

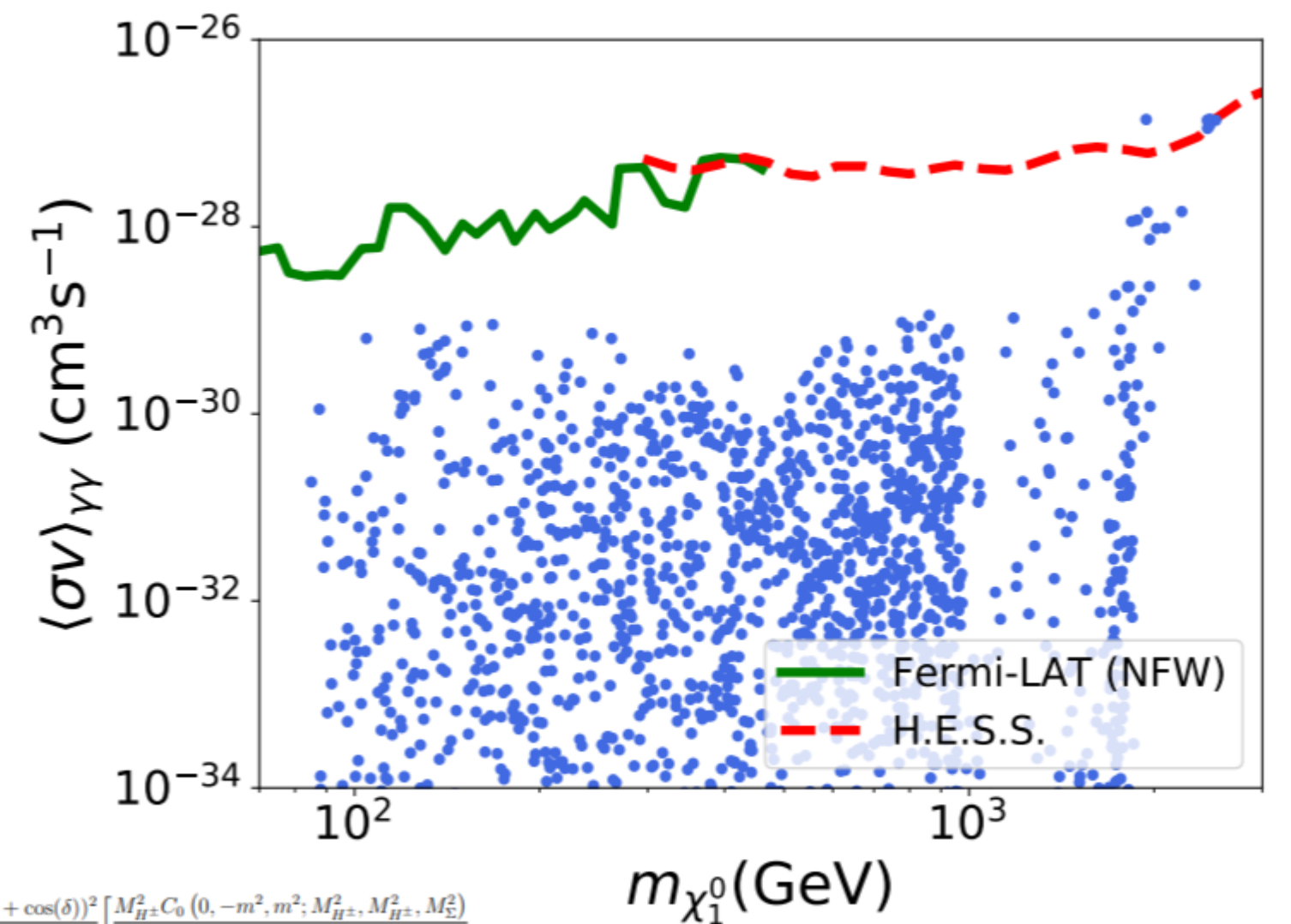
Scotogenic DM

$$h_{i\alpha} \overline{L}_i \tilde{\eta} N_{R\alpha}$$

$$N_{R2} \rightarrow \Sigma$$

with A. Rivera, arXiv:1907.11938

$$\sigma v (\chi_1^0 \chi_1^0 \rightarrow \gamma\gamma) = \frac{|\mathcal{B}|^2}{32\pi m_{\chi_1^0}^2}$$



