure of [Fe-Fe]-hydrogenase in Chlorella vulgaris microalga, which is relevant for clean hydrogen production; ii) the redox chemistry of Cu ions and amyloid-b peptides in the synapse; iii) and the interaction of SARS-CoV-2 proteins of unknown function with Zn ions and host first-defense proteins.

Richiesta in KE: 11 KE

TIME2QUEST

Title: Advanced Theoretical methods for emerging 2D materials in Quantum Information Technology Studies

Responsabile Nazionale: Antonello Sindona
Responsabile Locale: Gianluca STEFANUCCI

Anagrafica:
1) Gianluca Stefanucci (PA) - 100%
2) Enrico Perfetto (PA) - 100%
3) Olivia Pulci (PO) - 100%
4) Maurizia Palummo (PA) - 100%
5) Simone Grillo (PhD) - 70%
6) Simone Brozzesi (PhD) -70%
7) Domenico Corona (PhD) -70%
8) Alessia Muroni (PhD) -70%
9) Vasil Saroka (Postdoc) -50%
10) Igor Kupchak (Postdoc) -50%

Ricercatori 10, FTE 6.4

Attività' scientifiche:

The formalism of nonequilibrium Green's functions has been further developed to simulate many-body quantum dynamics (fermions and bosons) with algorithms that scale linearly in time. The method has been successfully employed in the study of the relaxation dynamics of charge carriers in photo-excited semiconductors and semimetals
The consequences of the theory describing photoemission spectra from semiconductors resonantly excited with the exciton energy have been elaborated. In particular, the evolution of the spectrum following high pumping and the consequences of the decoherence effects induced by the coupling with the phonons have been worked out. The results of our predictions have recently been confirmed by experiments in two-dimensional materials
The equilibrium density functional theory (DFT) has been generalized to systems in nonequilibrium stationary states. The new theory was then used to calculate the spectral function of strongly correlated systems. Within two he new framework we have shown how to access the Mott metal-insulator transition, a hallmark of strong correlation effects.

Richiesta in KE: 11 KE

Title: Exploring New Physics

Responsabile Nazionale: Gennaro Corcella
Responsabile Locale: Alberto Salvio

Anagrafica:

1) Roberto Frezzotti (PA 40%)
2) Alberto Salvio(RTDB) 75%
3) Antonio Evangelista(studente laurea magistrale 40%)

Ricercatori 3, FTE 1.55

Attività' scientifiche:

Research activity

- We will extend lattice-based work on the hadronic contribution to the muon anomalous magnetic moment, by increasing statistics, lattice volume and including isospin-breaking effects.
- We shall examine alternative solutions to the strong CP problem
- We will investigate new physics effects in gravity and cosmology, e.g., phase transitions producing gravitational waves.

Richiesta: 5 KE

QCDLAT

Title: Next generation lattice field theory for searching new phenomena in particle physics
Responsabile Nazionale: Leonardo Giusti
Responsabile Locale: Giulia Maria de Divitiis

Anagrafica:

1)Giulia Maria de Divitiis 100%
2) Mauro Lucio Papinutto 50%
3) Anastassios Vladikas 100%
4) Ludovica Pirelli 100%

Ricercatori 4, FTE 3.5

Attività' scientifiche:

The purpose of the QCDLAT project is to give high-precision theoretical predictions of QCD,
so as to provide results useful for the search for potential signals of physics beyond the Standard Model.
The regularisation of the lattice allows to perform non-perturbative investigations from first principles by means of Monte Carlo simulations.
The Tor Vergata unit focuses on research concerning renormalization and non-perturbative evolution in QCD and Flavour physics in SM and beyond.
In particular, the study concerns

1) the non-perturbative renormalisation and RG-running in QCD with three dynamical flavours Nf=3 of flavour non-singlet quark bilinears and DeltaF=2 four-fermion operators present in the effective weak Hamiltonian relevant for the study of neutral meson oscillations.
The RG-evolution runs between a hadronic scale (~200 MeV) and an electroweak energy scale (~100 GeV) where perturbation theory can safely be applied, by using chirally-rotated Schrödinger-Functional (XSF) renormalization scheme.

2) the determination of the bare matrix elements of DeltaF=2 four-fermion operators on hadronic states

3) the computation of coefficients for the O(a) Symanzik improvement in lattice QCD with Wilson fermions

In the past year:
--We have concluded the renormalization constant of the flavor-non-singlet tensor operators which is important in the rare heavy meson decays and the neutron electric dipole moment, and which still lacks a non-perturbative determination. For this analysis we adopted four different renormalisation schemes, using different denominators to cancel the Schrödinger functional boundary fields. The article is in preparation.
--We have performed an explorative analysis to extract the four-quark RG-running in half the energy range. Our preliminary investigations reveal how perturbation theory breaks down at the scale of a few GeV, and how crucial the non-perturbative evolution becomes. Furthermore, for some of the operators for which the standard perturbative approach to the computation of the RG-running fails in the Nf=3 case, we have implemented a recently proposed new formulation that is well defined for arbitrary Nf.
--We have developed a new strategy to evaluate b_g, the Symanzik improvement coefficient of the gauge coupling in lattice QCD with Wilson fermions, using a chiral Ward identity which relates correlation functions of singlet scalar and non-singlet pseudoscalar densities.

Richiesta in KE: 5 KE

Dotazione IV

Coordinatore: Francisco Morales
FTE: 60
Richiesta in KE: 57 KE

Capitolo	Descrizione	Parziali (K-EUR)	Parziali SJ (K-EUR)	Totale/Cap (K-EUR)	Totale/Cap SJ (K-EUR)
consumo	cancelleria, materiali stampanti, manutenzione	4.00	0.00	4	0
interno	Partecipazione a conferenze	12.00	0.00	12	0
inventario	computer, stampante	15.00	0.00	15	0
inviti	Invito per periodi di 7-60 giorni	12.00	0.00	12	0
licenze-SW	licenze zoom, altri software	2.00	0.00	2	0
seminari	organizzazione di seminari	10.00	0.00	10	0
spservizi	attivitÃ di terza misione	2.00	0.00	2	0
Totale	/	0	0	57	0