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Higgs decays into lepton pairs and a photon

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We present a study of Higgs boson decays involving a photon and leptonic or neutrino pairs within the Standard Model. For $H \to \ell^+\ell^-\gamma$ with $\ell = e, \mu$, we calculate differential decay rates, branching fractions, and forward-backward asymmetries, providing analytic expressions for experimental analyses. Our approach distinguishes the resonant $H \to Z\gamma$ contribution from non-resonant contributions enabling precise extraction of $\Gamma(H \to Z\gamma)$. We propose optimized kinematic cuts to effectively separate these components, thereby enhancing the discovery potential for both $H \to Z\gamma$ and the tree-level $H \to \mu^+\mu^-\gamma$ decay. Additionally, for $H \to \nu\bar{\nu}\gamma$, we present leading-order one-loop calculations, highlighting the role of non-resonant box diagrams.

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