BLACK HOLE EXPLOSIONS

Aidan Symons

with

Michael Baker, Andrea Thamm, Joaquim Iguaz Juan

at

The University of Massachusetts, Amherst

July 31, 2025

Institut d’Études
Scientifiques de Cargèse

Talk Outline

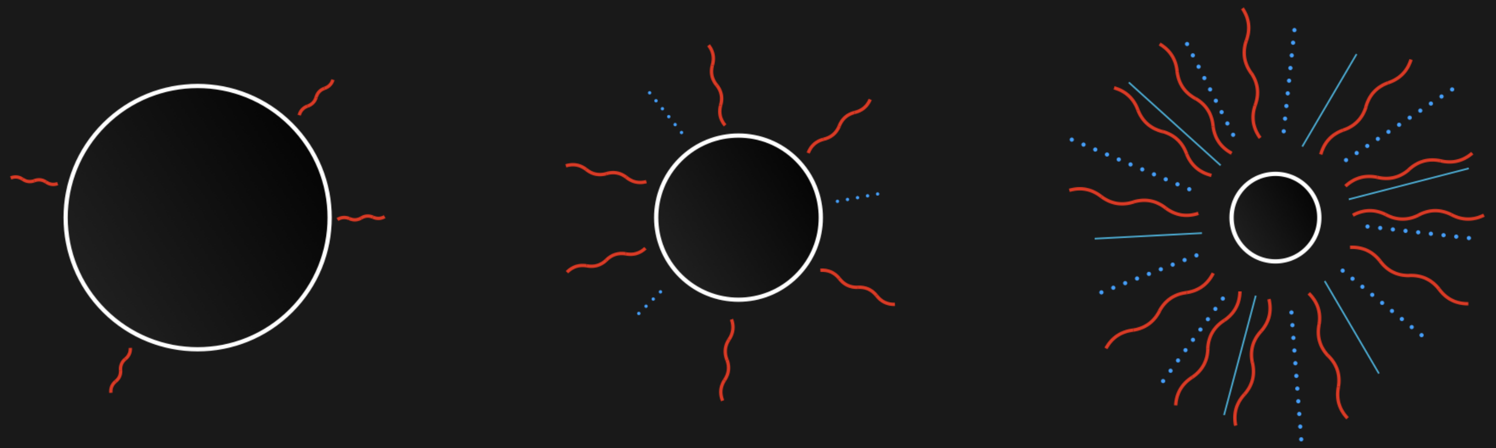
What are BH explosions?

Why are they interesting for BSM?

Could we see one?

