

Plenary Talk

PLV VI Wed 8:30 ZHG011

The Higgs Boson and the Quantum Vacuum: Understanding Mass and Symmetry Breaking — ●BEATE HEINEMANN — DESY, Notkestr. 85, 22607 Hamburg, Germany

In 2012, the ATLAS and CMS collaborations at CERN announced the discovery of the Higgs boson * the quantum excitation of the scalar field responsible for electroweak symmetry breaking within the Standard Model of particle physics. This long-sought particle provides direct evidence for the Higgs mechanism, which explains how elementary particles acquire mass through their interaction with the Higgs field. The Higgs field constitutes an essential component of the quantum vacuum: its nonzero vacuum expectation value spontaneously breaks the

electroweak symmetry, thereby endowing gauge bosons and fermions with mass.

In this talk, we will examine the theoretical framework of the Higgs mechanism and the role of the Higgs field in quantum field theory. We will discuss how spontaneous symmetry breaking shapes the structure of the Standard Model and consider the broader implications for our understanding of fundamental interactions and the vacuum structure of the universe. The presentation will also highlight the experimental challenges and milestones in the search for the Higgs boson, culminating in its discovery at the Large Hadron Collider. Particular emphasis will be placed on the key measurements, detector technologies, and the collaborative global effort that led to one of the most significant achievements in contemporary physics.