Metastable Fuzzballs

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based on

1109.5180 & 1207.XXXX

with Iosif Bena and Bert Vercnocke

Strings 2012 Munich - Gong Show

Idea and Result

Resolution of black hole singularity and information paradox via fuzzballs:

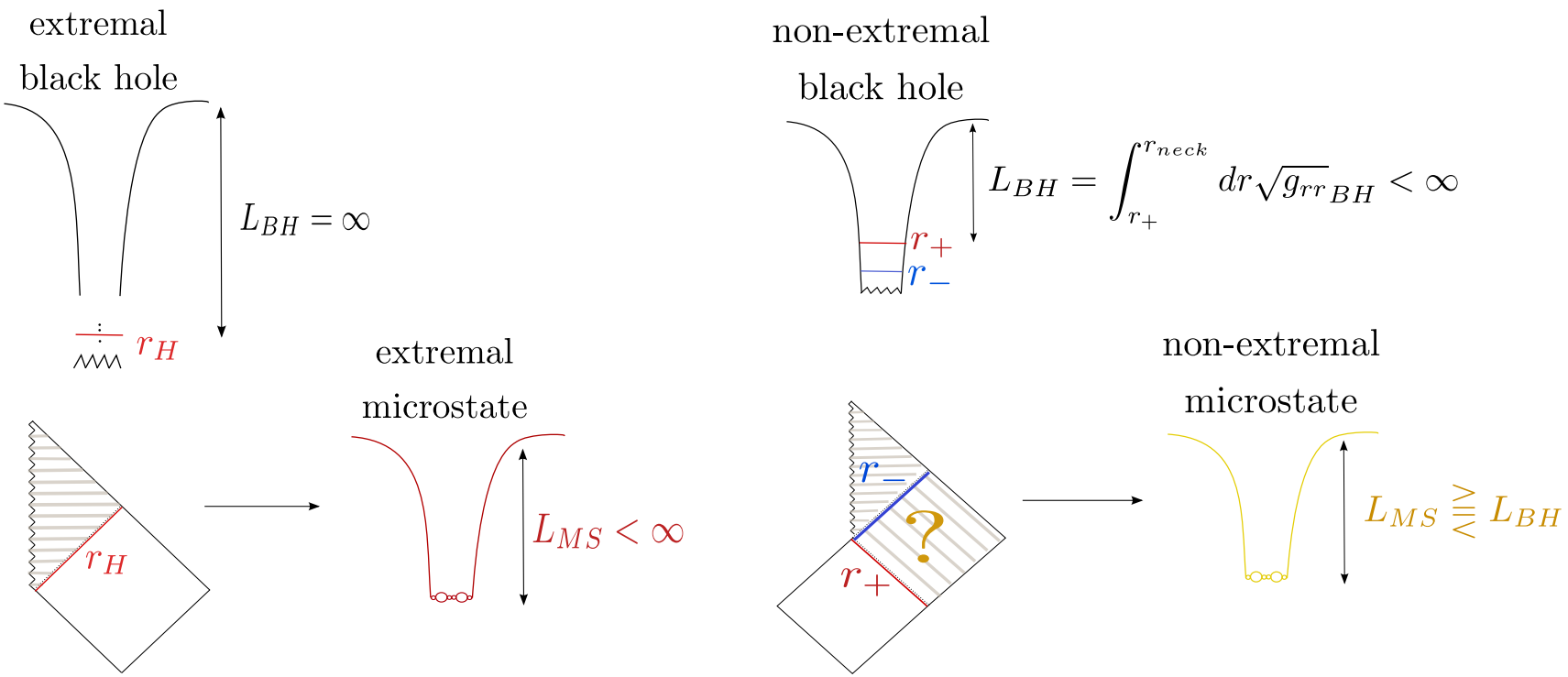

Figure: *Singularity resolution scale for extremal and non-extremal black holes.*

