Contribution ID: **19** Type: **not specified**

Multi-photon decays of the Higgs boson at the LHC

Tuesday, May 16, 2023 2:30 PM (25 minutes)

Many new physics scenarios predict multi-photon Higgs resonances. One such scenario is the dark axion portal model. The primary decay chain that we study is the Higgs to dark photon (γ_D) pairs that subsequently decay into a photon (γ) and an axion-like particle (a). The axion-like particles then decay into photon pairs. Hence, the signal is a six-photon Higgs decay: $h \to \gamma_D\, \gamma_D \to 2\,\gamma 2\,a \to 6\gamma$. However, depending on the relevant kinematics, the photons can become well-collimated and appear as photon-jets (multiple photons that appear as a single photon in the detector) or ξ-jets (non-isolated multi-photon signals that do not pass the isolation criterion). These effects cause the true six-photon resonance to appear as other multi-photon signals, such as two and four photons. We classify the mass regions where two, four, and six-photon resonances dominate. The four-photon signal is particularly interesting. These events mainly occur when the photons from the axion-like particles are collimated into photon-jets. The decay of the dark photon is then $\gamma_D \to \gamma a \to \gamma + \gamma$-jet, which is an apparent violation of the Landau-Yang theorem. We show that current measurements of $h \to 2\gamma$ and searches for $h \to 4\gamma$ at the Large Hadron Collider (LHC) can limit $\mathrm{BR}(h \to \gamma_D\gamma_D) < 10^{-3}$. This model also motivates new searches for Higgs decays into six isolated photons or ξ-jets at the LHC. While there are currently no dedicated searches, we show that many of the Higgs to six isolated photons or ξ-jet events could pass two or three-photon triggers. That is, new physics could be found by reanalyzing existing data. These multi-photon signals provide excellent footing to explore new physics at the LHC and beyond.

Primary authors: LEE, Hye-Sung (KAIST); LEWIS, Ian (The University of Kansas); LANE, Samuel (KAIST)

Presenter: LEWIS, Ian (The University of Kansas)

Session Classification: Collider