CHARM-YUKAWA INTERACTION
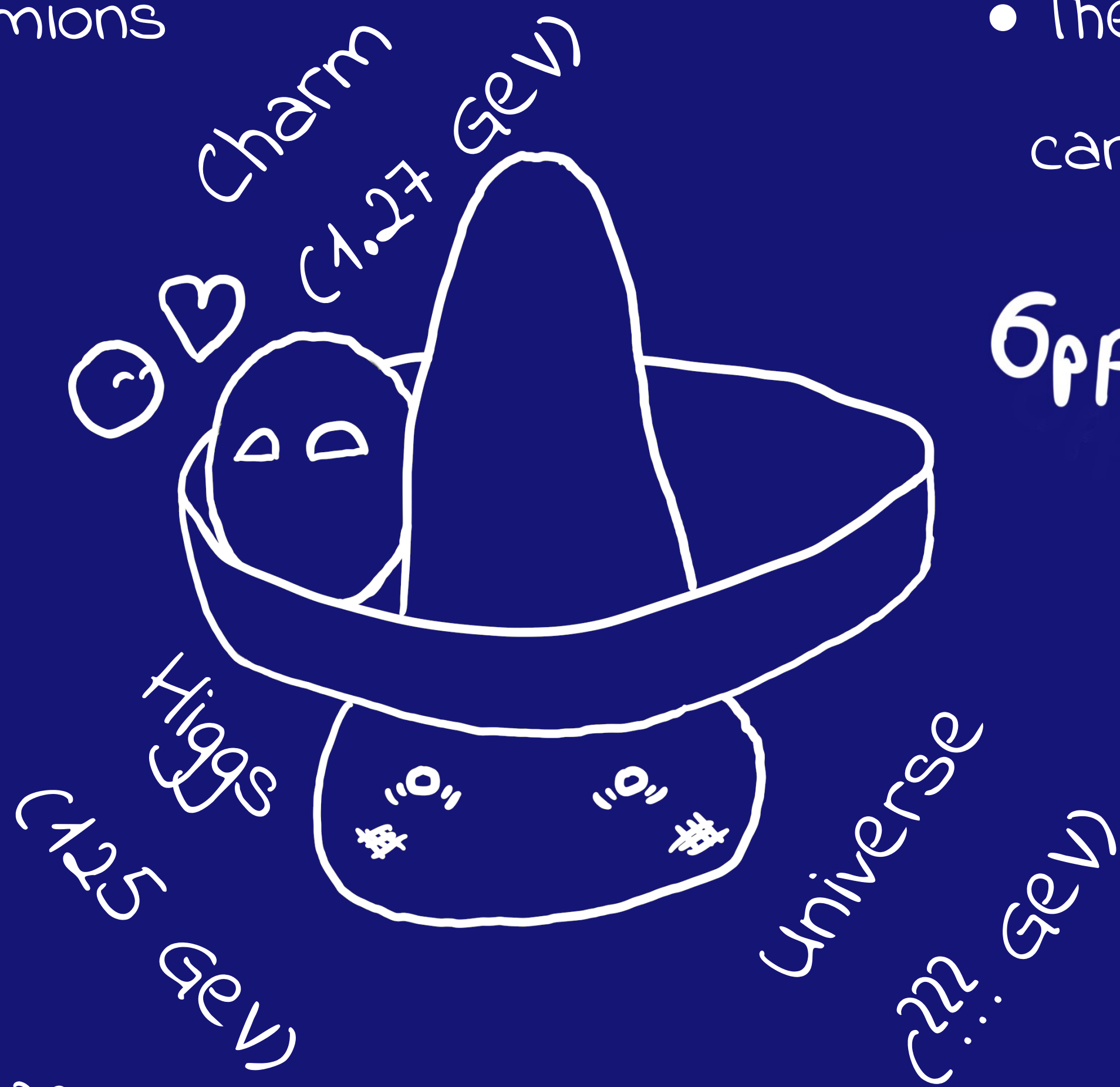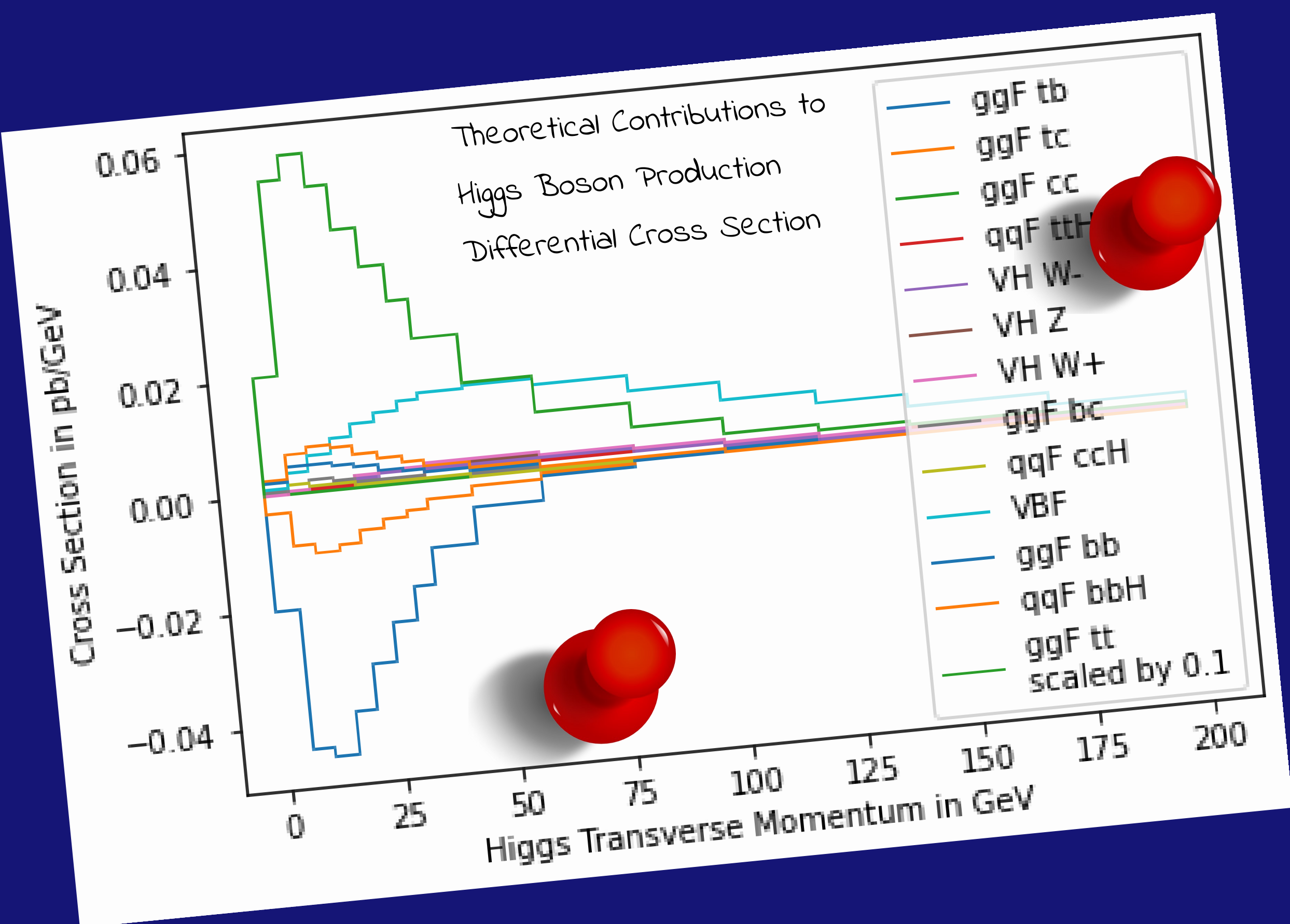
- The Coupling strength of fermions with the Higgs field depends on their mass