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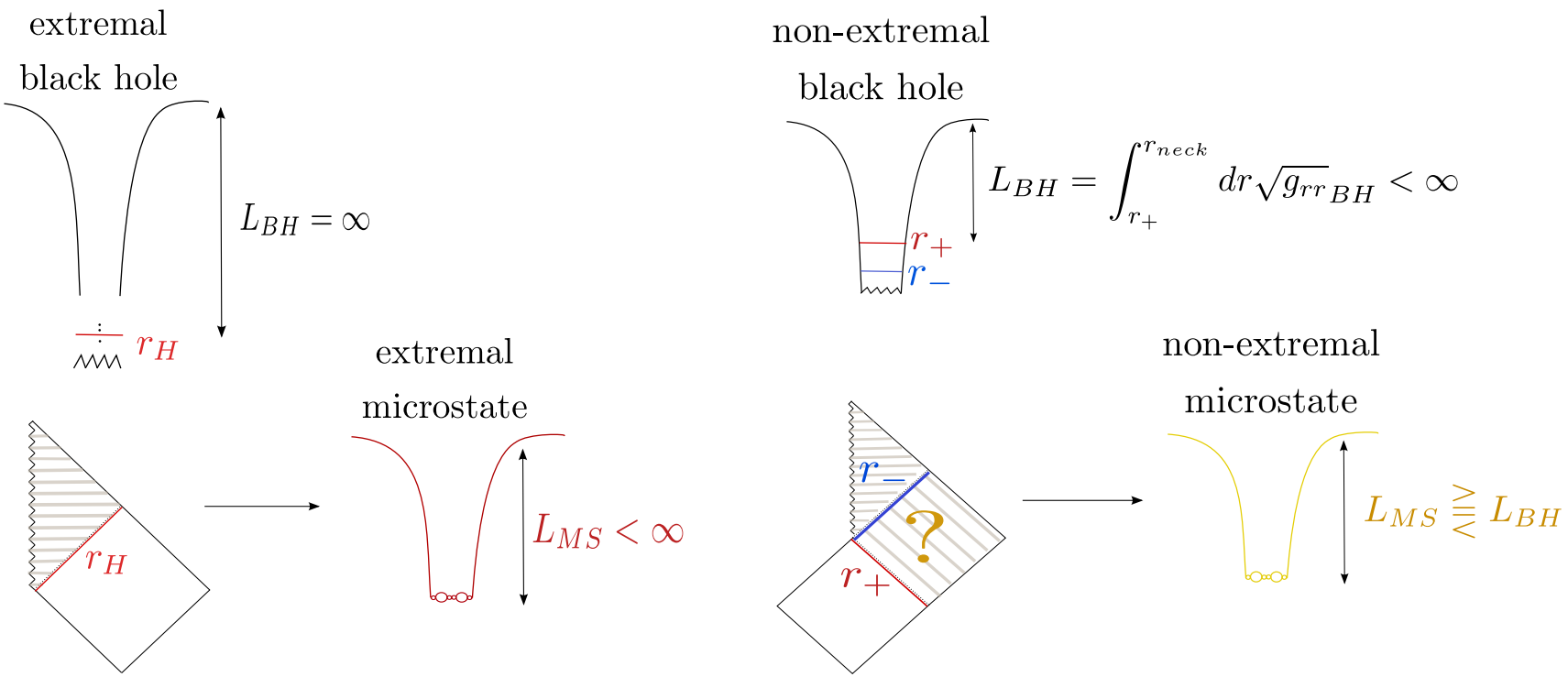
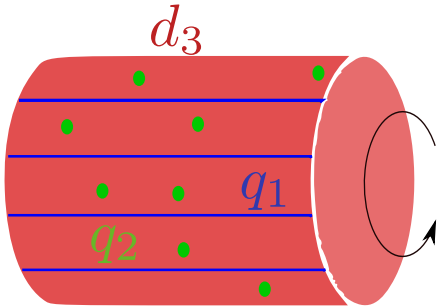


Figure: *Singularity resolution scale for extremal and non-extremal black holes.*

We find metastable fuzzballs with size $\sim$ black hole (outer) horizon $\rightarrow$

Fuzzball proposal extends to near-extremal black holes!

