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The decay $A^0 \rightarrow hZ^*$ in the inverted hierarchy and the production for A^0 at the LHC in normal hierarchy in 2HDM

Searches are being carried out for the decay $A^0 \rightarrow hZ^*$ in the normal hierarchy (with $m_h = 125$ GeV)at the Large Hadron Collider (LHC) in the context of Two-Higgs-Doublet Models (2HDMs). In this study, we focus on the decay $A^0 \rightarrow hZ^*$ in the inverted hierarchy scenario where m_h can be significantly lighter than 125 GeV. This research in this scenario has not been carried out experimentally by ATLAS and CMS. In order to find a region that respects all theoretical and experimental constraints with a visible signal, we do a scan over the 2HDM Type-I parameter space, by using the public code 2HDMC-1.8.0 interfaced with HiggsBounds and HiggsSignals and flavour constraints using SuperISO.

We calculate the product $gg \rightarrow A^0 \rightarrow hZ^{(*)} \rightarrow Z^{(*)}b\vec{b}$ at $\sqrt{s} = 13$ in 2HDM type I in the region $m_{A^0} < 225$ GeV and compare its magnitude with the result from the CMS Collaboration in the normal hierarchy ($m_h = 125$ GeV). It shows that in the inverted hierarchy scenario we seem to have significantly larger cross sections for product $gg \rightarrow A^0 \rightarrow hZ^{(*)} \rightarrow Z^{(*)}b\vec{b}$ than in the normal hierarchy case. A manuscript of the study was submitted on arxiv, arXiv:2301.00728.

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