- Therefore H→cc decay has small branching ratio

- Charm quark initiated jets are hard to identify and background rates are large

- ATLAS H→cc analysis sets an upper limit to the Charm-Yukawa coupling $k_c < 8.5$ at 95% confidence limit [EPJC 82 (2022) 717]

Charm (1.27 GeV)

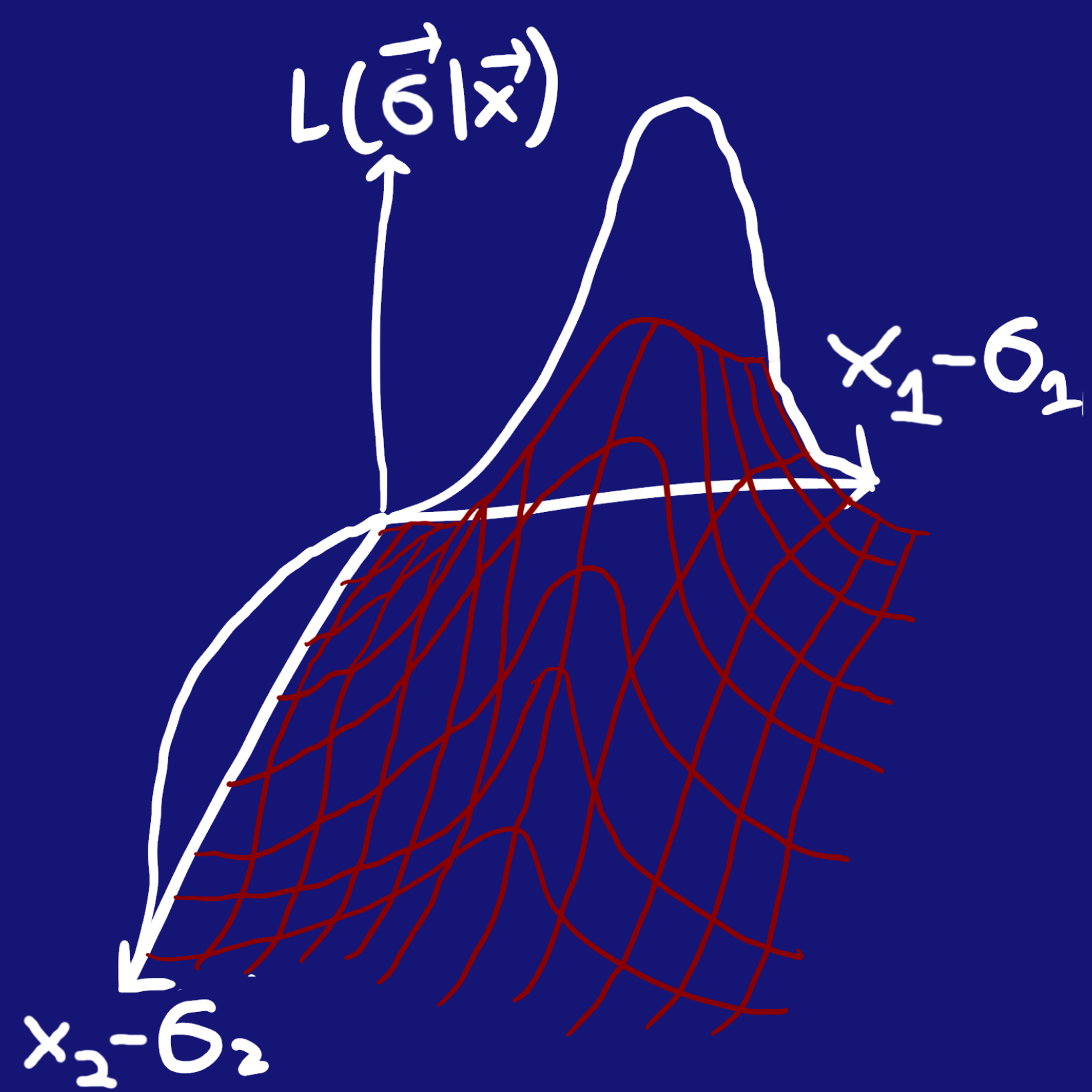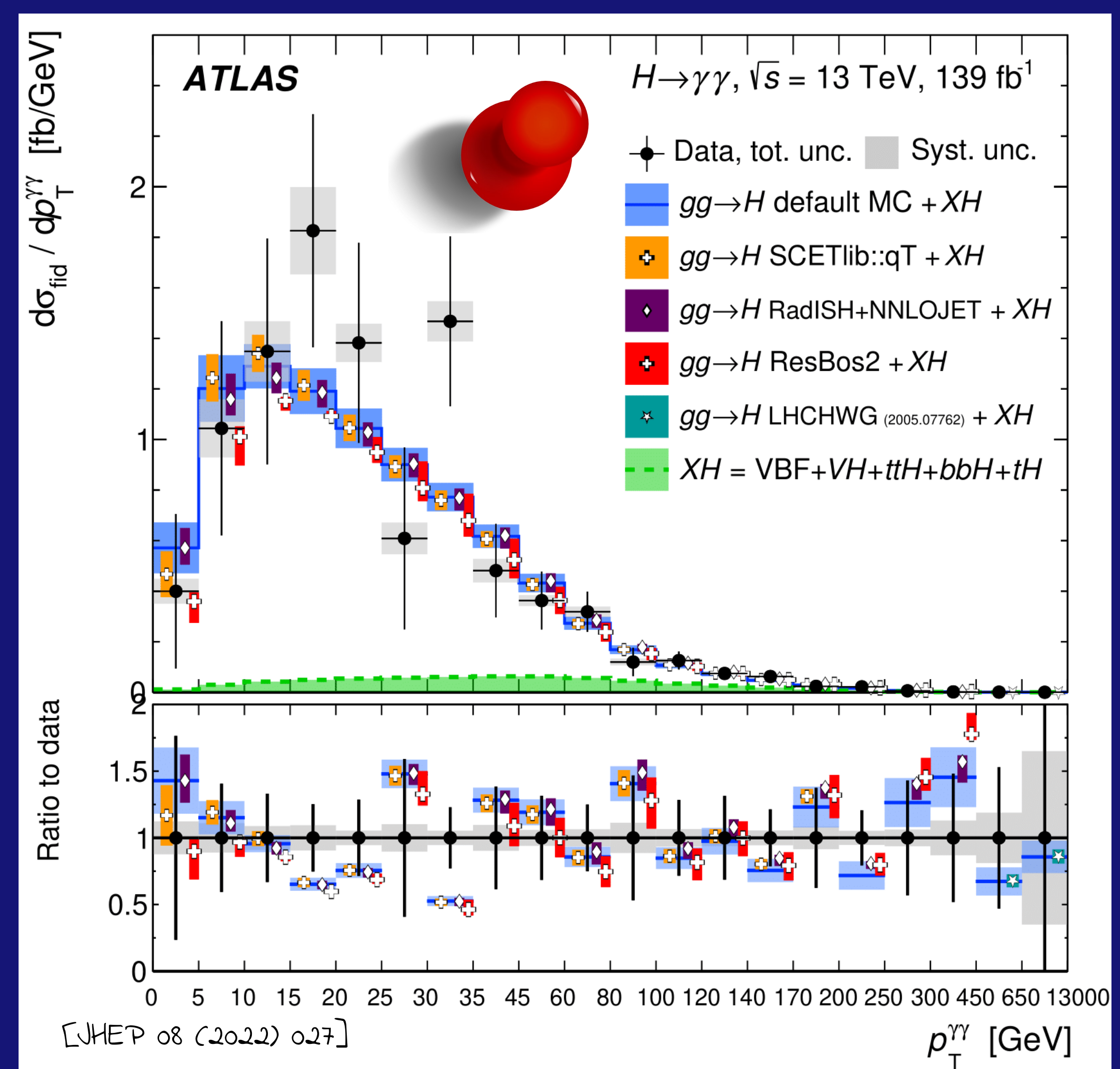Higgs (125 GeV)