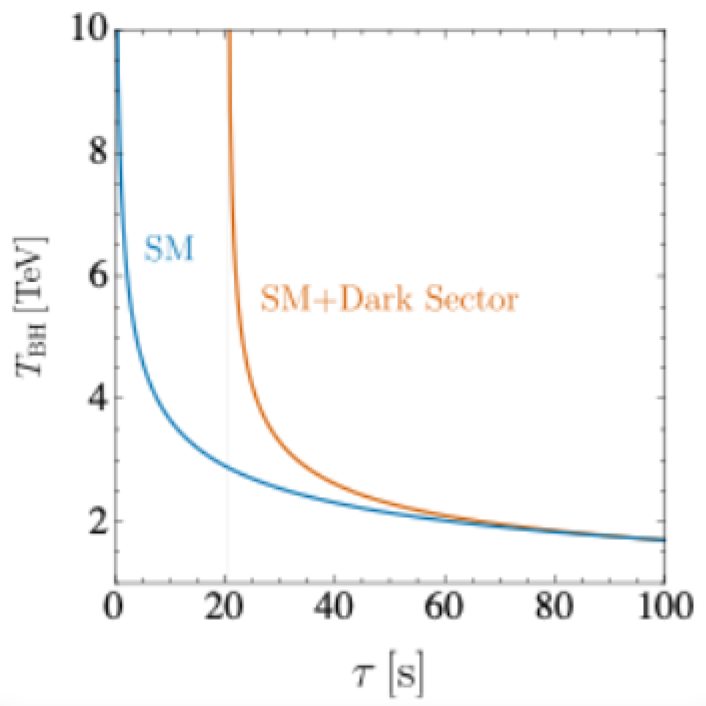
Black Hole Explosions

$$T \propto \frac{1}{M_{BH}}$$



Time →

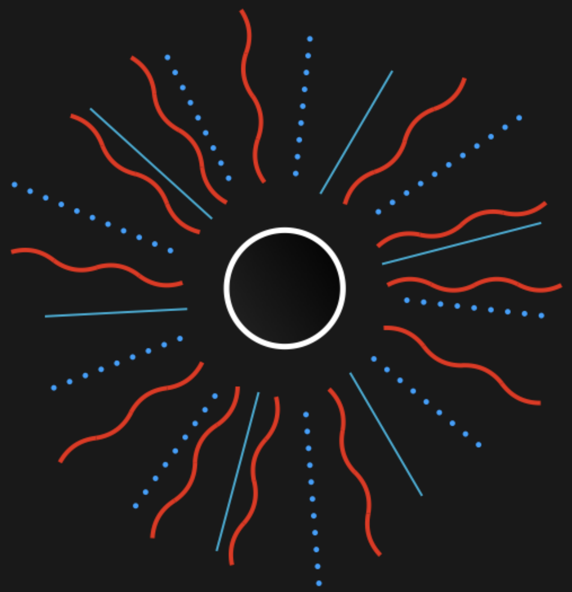
Black Hole Explosions



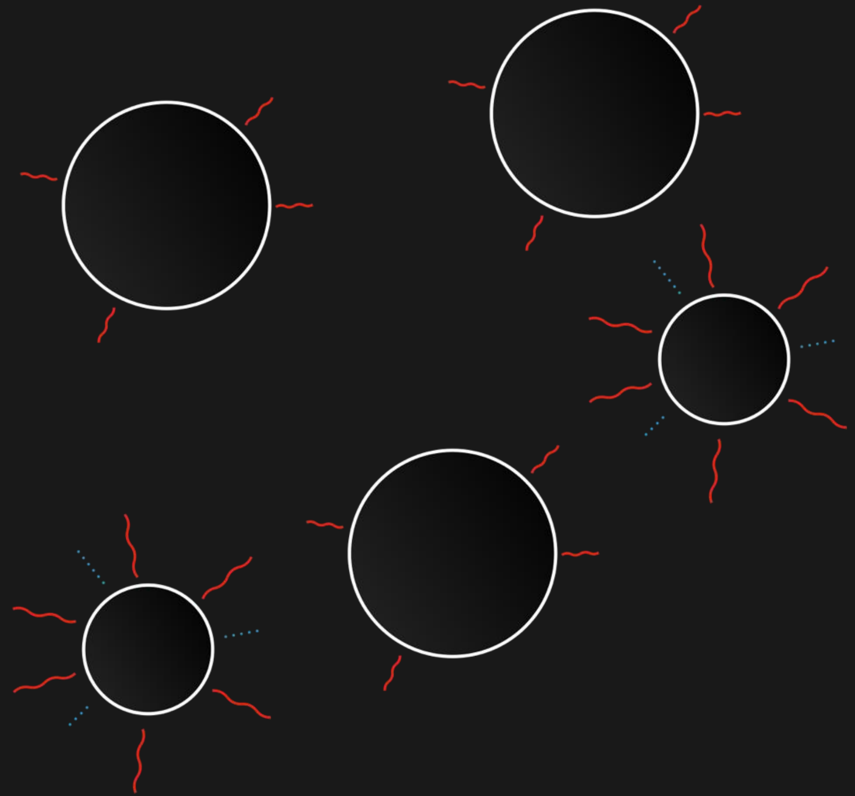
← Time

$$T \propto \frac{1}{M_{BH}}$$

Black Hole Explosions



vs.