$$\begin{aligned} \mathcal{B} = & \frac{\sqrt{2}\alpha m^2 \sin^2(\alpha) Y_0^2 (\sin(\delta) + \cos(\delta))^2}{\pi} \left[\frac{M_{H^\pm}^2 C_0(0, -m^2, m^2; M_{H^\pm}^2, M_{H^\pm}^2, M_\Sigma^2)}{M_{H^\pm}^2 - M_\Sigma^2} \right. \\ & - \frac{M_\Sigma (-2m M_{H^\pm}^2 - M_\Sigma M_{H^\pm}^2 + m^2 M_\Sigma + 2m M_\Sigma^2 + M_\Sigma^3) C_0(0, -m^2, m^2; M_\Sigma^2, M_\Sigma^2, M_{H^\pm}^2)}{(M_{H^\pm}^2 - M_\Sigma^2)(M_{H^\pm}^2 + m^2 - M_\Sigma^2)} \\ & \left. + \frac{2M_\Sigma(m + M_\Sigma) C_0(0, 0, 4m^2; M_\Sigma^2, M_\Sigma^2, M_\Sigma^2)}{-M_{H^\pm}^2 - m^2 + M_\Sigma^2} \right] \\ & + \frac{\alpha m^2 \sin(\alpha) \cos(\alpha) Y_N^\alpha Y_\Sigma^\alpha}{\pi} \left[- \frac{m_\eta^2 C_0(0, -m^2, m^2; m_\eta^2, m_\eta^2, m_{e_i}^2)}{m_\eta^2 - m_{e_i}^2} \right. \\ & + \frac{m_{e_i}^2 (m_{e_i}^2 + m^2 - m_\eta^2) C_0(0, -m^2, m^2; m_{e_i}^2, m_{e_i}^2, m_\eta^2)}{(m_\eta^2 - m_{e_i}^2)(-m_{e_i}^2 + m^2 + m_\eta^2)} + \frac{2m_{e_i}^2 C_0(0, 0, 4m^2; m_{e_i}^2, m_{e_i}^2, m_{e_i}^2)}{-m_{e_i}^2 + m^2 + m_\eta^2} \\ & + \frac{\alpha m^2 \cos^2(\alpha) (Y_\Sigma^\alpha)^2}{2\sqrt{2}\pi} \left[\frac{m_\eta^2 C_0(0, -m^2, m^2; m_\eta^2, m_\eta^2, m_{e_i}^2)}{m_\eta^2 - m_{e_i}^2} \right. \\ & - \frac{m_{e_i}^2 (m_{e_i}^2 + m^2 - m_\eta^2) C_0(0, -m^2, m^2; m_{e_i}^2, m_{e_i}^2, m_\eta^2)}{(m_\eta^2 - m_{e_i}^2)(-m_{e_i}^2 + m^2 + m_\eta^2)} - \frac{2m_{e_i}^2 C_0(0, 0, 4m^2; m_{e_i}^2, m_{e_i}^2, m_{e_i}^2)}{-m_{e_i}^2 + m^2 + m_\eta^2} \\ & \left. + \frac{\sqrt{2}\alpha m^2 \sin^2(\alpha) (Y_N^\alpha)^2}{2\pi} \left[\frac{m_\eta^2 C_0(0, -m^2, m^2; m_\eta^2, m_\eta^2, m_{e_i}^2)}{m_\eta^2 - m_{e_i}^2} \right. \right. \\ & - \frac{m_{e_i}^2 (m_{e_i}^2 + m^2 - m_\eta^2) C_0(0, -m^2, m^2; m_{e_i}^2, m_{e_i}^2, m_\eta^2)}{(m_\eta^2 - m_{e_i}^2)(-m_{e_i}^2 + m^2 + m_\eta^2)} - \frac{2m_{e_i}^2 C_0(0, 0, 4m^2; m_{e_i}^2, m_{e_i}^2, m_{e_i}^2)}{-m_{e_i}^2 + m^2 + m_\eta^2} \\ & \left. - \frac{8\sqrt{2}\alpha m^2 \cos^2(\alpha) M_W^2}{\pi (M_\Sigma^2 - M_W^2) (4v_\Omega^2 + v_\phi^2) (m^2 - M_\Sigma^2 + M_W^2) (m^2 + M_\Sigma^2 - M_W^2)} \right. \\ & \left. + 4(m^2 - M_W^2) (M_\Sigma^2 - M_W^2) (m^2 - M_\Sigma^2 + M_W^2) C_0(0, 0, 4m^2; M_W^2, M_W^2, M_W^2) \right. \\ & + 2M_\Sigma(2m - M_\Sigma) (M_\Sigma^2 - M_W^2) (m^2 + M_\Sigma^2 - M_W^2) C_0(0, 0, 4m^2; M_\Sigma^2, M_\Sigma^2, M_\Sigma^2) \\ & - (m^2 - M_\Sigma^2 + M_W^2) (-M_W^2 (m^2 + M_\Sigma^2) - 4m M_\Sigma (m^2 + M_\Sigma^2 - M_W^2) + 4M_\Sigma^4 + M_W^4) \\ & C_0(0, -m^2, m^2; M_W^2, M_W^2, M_\Sigma^2) - M_\Sigma (m^2 + M_\Sigma^2 - M_W^2) (4m^3 - 3m^2 M_\Sigma + M_\Sigma^3 - M_\Sigma M_W^2) \\ & \left. C_0(0, -m^2, m^2; M_\Sigma^2, M_\Sigma^2, M_W^2) \right] \end{aligned}$$