

Hadron Collider (LHC) physicists have searched for physics beyond the standard model and to determine what shape future physics will take.

A paper in *The European Physical Journal H* by Robert Harlander and Jean-Philippe Martinez of the Institute for Theoretical Particle Physics and Cosmology, RWTH Aachen University, Germany, and Gregor Schiemann from the Faculty of Humanities and Cultural Studies, Bergische Universität Wuppertal, Germany, considers the idea that particle physics may be on the verge of a new era of discovery and understanding in particle physics. The paper also considers the implications of the many possible scenarios for the future of high-energy physics.

"Over the last century, the concept of the particle has emerged as fundamental in the field of physics," Martinez said. "It has undergone a significant evolution across time, which has opened up new ways for particle observation, and thus for the discovery of new particles. Currently, observing a particle requires its on-shell production."

Martinez explained that a particle is called "on-shell" if its mass, energy and momentum combine in a certain way ($E^2 = m^2c^4 + p^2c^2$). "In today's sense of discovery of a new particle, the latter is required to be on-shell in the experiment at least for a short time," he said.

In the paper, Martinez and his fellow authors argue that all new particles could be too heavy for on-shell production, meaning particle physics will have to undergo yet another evolutionary step in particle observation and maybe even in the concept of the particle itself.

"Particle physics is currently at a very special point in time," Martinez continued. "We still have to face the possibility that the age of particle discoveries as we know them today is over. We show that particle physics has gone through many evolutionary steps, and we claim that the

next such step may be right ahead of us. However, as with previous developments, such a change will most likely come from within [particle physics](#) itself."

More information: Robert Harlander et al, The end of the particle era?, *The European Physical Journal H* (2023). [DOI: 10.1140/epjh/s13129-023-00053-4](#)

Provided by Springer

Citation: Is the end of the 'particle era' of physics upon us? (2023, July 20) retrieved 9 May 2024 from <https://phys.org/news/2023-07-particle-era-physics.html>

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