$E \gtrsim 100$ GeV

$E \sim 100$ MeV

Dark Sector

$$T_{Schw} \propto \frac{1}{M} \qquad T_{RN} \propto \frac{1}{M} \frac{\sqrt{1 - {Q_*}^2}}{\left(1 + \sqrt{1 - {Q_*}^2}\right)^2} \qquad \text{where } Q_* = \frac{Q}{M}$$

Introduce new QED-like dark sector

$$m_D \gtrsim 10^6 \text{ GeV} \gg T_{BH}$$

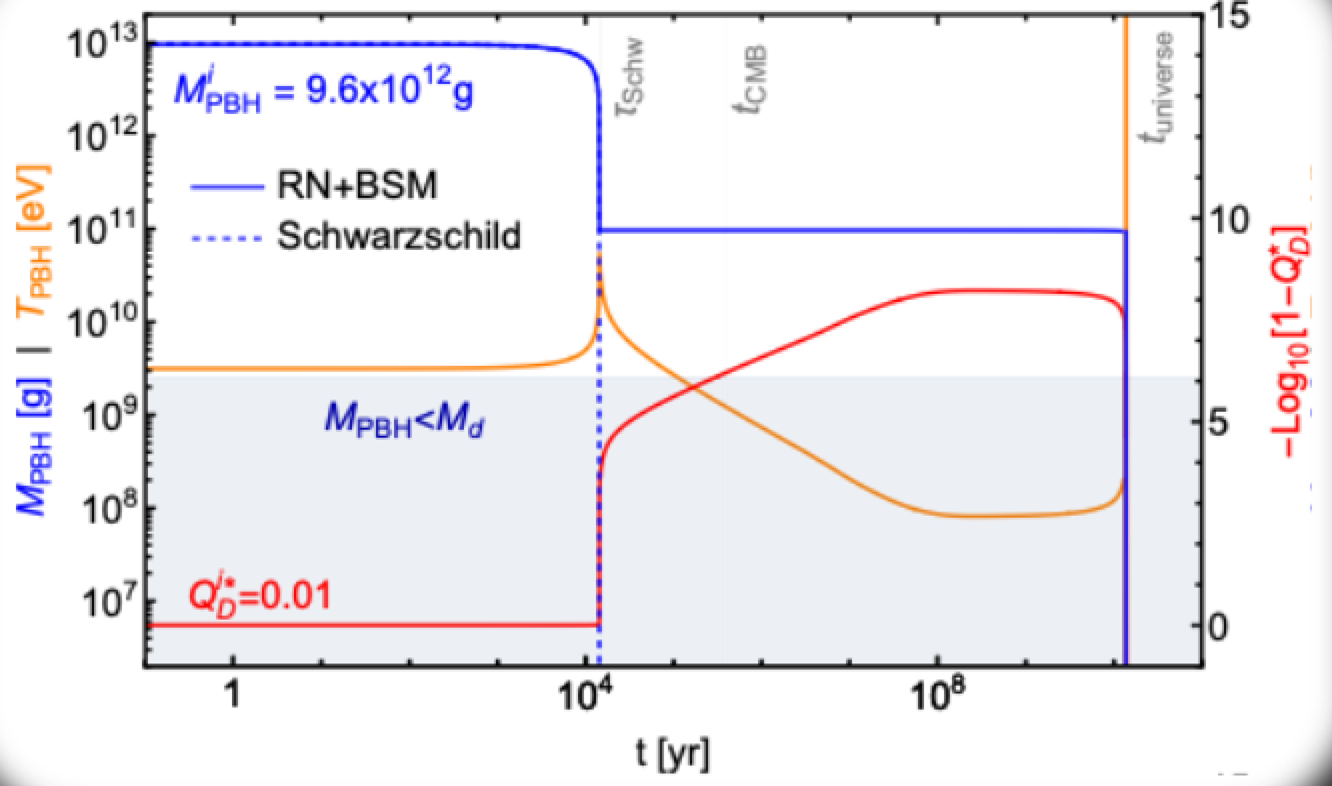
2503.10755

Dark Sector

$$\dot{M} = -\frac{\alpha(M,Q)}{M^2} + \frac{Q}{r_+}\dot{Q}$$

$$\dot{Q} = -\frac{{e_D}^4}{2\pi\, {m_D}^2}\frac{Q^3}{{r_+}^3}\exp\left(-\frac{\pi\, {r_+}^2\, {m_D}^2}{Q e_D}\right)$$

$$T_{RN} = \frac{{M_{Pl}}^2}{2\pi M}\frac{\sqrt{1-{Q_*}^2}}{\left(1+\sqrt{1-{Q_*}^2}\right)^2}$$



