

Theory support WP2.4

Gert Aarts







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THEORY

2 pillars:

ECT*, European Centre for Theoretical Studies in Nuclear Physics and Related Areas
 Trento, Italy – Gert Aarts

Theo4Exp: Virtual Access to well-established computing codes
 Manuela Rodríguez-Gallardo (Universidad de Sevilla)



THEORY – ECT*

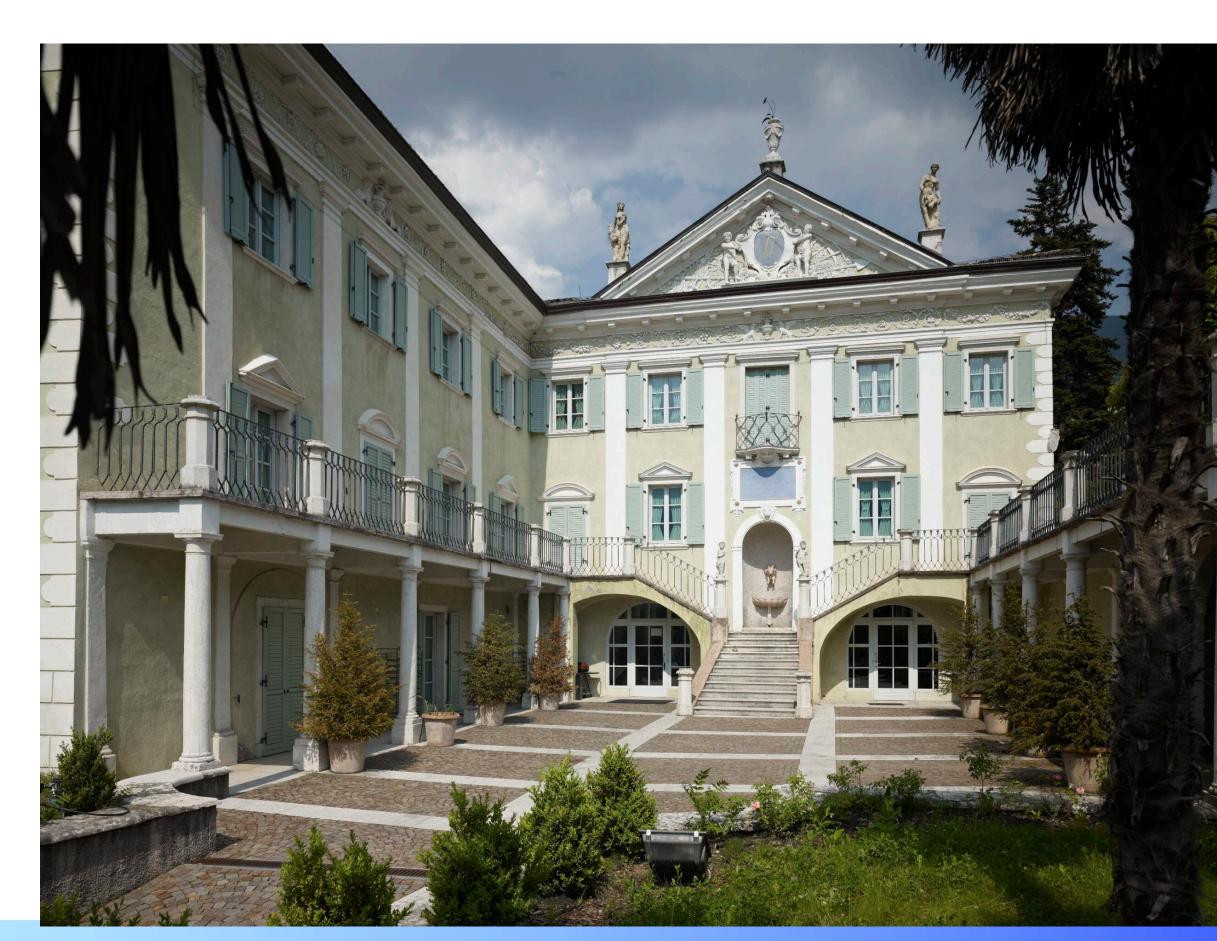
ECT*, European Centre for Theoretical Studies in Nuclear Physics and Related Areas

unique centre in Europe in theoretical nuclear physics in the broadest sense

main activity is annual programme of

- week-long workshops (about 22/year)
- Doctoral Training Programme (3-6 weeks)
- TALENT school (every other year)
- visitor programme

also a local research group with 5 permanent researchers, 3 postdocs and 2 PhD students





