Study of $t\bar{t}H$ production at HL-LHC

I. Carr[a] and G. Taylor[a]

[a]*School of Physics, The University of Melbourne, Melbourne, Victoria 3010, Australia.*

The High-Luminosity Large Hadron Collider (HL-LHC) is an upgrade to the current LHC whose predominant objective is to drastically increase the luminosity of the LHC, allowing for more collisions and a more statistically significant dataset to be produced overtime. In particular, one major goal of the HL-LHC upgrade is to attain precise measurements of the Higgs boson properties, as well as to probe physics Beyond the Standard Model of Particle Physics (BSM). The Yukawa coupling of the Higgs boson to the top quark is an important parameter that has not been able to be measured to high levels of precision at the LHC. These couplings can be directly determined by measuring the rate of the process where the Higgs boson is produced in association with a $t\bar{t}$ pair ($t\bar{t}H$). Additionally $t\bar{t}H$ events may be able to shed light onto 'invisible' Higgs decays [1], that is decays where the decay products are undetectable, such as $H \to \nu\bar{\nu}$. An excess in the SM expected branching ratio could be explained by many BSM models, including the possibility of the Higgs boson coupling to dark matter particles, known as Higgs portal models [2]. We present an investigation into this $t\bar{t}H$ process, including the capability for measuring the Higgs boson 'invisible' decays with the HL-LHC and ATLAS detector upgrade.

[1] ATLAS Collaboration. "Search for invisible Higgs-boson decays in events with vector-boson fusion signatures using 139fb^{-1} of proton-proton data recorded by the ATLAS experiment." arXiv preprint arXiv:2202.07953 (2022).

[2] Lopez-Honorez, Laura, Thomas Schwetz, and Jure Zupan. "Higgs portal, fermionic dark matter, and a Standard Model like Higgs at 125 GeV." Physics Letters B 716.1 (2012): 179-185.