Summary

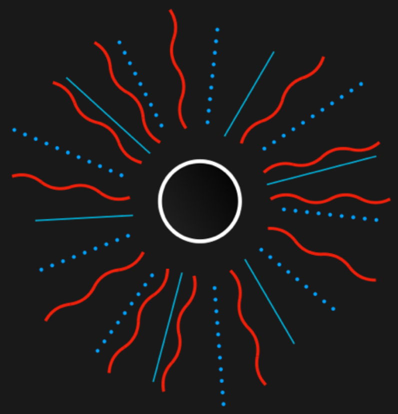
Hawking radiation $\Longrightarrow$ Black holes explosions

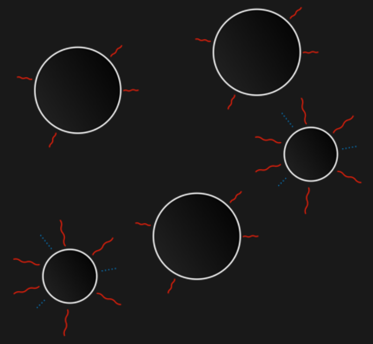
BH explosion encodes information on dark sectors
(2508.XXXXX)

QED-like dark sector can drastically change
phenomenology & evade constraints
(2503.10755 & 2505.22722)

Backup slides

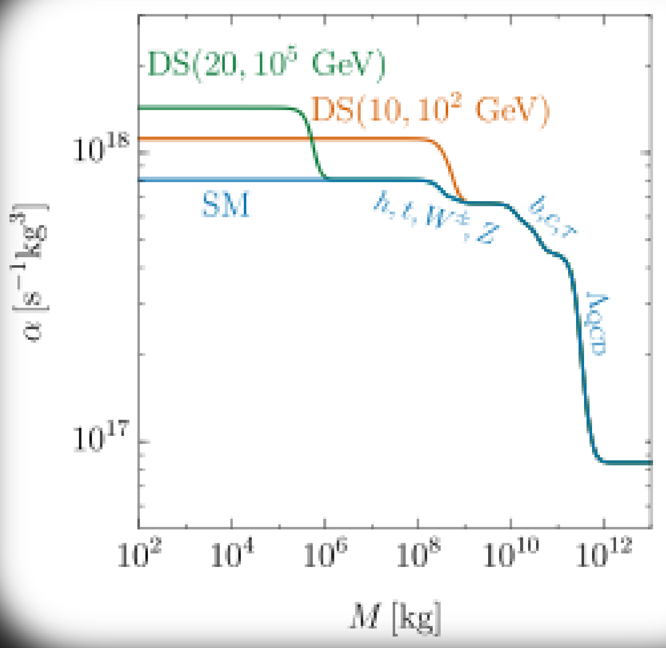
Direct	Indirect
• Individual BH	• Population of BHs
• Transient point-like	• Continuous flux
• $E \gtrsim 100$ GeV	• E ~100 MeV
• Distance $\lesssim 0.1$ pc	• Galactic/Cosmological

