Introducing the Lattice Virtual Academy (LaVA)

Speaker:
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[On behalf of LaVA]

Lattice 2023, 31/07/23

Fermilab, Batavia, Illinois, USA

General introduction

LaVA is a virtual platform for advanced e-learning and mixed learning in Lattice Field Theory and related areas.

Under development within STRONG-2020 EU-funded project
+ technical and financial support by FBK/ECT* and by INFN.

The pandemic has led to the production of a large collection of videos and written material. Now that we are back to normality, we thought it may be useful that such legacy is not lost, but saved, collected, organized and complemented, for the benefit of the scientific Community.

Goals of LaVA

- Provide students and early-stage researchers with a wide collection of recorded video lecture and written lecture-notes in Lattice Field Theories (LFTs)
- The platform will include both links to pre-existing public material publicly available online (e.g., video recordings and lecture notes from past school or training events) and **new** ad-hoc material that will be developed for LaVA (video-recorded lecture snippets with related notes/slides)
- Provide organizes list of topics, each one with its syllabus, so that users (both within and outside the Lattice community) can be more easily introduced to the main active research areas in LFTs, as well as to the basic foundations of the field
- Covered topics will range from very introductory (e.g., how to discretize scalar fields) to more advanced one (e.g. precision physics, quantum simulations, machine learning applications, . . .)
- Important to improve diversity and inclusivity in our field: LaVA can help aspirant lattice practitioners from under-represented categories to enter the Lattice community

People

LaVA Launching Committee

Claudio Bonanno, *IFT UAM/CSIC Madrid*

Maria Paola Lombardo, *INFN and University of Florence*

Mike Peardon, *Trinity College Dublin*

LaVA group

Costantia Alexandrou, *University of Cyprus and The Cyprus Institute*

Andreas Athenodorou, *University of Cyprus and The Cyprus Institute*

Claudio Bonanno, *IFT UAM/CSIC Madrid*

Francesco Di Renzo, *University of Parma*

Margarita Garcia Perez, *IFT UAM/CSIC Madrid*

Christof Gattringer, *Institute of Physics, Graz and FWF Austrian Science Fund*

Simon Hands, *University of Liverpool*

Karl Jansen, *DESY Zeuthen*

Frithjof Karsch, *University of Bielefeld*

Maria Paola Lombardo, *INFN and University of Florence (chair)*

Tereza Cristina de Rocha Mendes, *Universidad de Sao Paulo*

Guy Moore, *TU Darmstadt*

Kari Rummukainen, *University of Helsinki*

Alexander Rothkopf, *University of Stavanger*

Giancarlo Rossi, *University of Tor Vergata*

Andrea Shindler, *Michigan State University*

Davide Vadacchino, *University of Plymouth*

Andre' Walker-Loud, *Lawrence Berkley National Laboratory*

LaVA is hosted by ECT*

European Centre for Theoretical Studies in Nuclear Physics and Related Areas

Director:

Gert Aarts

Internal organization:

Barbara Gazzoli, ECT* - Project Assistant

Francesca Guerzoni, Petra Jansen - FBK - Web and Communication

Strong-2020 core group

Gunnar Bali, *Regensburg University*

Luigi Del Debbio, *Edinburgh University*

Gregorio Herdoiza, *UAM Madrid*

Maria Paola Lombardo, *INFN and University of Florence*

Mike Peardon, *Trinity College Dublin (chair)*

Hartmut Wittig, *Mainz University*

Graphic design and brand identity

Gaia Stirpe,
Ufficio Comunicazione INFN

Photography

Giancarlo Tine' ,
Giancarlotine' Photography,
https://www.giancarlotine.it/

The LaVA Group and the convenors reunited in Trento at ECT*, Feb. 20th – 24th, 2023, to discuss the organization of topics, their syllabi, and how to proceed to develop new material for the platform.

