What’s next?

Baltic Teacher Programme

27 April 2023

Outcome and To-Do-List

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Share your experience with your students, your colleagues, and the general public.

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Act as ambassadors for science/engineering and in particular for particle physics.

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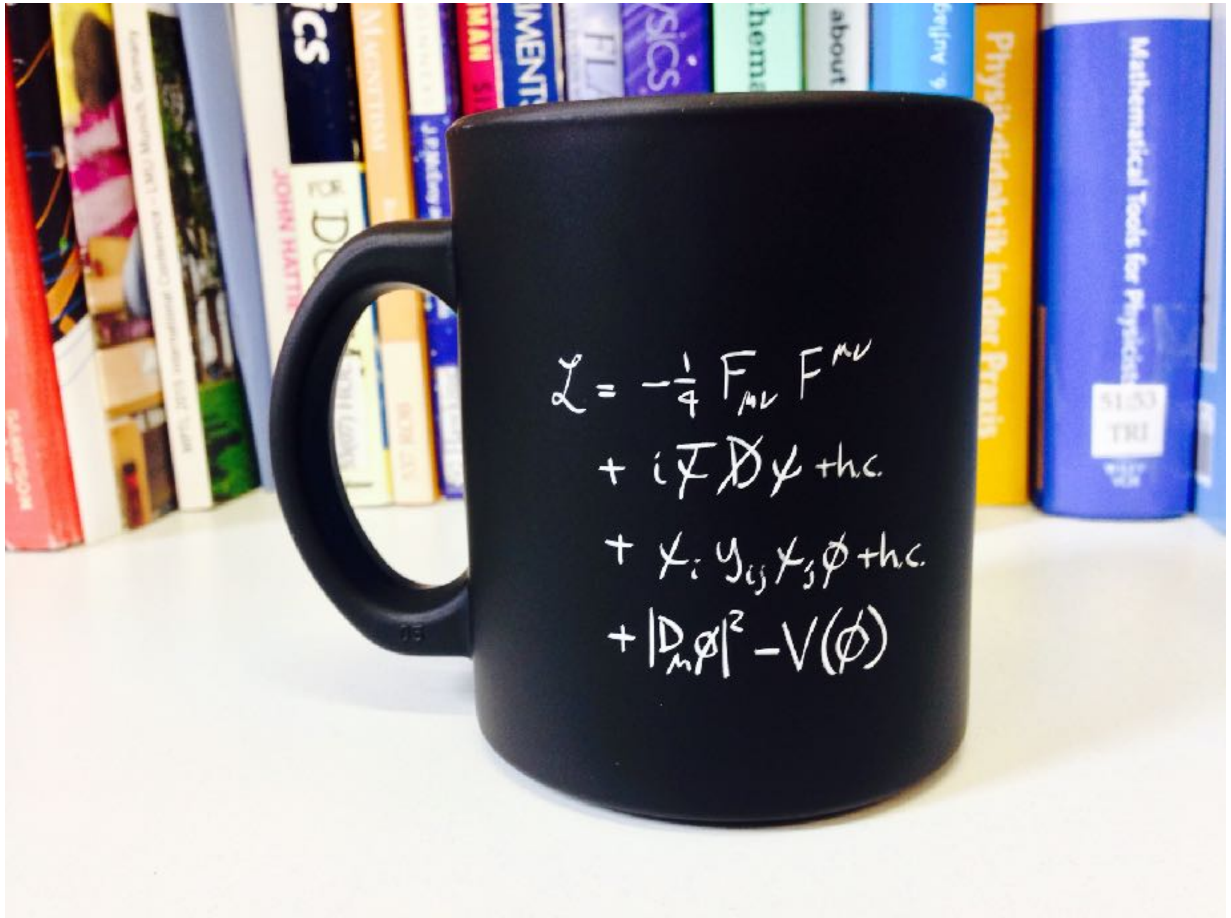
Organise follow-up activities.


$\mathcal{L} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu}$
$+ i \bar{\psi} \not{D} \psi + h.c.$
$+ \psi_i y_{ij} \psi_j \phi + h.c.$
$+ |D_\mu \phi|^2 - V(\phi)$

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Let’s have a coffee with the Standard Model of particle physics!

