

## **New heavy state(s) at the LHC?**

### ***Either the “Toponium” or the A-Higgs boson discovered?***

*/Experiment. Phenomenology. Theory/*

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Abstract

Searches for heavy quarkonia as well as the additional Higgs bosons rank high among probes of possible new physics beyond the Standard (SM), and feature strongly in the research programs of the CMS and ATLAS experiments at the LHC and in studies for proposed next-generation particle colliders. The most recent such search by the CMS collaboration (2024) has produced an intriguing result, namely a  $5\sigma$  enhancement of events close to the  $t\bar{t}$  threshold containing final states with leptons and jets, whose angular correlations are characteristic of production of a pseudoscalar spin-parity state. This signal has been confirmed by the ATLAS collaboration (2025) at the level of  $7.7\sigma$  enhancement, but one may nevertheless start asking whether it could be due to a new pseudoscalar Higgs boson  $A$  that occurs in extensions of the SM, or if it is a QCD effect with the “toponium” production. The theoretical, the phenomenological issues based on the experimental data related to the production and the decays of the “toponium” and the pseudoscalar Higgs boson  $A$ , as well as the perspectives for their investigations further are discussed.