Universe (?.?? GeV)

$$K_c = \frac{y_c}{y_c^{SM}}$$

- The Total Higgs Boson Differential Cross Section can be parameterised in terms of k_t, k_b, and k_c

$$\sigma_{ppH} = k_t^2 \left(\left| \begin{smallmatrix} \text{(diagram)} \end{smallmatrix} \right|^2 + \left| \begin{smallmatrix} \text{(diagram)} \end{smallmatrix} \right|^2 \right)$$
$$+ k_t k_b \left(2 \left| \begin{smallmatrix} \text{(diagram)} \end{smallmatrix} \right| \left| \begin{smallmatrix} \text{(diagram)} \end{smallmatrix} \right| \right)$$
$$+ k_t k_c \left(2 \left| \begin{smallmatrix} \text{(diagram)} \end{smallmatrix} \right| \left| \begin{smallmatrix} \text{(diagram)} \end{smallmatrix} \right| \right)$$
$$+ k_b k_c \left(2 \left| \begin{smallmatrix} \text{(diagram)} \end{smallmatrix} \right| \left| \begin{smallmatrix} \text{(diagram)} \end{smallmatrix} \right| \right)$$
$$+ k_b^2 \left(\left| \begin{smallmatrix} \text{(diagram)} \end{smallmatrix} \right|^2 + \left| \begin{smallmatrix} \text{(diagram)} \end{smallmatrix} \right|^2 \right)$$
$$+ k_c^2 \left(\left| \begin{smallmatrix} \text{(diagram)} \end{smallmatrix} \right|^2 + \left| \begin{smallmatrix} \text{(diagram)} \end{smallmatrix} \right|^2 \right)$$
$$+ \text{Other}$$