2022 PROGRAMME OF ACTIVITIES

	ZUZZ I HOUHAMI		AGTIVITIES .
JANUAI	RY		INFN), K. PISCICCHIA (Centro Fermi, Roma), N. YUNES (University of
31.1-4.2	Alpha_S (2022): Workshop on Precision Measurements of the Strong Coupling Constant	AUGUST	Illinois at Urbana-Champaign)
APRIL 11-15.4	D. ENTERRIA (CERN), S. KLUTH (MPP), G. ZANDERIGHI (MPP) Nuclear Physics from Atomic Spectroscopy (ONLINE) L. PLATTER (University of Tennessee), R. GARCIA RUIZ (Massachusetts Institute of Technology), C. JI (Central China Normal University),	1-5.8	Neutron Electric Dipole Moment: from Theory to Experiment* A. ATHENODOROU (Pisa University), D. GIATAGANAS (National and Kapodistrian University of Athens), B. LUCINI (Swansea University), E. RINALDI (Arithmer Inc., Tokyo), K. CRANMER (New York Universit C. ALEXANDROU (University of Cyprus)
MAY	S. PASTORE (Washington University)	29.8-2.9	LFC22: Strong Interactions from QCD to New Strong Dynamics at LHC and Future Colliders*
-20.5	ECT* DOCTORAL TRAINING PROGRAM: Hadron Physics with Functional Methods R. ALKOFER (University of Graz), G. EICHMANN (LIP Lisboa), M. HUBER (Giessen University)	SEPTEM	G. CORCELLA (LNF-INFN), S. DE CURTIS (INFN Florence), S. MORI (University of Southampton), G. PANCHERI (LNF-INFN), R. TENCHIN (INFN Pisa), M. VOS (IFIC Valencia) BER
3-27.5 UNE	Gauge Topology, Flux Tubes and Holographic Models: The Intricate Dynamics of QCD in Vacuum and Extreme Environments* E. SHURYAK (Stony Brook University), M. D'ELIA (University of Pisa), J. GREENSITE (San Francisco State University), E. KIRITSIS (University of Crete), I. ZAHED (Stony Brook University)	5-9.9	From Hadrons to Therapy: Fundamental Physics Driving New Medical Advances P. DE VERA GOMIS (Universidad de Murcia), M. DURANTE (GSI), C. HOEHR (TRIUMF), K. PARODI (Ludwig-Maximilians-Universität München), V. CONTE (LNL-INFN), J. KOHANOFF (Universidad Politécnica de Madrid), M. SCHWARZ (APSS, Trento), R. GARCIA-MOLINA (Universidad de Murcia)
10.6	Connections Between Cold Atoms and Nuclear Matter:	12-16.9	Revealing Emergent Mass through Studies of Hadron
	From Low to High Energies C. SA DE MELO (Georgia Institute of Technology), A. GEZERLIS (University of Guelph)		Spectra and Structure* D. BINOSI (ECT*), H. W. LIN (Michigan State University), T. HORN (Catholic University of America), C. ROBERTS (Nanjing University)
3-17.6	Jet Quenching in the Quark-Gluon Plasma* J. MULLIGAN (UC Berkeley), Y.J. LEE (MIT), K. TYWONIUK (University of Bergen), L. CUNQUEIRO (École Polytechnique), S. CAO (Shandong University)	26-30.9	Opportunities with JLAB Energy and Luminosity Upgrade H. AVAGYAN (Jefferson Lab), J. ARRINGTON (LBL), A. BACCHETTA (Pav University), O. HEN (MIT), X. JI (UMD), K. JOO (UConn), X. ZHENG (UVa)
)-24.6	Neutron Stars as Multi-Messenger Laboratories for Dense Matter* I. TEWS (LANL, Los Alamos), B. GIACOMAZZO (University of Milano), S.	OCTOBE 3-14.10	Reduced Density-Matrix Functional Theory: Improving
	GUILLOT (CNRS Toulouse), J. MARGUERON (IPN Lyon), S. NISSANKE (University of Amsterdam)	3-14.10	its foundation and extending its scope C. L. BENAVIDES-RIVEROS (Max-Planck Institute for Complex Systems), E. K. U. GROSS (Hebrew University) and C. SCHILLING (LMU, Munich)
7.6-1.7 ULY	Saturation and Diffraction at the LHC and the EIC C. ROYON (Kansas University), A. SABIO VERA (Universidad Autónoma de Madrid), S. SCHLICHTING (University of Bielefeld), A. DESHPANDE (Stony Brook University), G. SOYEZ (IphT, Saclay), M. HENTSCHINSKI (Universidad de Las Americas Puebla)	17-21.10	EXOTICO: EXOTIc Atoms Meet Nuclear Collisions for a New Front Precision Era in Low-Energy Strangeness Nuclear Physics* O. VAZQUEZ DOCE (LNF-INFN), C. CURCEANU (LNF-INFN), A. RAMOS (Universitat de Barcelona), J. ZMESKAL (SMI-Vienna), J. MAREŠ (Czech Academy of Sciences)
8.7	Nuclear Physics at the Edge of Stability* G. HUPIN (IJClab), O. SORLIN (GANIL), A. GADE (MSU), L. PLATTER (UTK)	24-28.10	Giant and Soft Modes of Excitation in Nuclear Structure and Astrophysics*
-15.7	Advances on Giant Nuclear Monopole Excitations and Applications to Multi-messenger Astrophysics*	NOVEME	E. LITVINOVA (Western Michigan University), R. BROGLIA (Niels Bol Institute), H. LENSKE (Justus-Liebig-Universität, Giessen)
1111111	Y. BLUMENFELD (IJCLab), G. COLÒ (University of Milano and INFN), U. GARG (University of Notre Dame), E. KHAN (IJCLab), M. VANDEBROUCK (DPhN, CEA Saclay)	7-11.11	Tomography of Light Nuclei at an EIC* A. FREESE (University of Washington), W. COSYN (Ghent University &
3-22.7	Radiative Corrections from Medium to High Energy Experiments* E. CLINE (Stony Brook University), A. AFANASEV (George Washington Hairweite), S. RADIANOVA (Managing University of New Joyn June 1)	DECEMB	
	University), S. BARKANOVA (Memorial University of Newfoundland), J. BERNAUER (Stony Brook University), R. GILMAN (Rutgers University), H. SPIESBERGER (Johannes Gutenberg University of Mainz)	12-16.12	Key Reactions in Nuclear Astrophysics* A. TUMINO (University of Enna "Kore" & INFN-LNS, Catania), J. JOSÉ (Technical University of Catalonia), C. BERTULANI (Texas A&M University-Commerce), R. DIEHL (MPI Munich), L. TRACHE (IFIN-HH Buc
5-29.7	Nuclear and Atomic Transitions as Laboratories for High Precision Tests of Quantum Gravity Inspired Models A. MARCIANO (Fudan University), S. ALEXANDER (Brown University, Providence), E. BARBERIO (Melbourne University), C. CURCEANU (LNF-	Rea.	Magurele, Romania) *STRONG-2020 supported work