Julia Woithe[1,2], Gerfried J Wiener[1,3] and Frederik F Van der Veken[1]

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Abstract
The Standard Model of particle physics is one of the most successful theories in physics and describes the fundamental interactions between elementary particles. It is encoded in a compact description, the so-called ‘Lagrangian’, which even fits on t-shirts and coffee mugs. This mathematical formulation, however, is complex and only rarely makes it into the physics classroom. Therefore, to support high school teachers in their challenging endeavour of introducing particle physics in the classroom, we provide a qualitative explanation of the terms of the Lagrangian and discuss their interpretation based on associated Feynman diagrams.

1. Introduction

The Standard Model of particle physics is the most important achievement of high energy physics to date. This highly elegant theory sorts elementary particles according to their respective charges and describes how they interact through fundamental interactions. In this context, a charge is a property of an elementary particle that defines the fundamental interaction by which it is influenced. We then say that the corresponding interaction particle ‘couples’ to a certain charge. For example, gluons, the interaction particles of the strong interaction, couple to colour-charged particles. Of the four fundamental interactions in nature, all except gravity are described by the Standard Model of particle physics: particles with an electric charge are influenced by the electromagnetic interaction (quantum electrodynamics, or QED for short), particles with a weak charge are influenced by the weak interaction (quantum flavour dynamics or QFD), and those with a colour charge are influenced by the strong interaction (quantum chromodynamics or QCD). Contrary to the fundamental interactions, the Brout–Englert–Higgs (BEH) field acts in a special way. Because it is a scalar field, it induces spontaneous symmetry-breaking, which in turn gives mass to all particles with which it interacts (this is commonly called the Higgs mechanism). In addition, the Higgs particle (H) couples to any other particle which has mass (including itself).

Interactions are mediated by their respective interaction particles: photons (γ) for the

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$$\mathscr{L} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + i\bar{\psi}\not{D}\psi + h.c. + \psi_i y_{ij}\psi_j\phi + h.c. + \left|D_\mu\phi\right|^2 - V(\phi)$$

interaction particles

interactions between matter particles

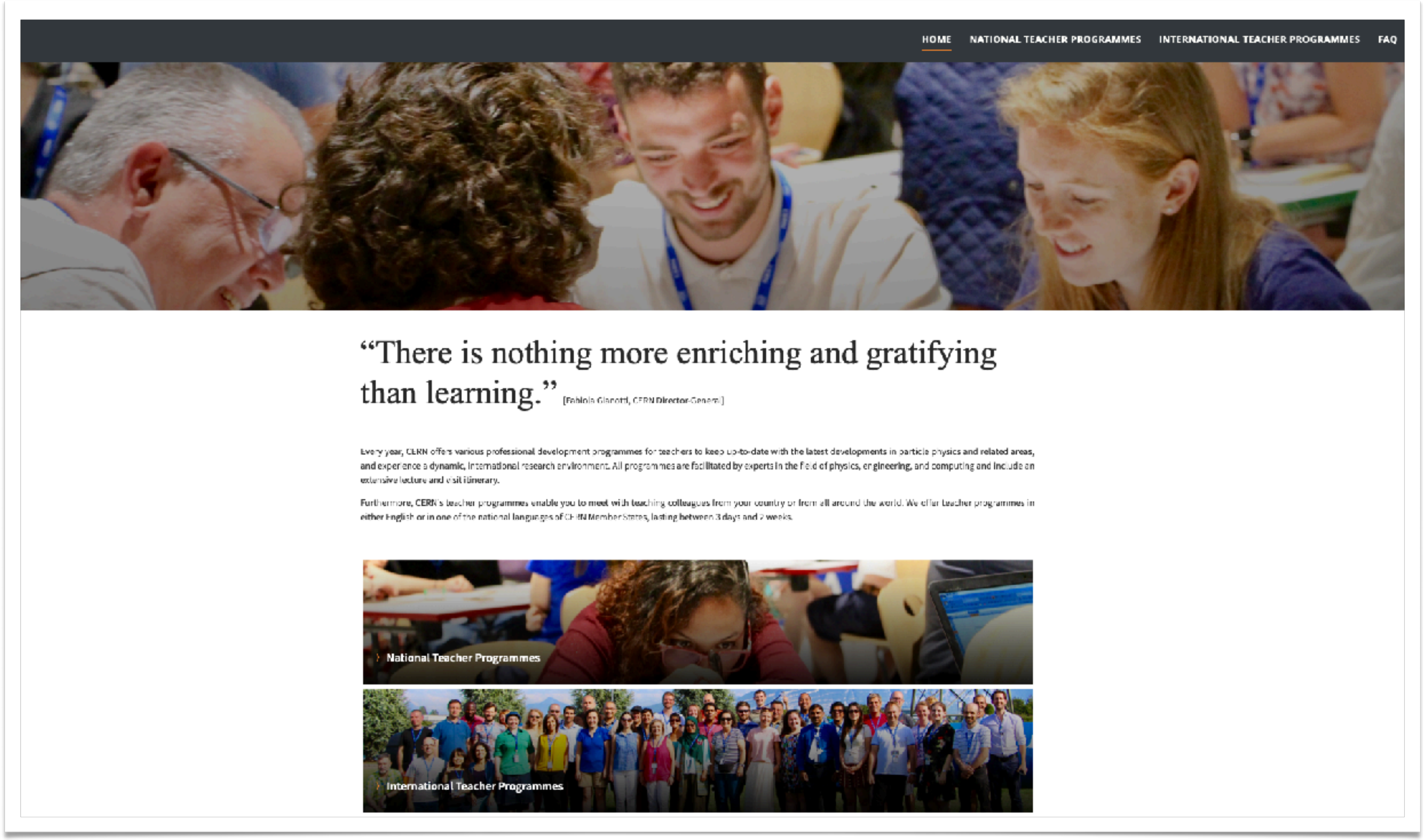
hot coffee (can be omitted)