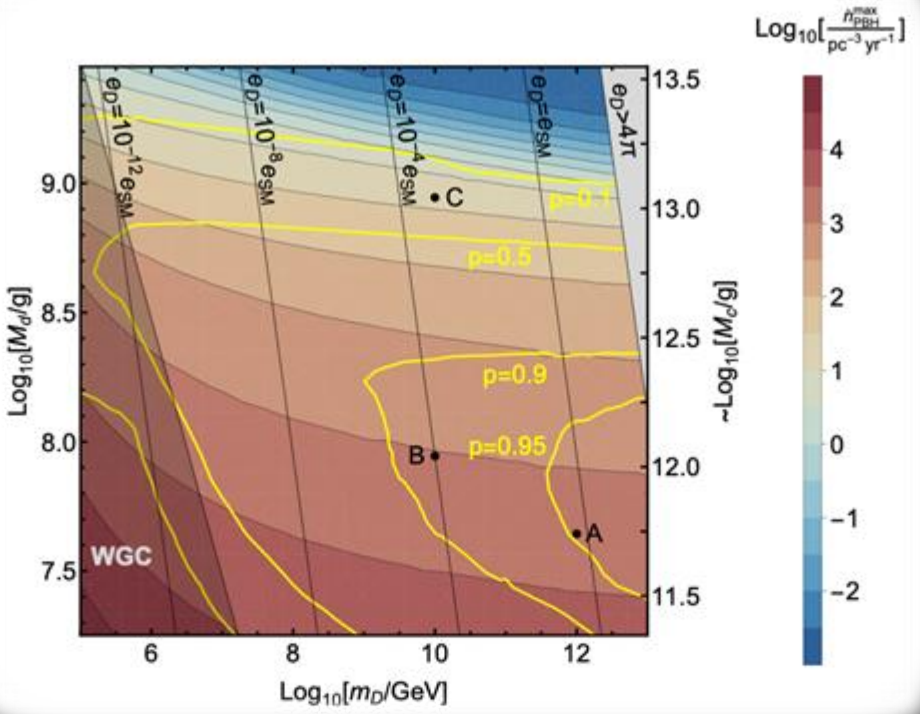




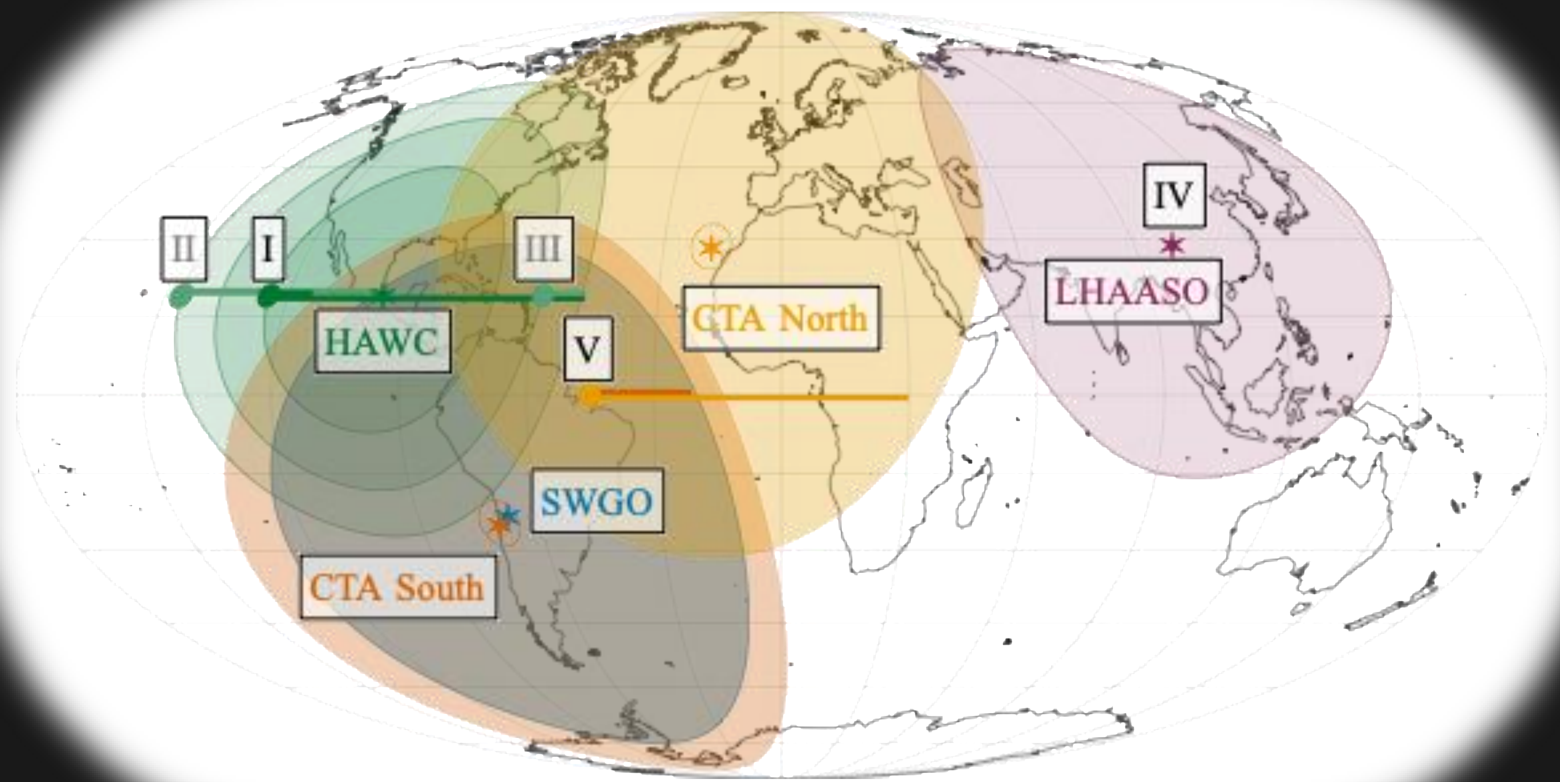
$$\alpha(M_{\mathrm{PBH}}, Q_D) = M_{\mathrm{PBH}}^2 \sum_i \int_0^\infty \frac{d^2 N_i}{dE dt} E\, dE\,,$$