Hadron Physics with Functional Methods

Doctoral Training Programme 2022 Trento, 2-20 May 2022

LECTURERS AND TOPICS

lan Cloet, Argonne National Laboratory
Hadron structure at the EIC

Christian S. Fischer, Giessen University Functional methods

Astrid N. Hiller Blin, Thomas Jefferson National Accelerator Facility Amplitude analysis and electroproduction experiments

Pieter Maris, Iowa State University

Dyson-Schwinger and Bethe-Salpeter
equations

Jan M. Pawlowski, University of Heidelberg Functional renormalization group

Elena Santopinto, INFN Sezione di Genova Quark models

Alessandro Pilloni, INFN Sezione di Roma Exotic hadron spectroscopy

PROGRAMME COORDINATORS

Reinhard Alkofer, University of Graz Gernot Eichmann, LIP Lisboa Markus Huber, Giessen University

STUDENT COORDINATOR AND ADVISOR

Markus Huber, Giessen University

APPLICATIONS

Applications for the ECT* Doctoral Training
Programme should be made electronically
through the ECT* web page. It should include: a
curriculum vitae, a 1-page description of
academic and scientific achievements, a short
letter expressing the applicants' personal
motivation for participating
in the Programme.
In addition, a reference letter from the candidate's
supervisor should be sent to Barbara Gazzoli
(gazzoli@ectstar.eu)
for the attention of Professor
Gert Aarts - Director of ECT*.
For further details see www.ectstar.eu





