CP³ Origins

What lies beneath
Highlights 2016

The Centre for Cosmology and Particle Physics Phenomenology (CP³-Origins, www.cp3-origins.dk) opened on the 1st of September 2009 at the University of Southern Denmark in Odense. The centre currently counts ten staff members, five postdocs, fifteen PhD students, one centre administrator, one outreach coordinator and one IT administrator. Six internationally renowned scientists constitute the external board of the centre.

Goals

The boundaries of humankind's understanding of Nature are currently being pushed outwards by a number of ambitious and enlightening experiments around the Earth, and even beyond it. On July 4th 2012, the ATLAS and CMS experiments at CERN's Large Hadron Collider announced the discovery of a new high-energy particle, thus revealing a key piece of information on the basic laws of the Universe. This discovery heralds a new and exciting era in high-energy physics.
The very fabric of the spacetime we all inhabit is currently being probed by the LIGO experiment. LIGO's results offer us an entirely new way to observe the universe around us, and with it new discoveries we are only just beginning to dream about. Both beneath mountains and in the emptiness of space, sophisticated experiments are searching for direct or indirect traces of a mysterious form of non-luminous matter. This dark matter (DM) is five times more abundant than the atoms that make up all the stars on the night sky and the clouds of dust between them. We aim to:

Discover the origins of the bright and dark side of the Universe.

All known forces of Nature are described using the language of gauge theory. Quantum chromodynamics, the force that governs the constitution of protons and neutrons, is the prototypical example of a theory with multiple kinds of charges: A coloured gauge theory. Since the bulk of all luminous matter in the Universe is caused by its interactions, it is our ambition to:

Illuminate coloured gauge theories of fundamental interactions.

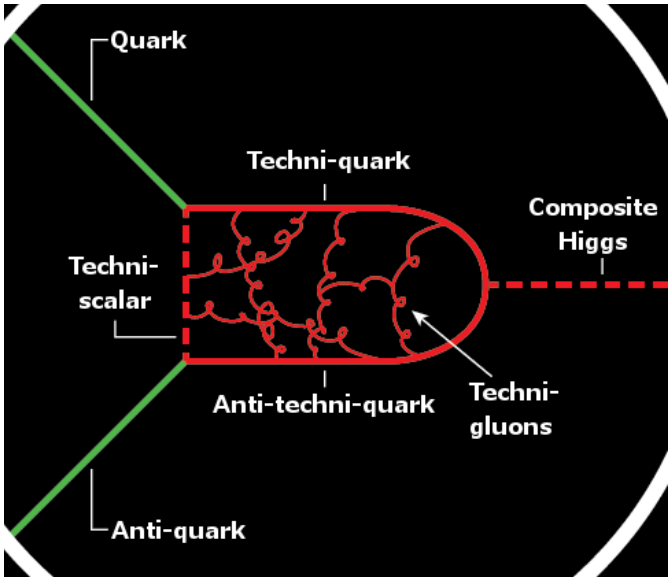
Understanding coloured dynamics will help us find the new fundamental theory that correctly describes the dark and bright fabric of the Universe.

Publication history

So far, the centre's core researchers have produced more than 300 high quality peer-reviewed research papers, published one book, one graduate lecture course, one centre-driven report and 46 proceedings. The body of work is published in the leading journals of the field, indeed twelve papers were published in Physical Review Letters, and fifty-four have become top cited.

$$L = -\tfrac{1}{2}\mathrm{Tr}\, F^{\mu\nu}F_{\mu\nu} + \mathrm{Tr}\left(\overline{Q}\, i\not{D}\, Q\right) + \mathrm{Tr}\left(\partial_\mu H^\dagger\, \partial^\mu H\right)$$
$$+y\,\mathrm{Tr}\left(\overline{Q}_L H Q_R + \overline{Q}_R H^\dagger Q_L\right) - u\,\mathrm{Tr}\left(H^\dagger H\right)^2 - v\left(\mathrm{Tr}\, H^\dagger H\right)^2$$

The Litim-Sannino theory: The first rigorous asymptotically safe theory in four dimension. It lays the foundation for new generations of theories of nature.



The Sannino (CP3 and CERN), Strumia (CERN), Tesi (Chicago) and Vigiani (Pisa) first complete theories (and novel paradigm) of fundamental composite Higgs and partial compositeness, elucidated diagrammatically.

We give many plenary talks worldwide, and referee for the most prestigious agencies worldwide, from the U.S. Department of Energy to the European Research Council, the U.K. Royal society and many others. We collaborate with more than one hundred major universities, research institutes and groups around the world. CP³-Origins has become a high-profile research centre worldwide. Our research papers collected close to ten thousand citations.

Research highlights

We are renowned in the physics community for having pioneered or strongly advanced the following research fields:

- Implications of conformality on the energy dependence and stability of gauge theories.
- New paradigms underlying elementary and composite Higgs dynamics.
- Composite and elementary Higgs dynamics at colliders and in cosmology.
- Lattice and analytical approaches to the phases of gauge theories.
- DM constraints from compact stars, composite DM with(out) supercomputers and DM phenomenology.
- Discovered the first rigorous example of asymptotic safety in four dimensions.
- Flavour physics on the lattice and determination of hadronic parameters for precision tests.
- Different approaches for inflationary cosmology and large scale structures.

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