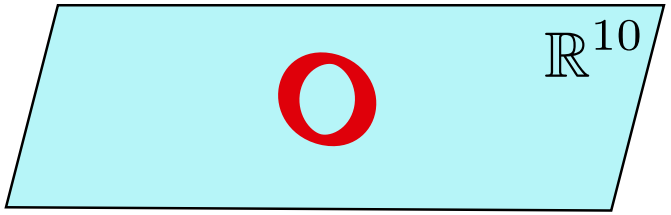
Supertubes in flat space



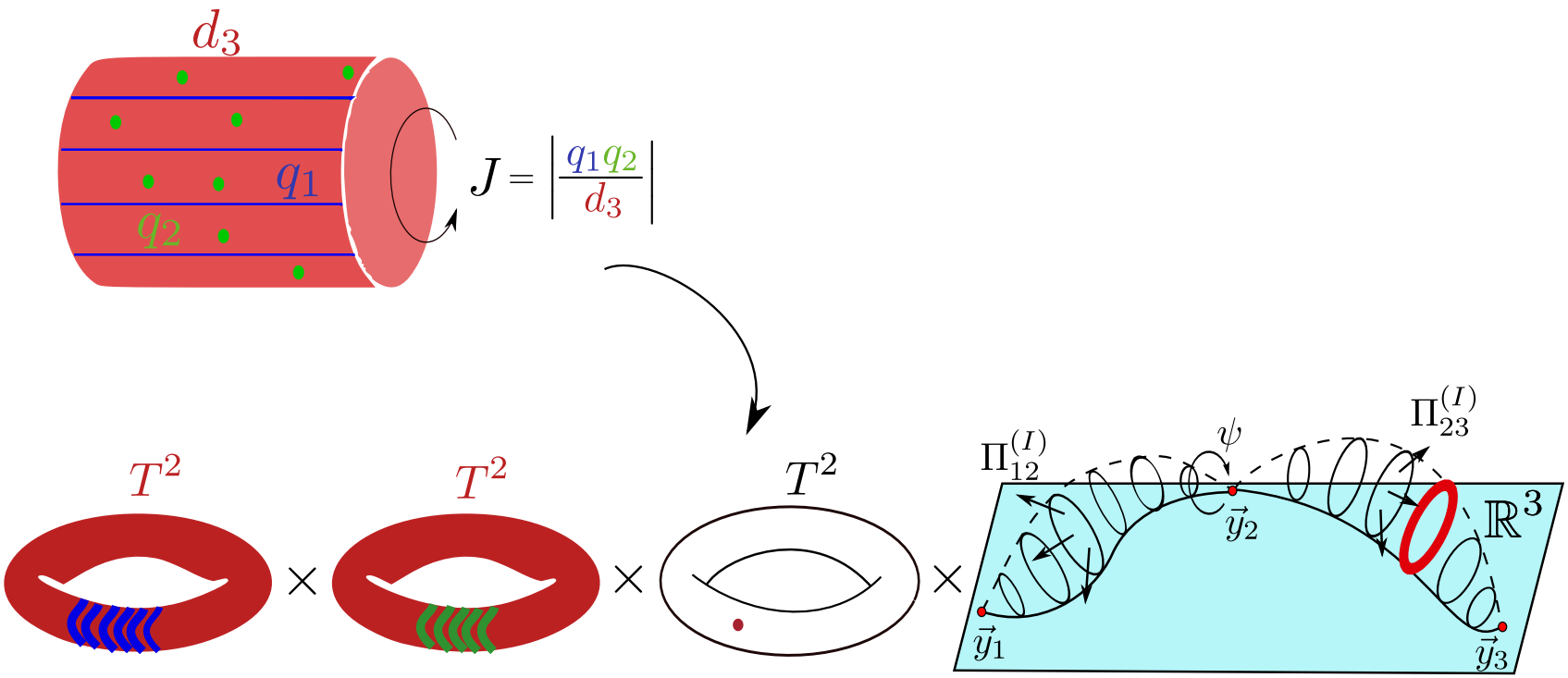
$$J = \left| \frac{q_1 q_2}{d_3} \right|$$

$$\mathcal{H} = \frac{1}{R} \sqrt{{q_1}^2 + {d_3}^2 R^2} \sqrt{{q_2}^2 + {d_3}^2 R^2}$$