THEORY - ECT*

bottom-up approach:

- programme based on proposals submitted by the community
- two calls: in May and September, straightforward web form
- decision made at ECT* Scientific Board meeting in June and October

ECT* supports workshops via subsistence (coffee breaks, lunches, two dinners) and partial or full support for accommodation

travel pending on conditions of support (ECRs, EU Horizon upon request)

ECT* Scientific Board

Almudena Arcones | TU Darmstadt (D)

Constantia Alexandrou | The Cyprus Institute (CY)

Carlo Barbieri | University of Milan (I)

Anna Corsi | IRFU/DPhN (F)

David Kaplan | University of Washington (USA)

Denis Lacroix | CNRS/IN2P3 (F)

Marek Lewitowicz | NuPECC/GANIL (F)

Barbara Pasquini | University of Pavia (I)

Urs Wiedemann, Board Chair | CERN-TH (CH)

Ex officio: Sandro Stringari | University of Trento (I)



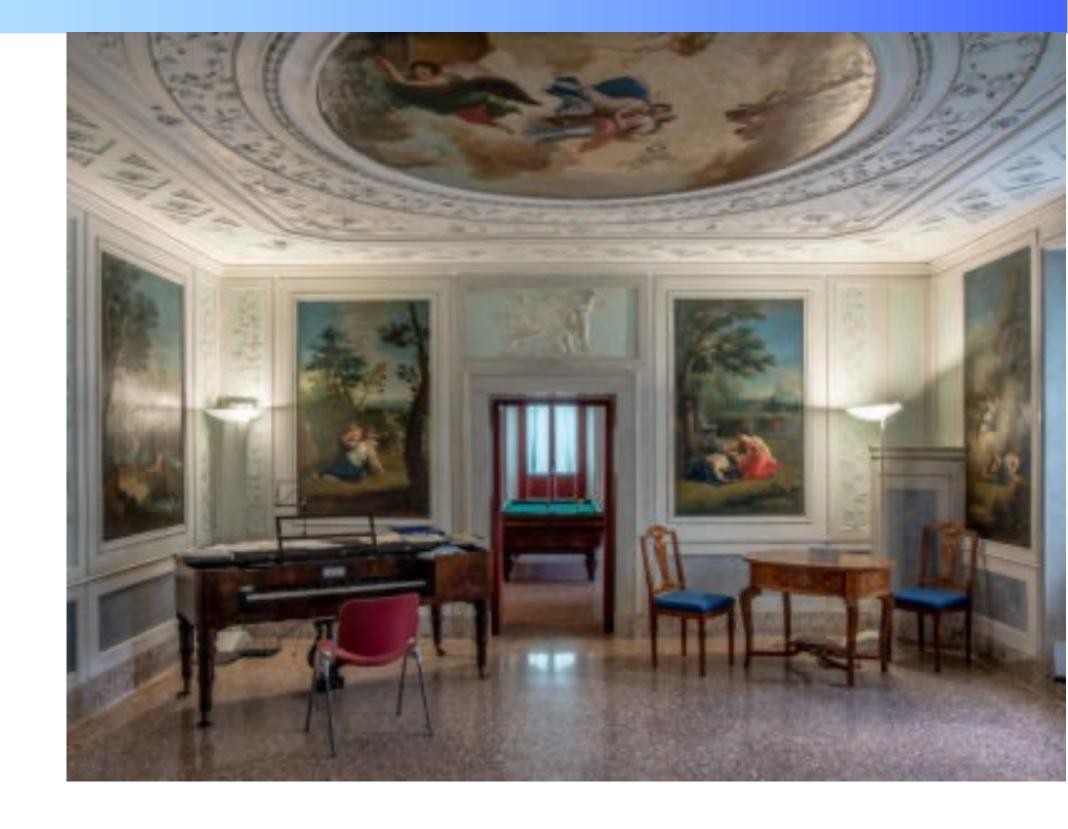
THEORY – ECT*

to apply to organize a workshop:

- submit proposals via standard route (see website)
- mention EURO-LABS (not compulsory)
- ECT* Scientific Board selects workshops
- with Director determines which workshops are supported by EURO-LABS

to apply as participant:

- workshop registration opens two months before start of workshop
- key participants are often contacted at submission stage



