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New Discovery Modes for a Light Charged Higgs Boson at the LHC

At the Large Hadron Collider (LHC), both the ATLAS and CMS Collaborations have been searching for light charged Higgs bosons via top (anti)quark production and decays channels, like $pp \rightarrow t\bar{t}$ with one top (anti)quark decaying into a charged Higgs boson and a b (anti)quark, when the decay is kinematically open. In this talk, we propose new searches at the LHC involving light charged Higgs bosons via their pair production channels like $pp \rightarrow H^\pm h/A$ and $pp \rightarrow H^+ H^-$ in the 2-Higgs Doublet Model (2HDM) Type-I and -X scenarios. We demonstrate that for a light charged Higgs boson state, at the LHC, such di-Higgs production and their bosonic decays, such as $H^\pm \rightarrow W^\pm h$ and/or $H^\pm \rightarrow W^\pm A$, can give rise to signatures with event rates much larger than those emerging from $pp \rightarrow t\bar{t} \rightarrow t\bar{t}bH^\pm + \text{c.c.}$. We specifically study $h/A \rightarrow b\bar{b}$ and $\tau^+\tau^-$ decays. We, therefore, claim that the discussed combination of new production and decay modes can result in an alternative discovery channel for charged Higgs bosons lighter than the top (anti)quark at the LHC within the above two 2HDM Types. This talk is based on arXiv:2106.13656.

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