[Mateos, Townsend]

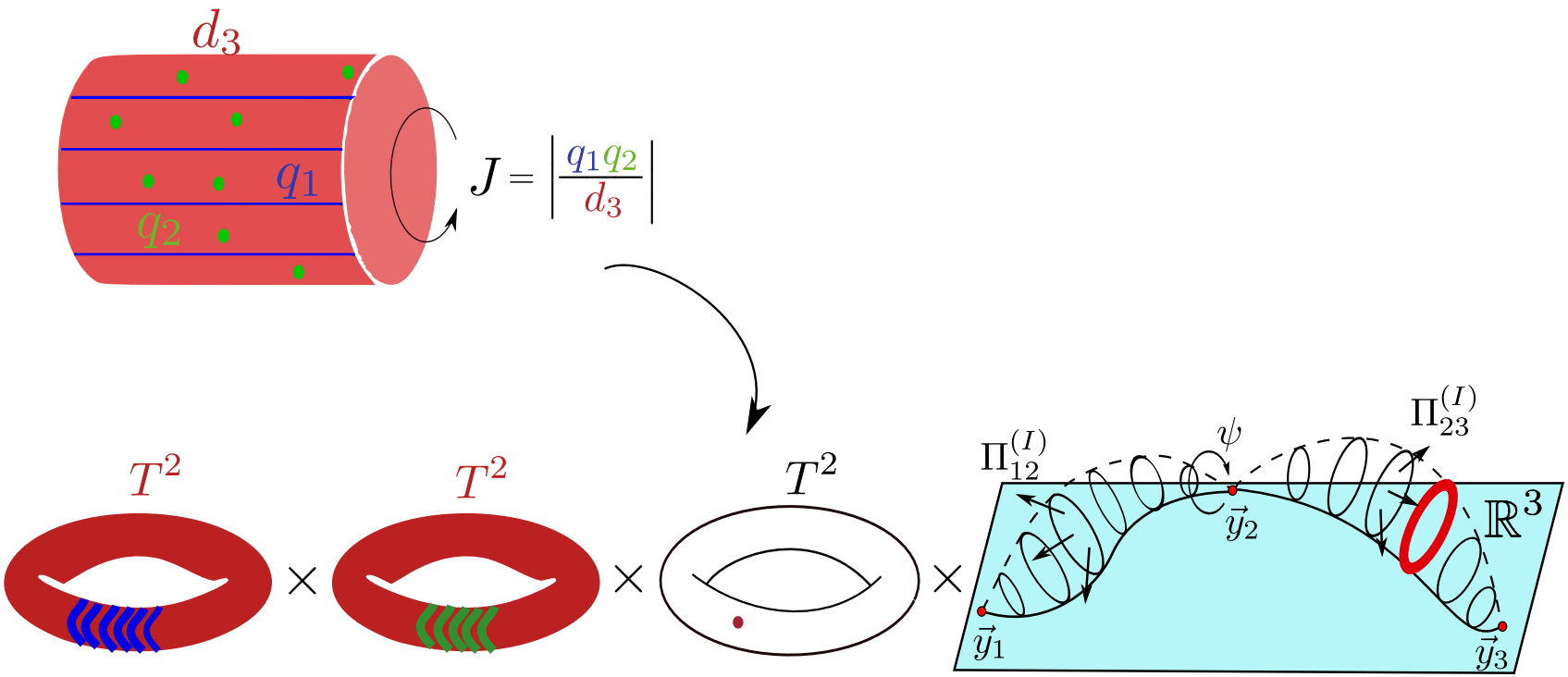


Supertubes in bubbling backgrounds



	0	1 2	3 4	5 6	7 8 9	ψ
$M5$	x	x x	x x			x
$M2$	x	x x				
$M2$	x		x x			

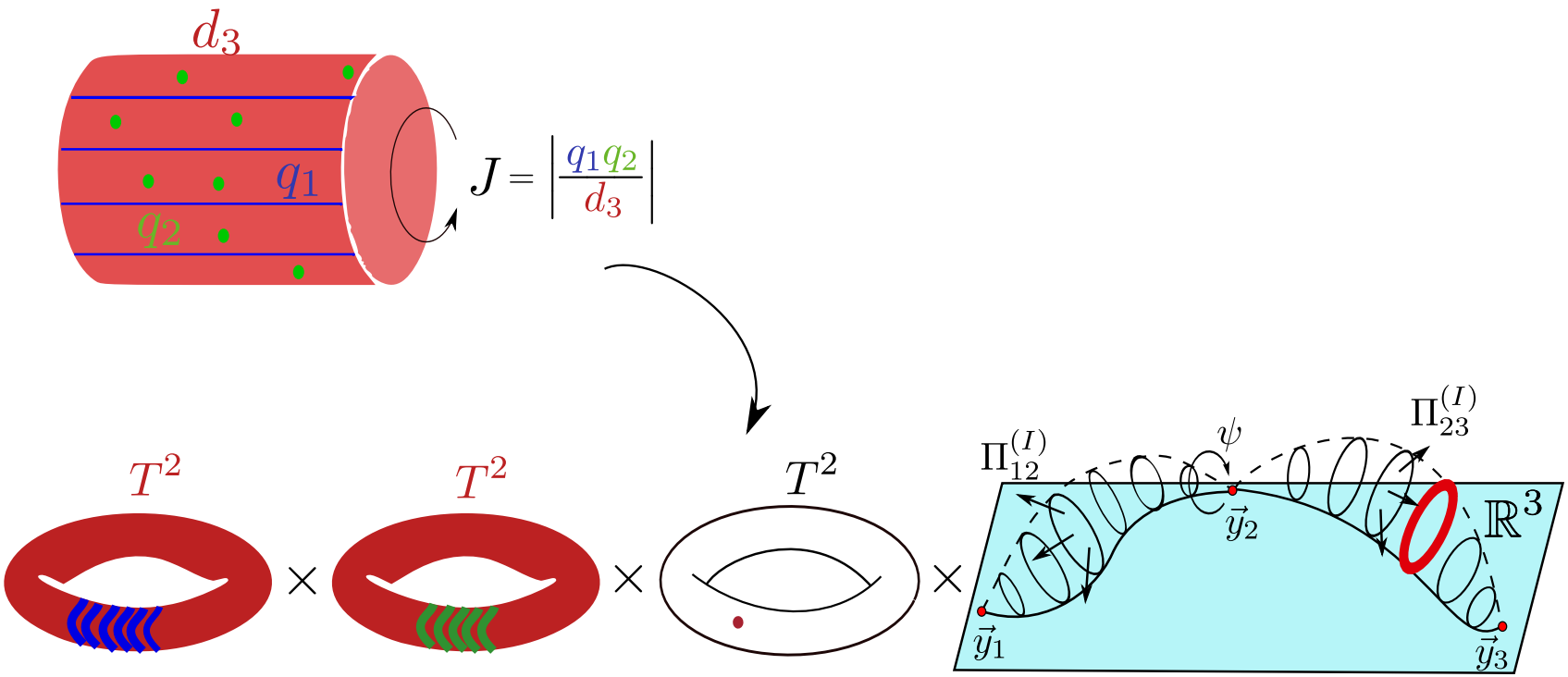
Supertubes in bubbling backgrounds



$$\mathcal{H} = \frac{\sqrt{Z_1 Z_2 Z_3 V^3}}{d_3 R}\sqrt{\tilde{q}_1{}^2 + d_3{}^2 \frac{R^2}{Z_2^2 V^2}}\sqrt{\tilde{q}_2{}^2 + d_3{}^2 \frac{R^2}{Z_1^2 V^2}}$$
$$+\frac{\mu V^2}{d_3 R}\tilde{q}_1 \tilde{q}_2 - \frac{\tilde{q}_1}{Z_1} - \frac{\tilde{q}_2}{Z_2} - \frac{d_3 \mu}{Z_1 Z_2} + q_1 + q_2$$