In 2022: one workshop supported

EXOTICO: EXOTIC ATOMS MEET NUCLEAR COLLISIONS FOR A NEW FRONTIER PRECISION ERA IN LOW-ENERGY STRANGENESS NUCLEAR PHYSICS

October 17-21 2022



Theo4Exp virtual access infrastructure: provide theoretical tools for the EURO-LABS project and wider experimental nuclear physics community

3 installations:

- MeanField4Exp (Krakow): access to mean-field theory service in the domain of nuclear structure physics. <u>Deputies</u>: Jerzy Dudek (IPHC Strasbourg)/Piotr Bednarczyk (Krakow)
- Reaction4Exp (Sevilla): codes used for nuclear reaction calculations.
 Coordinator: Manuela Rodríguez-Gallardo
- Structure4Exp (Milano): virtual access to other codes that use advanced tools of nuclear structure theory. <u>Deputy</u>: Gianluca Coló

website: institucional.us.es/theo4exp/



Coordinating Team (CT)

- Coordinator: Manuela Rodríguez-Gallardo
- Deputies: Jerzy Dudek and Gianluca Coló

International Review Panel (IRP)

- Piotr Bednarczyk (Chairperson) and Krzysztof Rusek
- Antonio M. Moro and Ian J. Thompson
- Enrico Vigezzi and Angela Gargano

IRP will meet annually to produce yearly internal assessment reports.

CT will provide the IRP a comprehensive list of results and achievements, access statistics and user feedback.

First IRP meeting: September 8 2022





MeanField4Exp

Theo4Exp

Manuela Rodríguez Gallardo

- Static macroscopic nuclear energies and macroscopic energies vs spin (Lublin-Strasbourg-Drop (LSD))
- Quasiparticle Routhians and alignments, Yrast and quasiparticle band energies and moments of inertia (HBF-Cranking)
- Energies and structures of nuclear K- amd yrast-tarp isomers
- Giant Dipole Resonance profiles at increasing spins and temperatures
- Muclear density functions for deformed nuclei
- Larger sets of pre-calculated results such as potential energy maps, electric and mass moments, reduced probabilities

LSD program: K. Pomorski and J. Dudek, PRC 67 (2003) 044316





Reaction4Exp

Theo4Exp

Manuela Rodríguez Gallardo

- Optical Model calculations: FRESCO (http://www.fresco.org.uk/)
- 2 Coupled-Channels calculations: FRESCO
- Semiclassical calculations (high energy collisions):
 EPM_SEV

Example: V. Pesudo et al., Phys. Rev. Lett. 118 (2017) 152502

Double folding potentials from density distributions:

DFPOT

J. Cook, Comp. Phys. Comm. 25(2), 125-139 (1982)

SPP

L.C. Chamon, B.V. Carlson and L.R. Gasques, Comp. Phys. Comm. 267 (2021) 108061







Structure4Exp

Theo4Exp

Manuela Rodríguez Gallardo

- Binding energies, density distributions and mean square radii (skyrme_rpa, hfbcs_qrpa)
- Energies and wave functions/transition densities of the excited states, as well as electromagnetic transition probabilities to the ground state (skyrme_rpa, hfbcs_qrpa)
- Calculations of charge-changing transitions
- 4 Beta-decay half-lives
- → skyrme_rpa G. Colò et al., Comp. Phys. Comm. 184, 142 (2013)
- → hfbcs_qrpa
 G. Colò and X. Roca-Maza, arXiv:2102.06562 [nucl-th]



Personnel (milestone for month 18):

- MeanField4Exp (IFJ PAN, Krakow): 2-year contract computer scientist to implement mean-field theory codes for large-scale calculations of nuclear structure; responsible for programming and management of user-friendly web interface
- Reaction4Exp (U. Sevilla): 2-year contract
 computer scientist for programming and management of user-friendly web interface
- Structure4Exp (U. Milano): 1-year contract computer scientist to improve existing nuclear structure codes; responsible for programming and management of user-friendly web interface

Servers: codes will run on new or existing servers, agreed with university computer centres



Access:

- free access contents in the webpage, collect feedback but not counted as unit of access
- possibility to run remotely some codes and download results, download pre-calculated data and some computer codes
- users apply to verify link to institutions; will receive access codes
- question: access to users outside of Europe?

Details to be added to website: institucional.us.es/theo4exp/



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