Theoretical Contributions to Higgs Boson Production Differential Cross Section
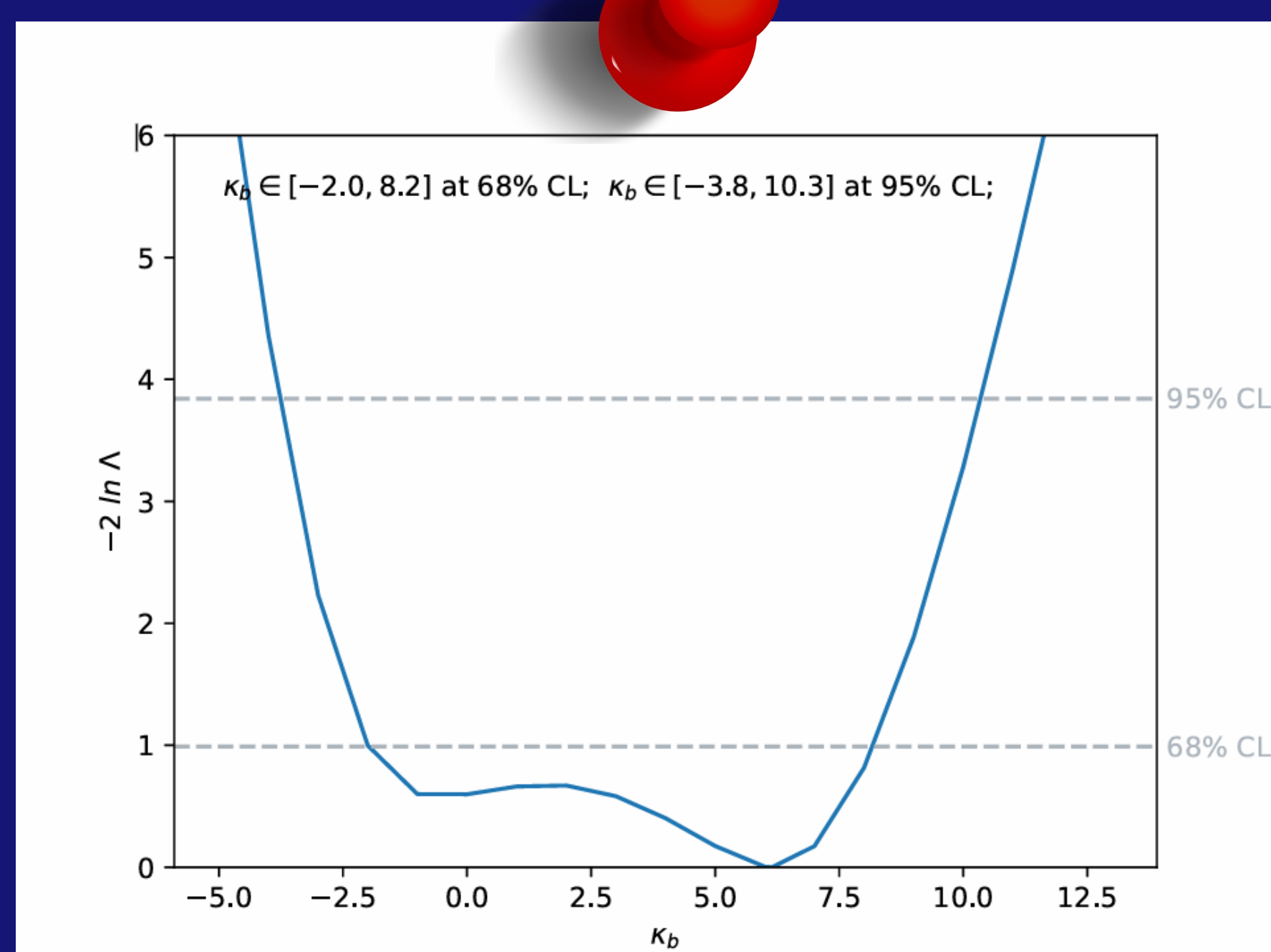
- For the H→γγ process, ATLAS data of the differential cross-section is plotted against transverse momentum.

- Varying parameter k_c in the model, we use it to predict transverse momentum and fit it to the measurements.

[JHEP 08 (2022) 027]

- Parameters are fitted to ATLAS H→γγ measurements by maximising the Multivariate Gaussian Likelihood function

$$\Lambda = \frac{L_{conditional}(\vec{k}, \hat{\vec{\theta}})}{L_{unconditional}(\vec{k}, \vec{\theta})}$$

- Plot the logarithm of test statistic Λ for each value of the coupling strength

- Add lines corresponding to confidence ratios to constrain Charm-Yukawa

$L(\vec{\sigma}|\vec{x})$

$x_1 - \sigma_1$

$x_2 - \sigma_2$

$$L(\vec{\sigma}(\vec{k}, \vec{\theta})|\vec{x}, V) = e^{-\frac{1}{2}(\vec{x} - \vec{\sigma})^T V^{-1}(\vec{x} - \vec{\sigma})} \cdot \prod_j \text{Gauss}(\theta_j; 0, 1)$$

SHAPE ONLY FIT! k_c

k_b

- Future steps will be to implement the parameterisation of the top-Yukawa coupling k_t into the model, and investigate the variations of k_t along with systematic uncertainties

$\kappa_b \in [-2.0, 8.2]$ at 68% CL; $\kappa_b \in [-3.8, 10.3]$ at 95% CL;

$\kappa_c \in [-9.7, 11.3]$ at 68% CL; $\kappa_c \in [-14.5, 18.8]$ at 95% CL;