$\tilde{q}_1 \equiv q_1 + d_3(K^2/V - \mu/Z_2)$ and $(1 \leftrightarrow 2)$, $\quad R^2 = Z_1 Z_2 Z_3 V - \mu^2 V^2$

Supertubes in bubbling backgrounds



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This potential has metastable minima!

Supersymmetric versus metastable minima

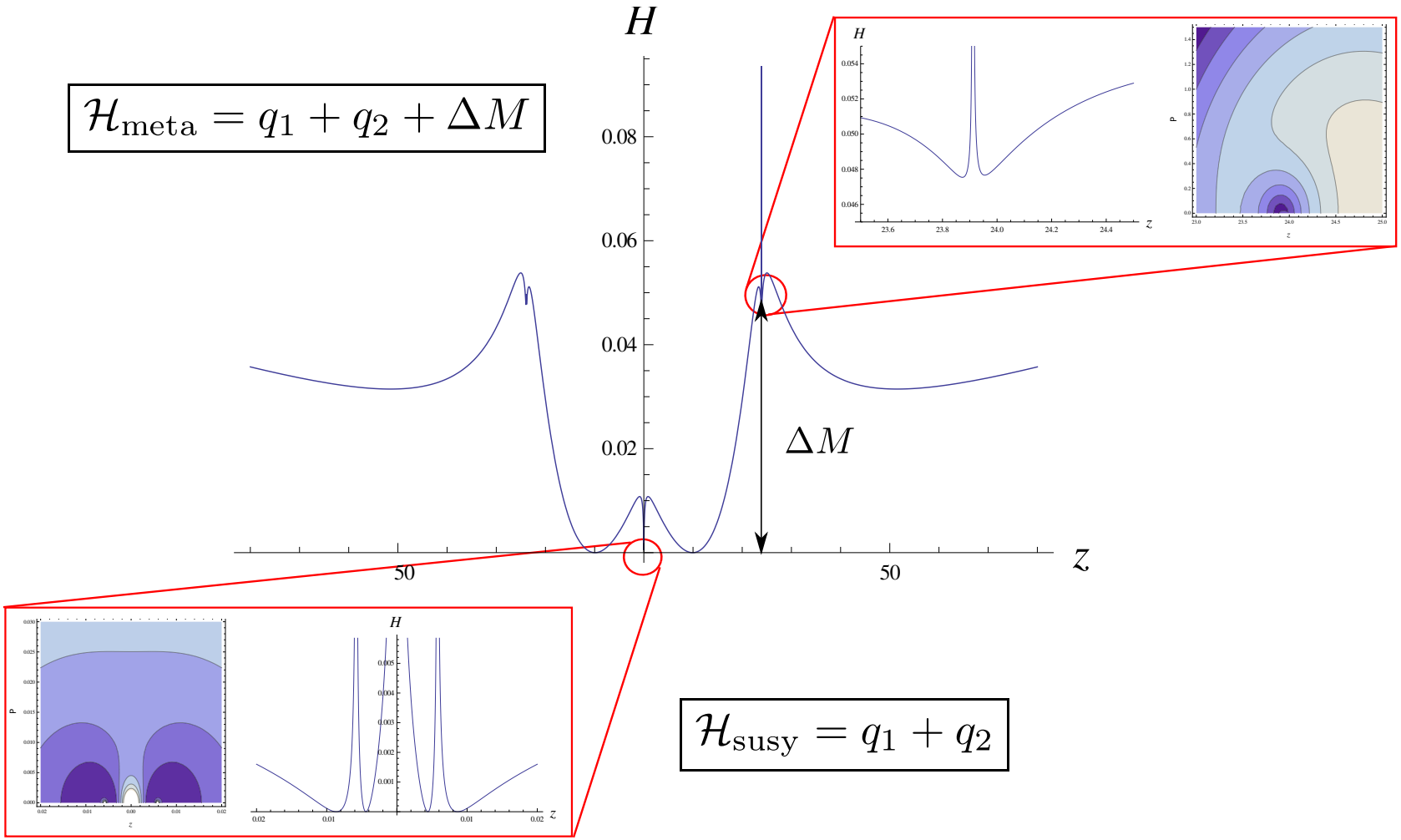

Figure: *Supersymmetric & metastable minima.*

Extremal versus non-extremal black hole microstates

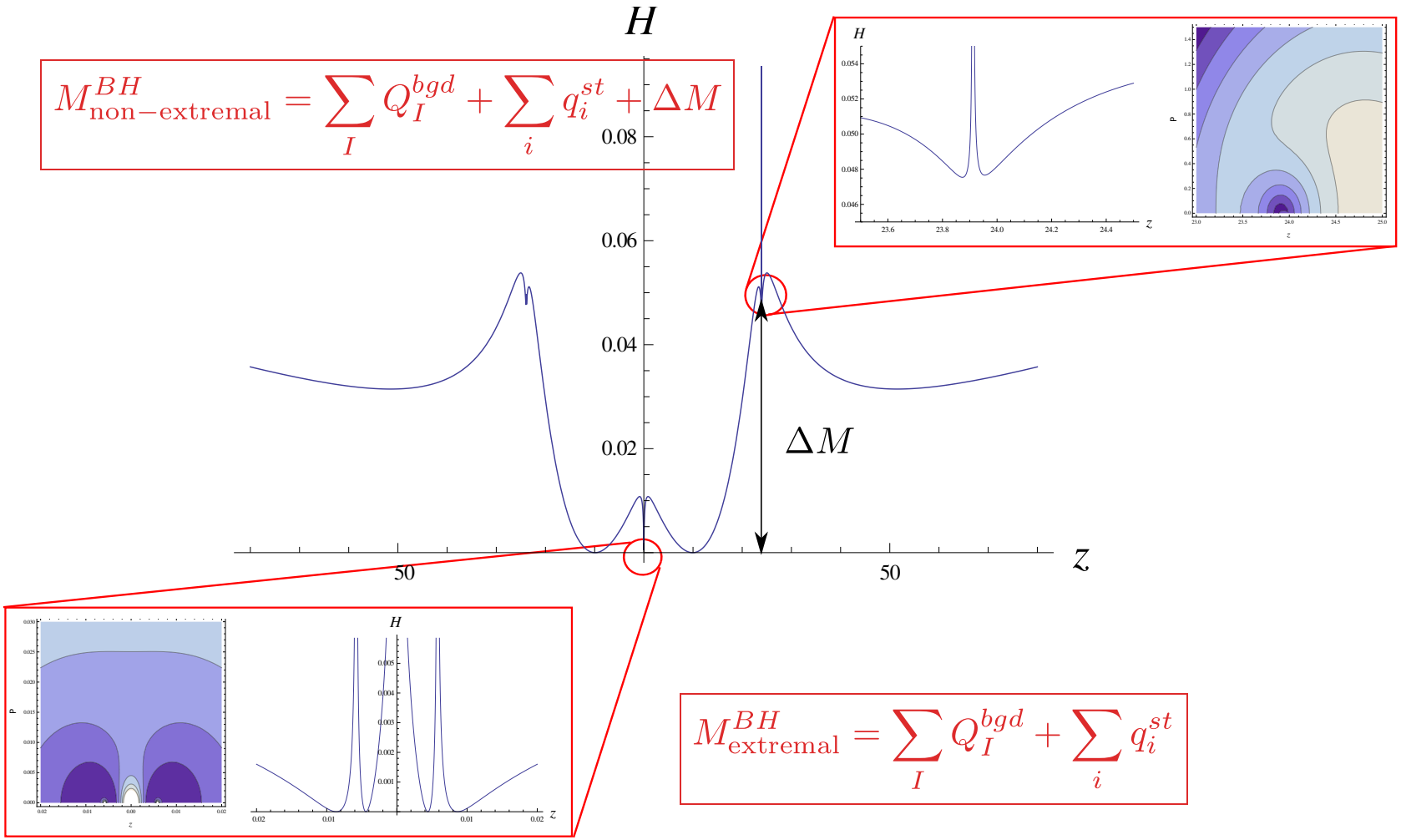

Figure: *Supersymmetric & metastable minima.*

Supertube dynamics: Brane-Flux Annihilation