$$\text{with} \quad \frac{d^2 N_i}{dE dt} = \frac{n_{\mathrm{dof}}^i \Gamma^i(M_{\mathrm{PBH}}, E, Q_D)}{2\pi(e^{E/T_{\mathrm{PBH}}} \pm 1)}\,,$$

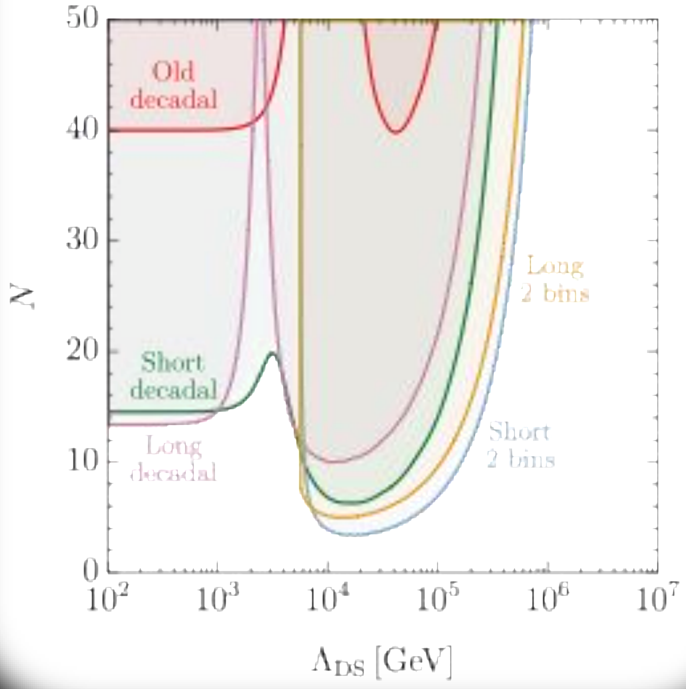




$$\dot{n}_{\rm PBH} \propto \frac{\rho_{\rm DM}}{t_U} \int dQ \int \frac{dM}{\sqrt{2\pi}\sigma_M M^2} \exp\left(-\frac{\log(M/\bar{M})^2}{2\sigma_M^2}\right) \times \frac{1}{\sqrt{2\pi}\sigma_Q} \exp\left(-\frac{(Q-\bar{Q})^2}{2\sigma_Q^2}\right) \delta\left(1-\frac{Q_c(M)}{Q}\right)$$


II
I
III
IV
HAWC
V
CTA North
LHAASO
SWGO
CTA South

Preliminary



$$q \equiv G = -2 \sum_i n_i \log\left(\frac{n_i}{e_i}\right)$$