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Top squarks from the landscape at high luminosity LHC

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Supersymmetric models with low electroweak finetuning are expected to be more prevalent on the string landscape than finetuned models. We assume a fertile patch of landscape vacua containing the minimal supersymmetric standard model (MSSM) as low energy/weak scale effective field theory (LE-EFT). Then, a statistical pull by the landscape to large soft terms is balanced by the requirement of a derived value of the weak scale which is not too far from its measured value in our universe. Such models are characterized by light higgsinos in the few hundred GeV range whilst top squarks are in the 1-2.5 TeV range with large trilinear soft terms which helps to push $m_h \sim 125$ GeV. Other sparticles are generally beyond current LHC reach and the $BR(b \to s\gamma)$ branching fraction is nearly equal to its SM value. The light top-squarks decay comparably via $\tilde{t}_1 \to b\tilde{\chi}_1^+$ and $\tilde{t}_1 \to t\tilde{\chi}_{1,2}^0$ yielding mixed final states of $b\bar{b}+\not{E}_T$, $t\bar{b}/\ \bar{t}b+\not{E}_T$ and $t\bar{t}+\not{E}_T$. We evaluate prospects for top squark discovery at high-luminosity (HL) LHC for the well-motivated case of natural SUSY from the landscape. We find for HL-LHC a 5σ reach out to $m_{\tilde{t}_1} \sim 1.65$ TeV and a 95% CL exclusion reach to $m_{\tilde{t}_1} \sim 1.95$ TeV. These reaches cover most (but not all) of the allowed stringy natural parameter space!

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