mass for antimatter particles

mass for matter particles

mass for interaction particles

Higgs self-interactions



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International Teacher Programmes 2024

International High School Teacher Programme
30 June - 13 July 2024

International Teacher Weeks Programme
4 - 17 August 2024

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The application process for HST2024 & ITW2024 will be open from 1 November 2023 - 15 January 2024!
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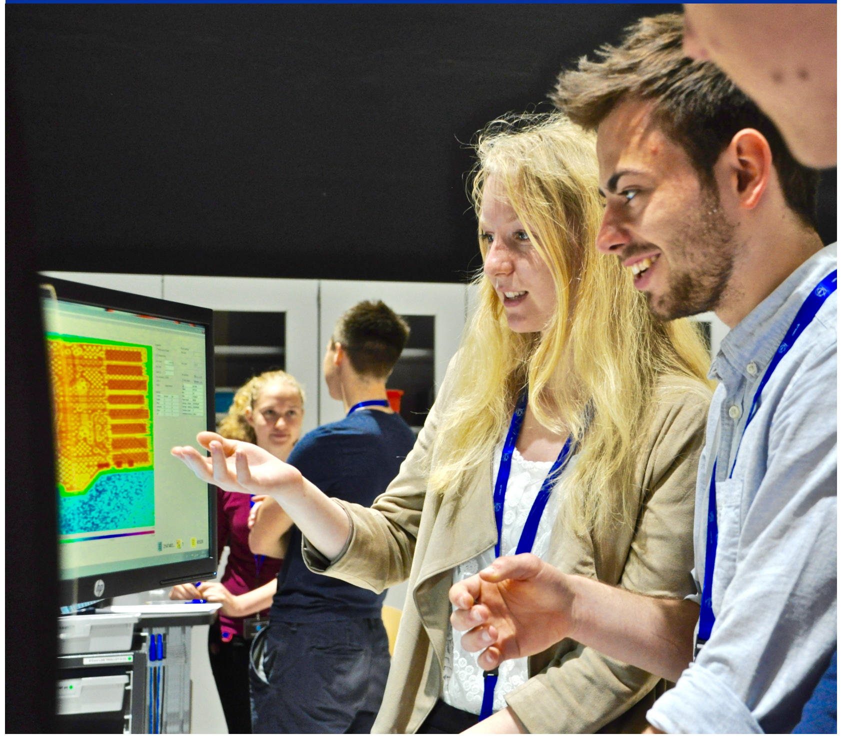
For your students

Beamline 4 Schools

CERN-Solvay
Education Programme



Science Gateway

See you soon!

Questions?

cern.ch/jeff.wiener