Topics


Essentials of Lattice Field Theory
Algorithms
Data Analysis
Lattice Fermions & Chiral Symmetry
Renormalization & Improvement
Thermal Field Theory
Approaches to Systems with Sign Problems
Quantum Computing & Tensor Networks
Machine Learning
Hardware & Software
Hadron Physics Essentials
Hadron Structure
Hadron Spectroscopy
Precision Frontier
Beyond the Standard Model Field Theories
Critical Phenomena & Renormalization Group
Vacuum Structure & Confinement
Reproducibility & Open Science

LaVA website - Beta version is now online

You can find a Beta version of the LaVA website at:

https://sites.google.com/view/lattice-virtual-academy

Note: this URL is **temporary** and will be migrated in the near future.

PRELIMINARY WEBPAGE! However, already started populating the website with material

$\longrightarrow$ "**Essentials**" section is at a pretty advanced stage. There we gathered **introductory video-lectures**, complemented by lecture notes.

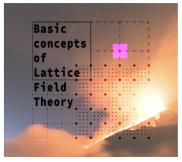
Conveners: **Margarita García Peréz, Christof Gattringer, Simon Hands.**

A sneak peek from the “Essentials” section

Conveners

Margarita García Pérez, Instituto de Física Teórica (IFT) UAM-CSIC Madrid
Christof Gattringer, Austrian Science Fund FWF & University of Graz
Simon Hands, University of Liverpool

General motivation



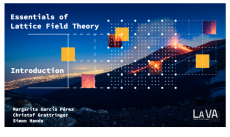
Quantum Chromodynamics (QCD) is the quantum field theory that describes the interactions between quarks and gluons. It is a strongly interacting theory at low energies, and therefore an ab-inito description of low-energy properties, such as confinement or chiral symmetry breaking, requires the use of a non-perturbative regulator.

In this unit on the fundamentals of lattice field theory, you will learn how to define a field theory on a discretised space-time grid and how to formally recover the continuum limit; the emphasis is on the Lagrangian formalism, but the Hamiltonian formalism is also introduced.

Prerequisites

Basic knowledge of relativistic field theory and in particular Quantum Chromodynamics.

Lectures



1 Introduction

- Outline and delimitation of this section

2 Euclidean *n*-point functions

- Euclidean *n*-point functions are a powerful tool in quantum field theory.
- They can be used to compute energy levels and matrix elements.
- Here we define Euclidean *n*-point functions and discuss their properties.

Slides

3 Euclidean *n*-point functions in QM

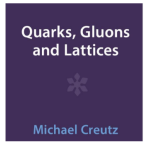
- Euclidean *n*-point functions have a representation in terms of euclidean path integrals.
- We work out the path integral representation for the example of 3d Quantum Mechanics.

Slides

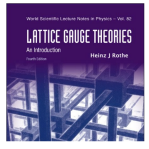
Structure:

- Short paragraphs synthesizing learning goals and pre-requisites
- Syllabus of topics, each one with short description, video-recorded lectures (we found very effective to use the “snippet” format, but some topics needed longer formats) and related short lecture notes
- Short collection of pre-existing materials: books, other lecture notes, other recorded material from other training activities (e.g., Ph.D. schools)
- Material produced for LaVA will be hosted on the `Zenodo` platform

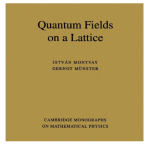
Books



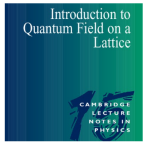
Creutz



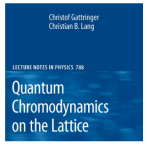
Rothe



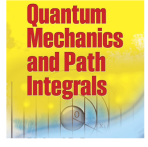
Montvay & Münster



Smit

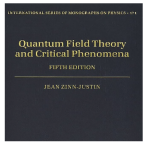


Gattringer & Lang



Feynman & Hibbs

Negele & Orland



Zinn-Justin

Schools

Les Houches 2009

INT Summer School 2021

EVERYONE IS WELCOME TO JOIN AND CONTRIBUTE!

We are happy to receive comments, suggestions or feedback! If you have material that you think could fit in the project, and you feel like sharing it, please feel free to reach out with LaVA!

lava@ectstar.eu

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Thank you for your attention!