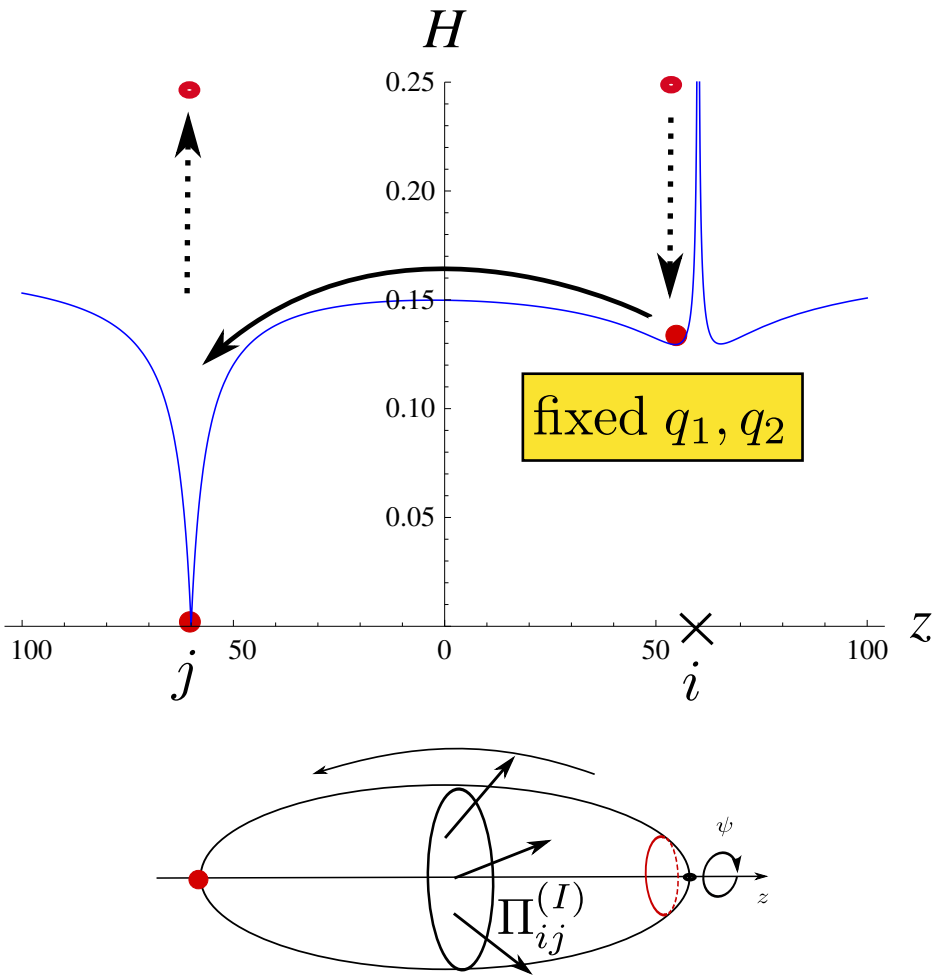

Figure: *A metastable supertube close to one center can tunnel to a stable supertube close to the other center, reducing in the process the flux on the two-cycle between these two centers → emission of last Hawking quanta.*

Singularity resolution scale

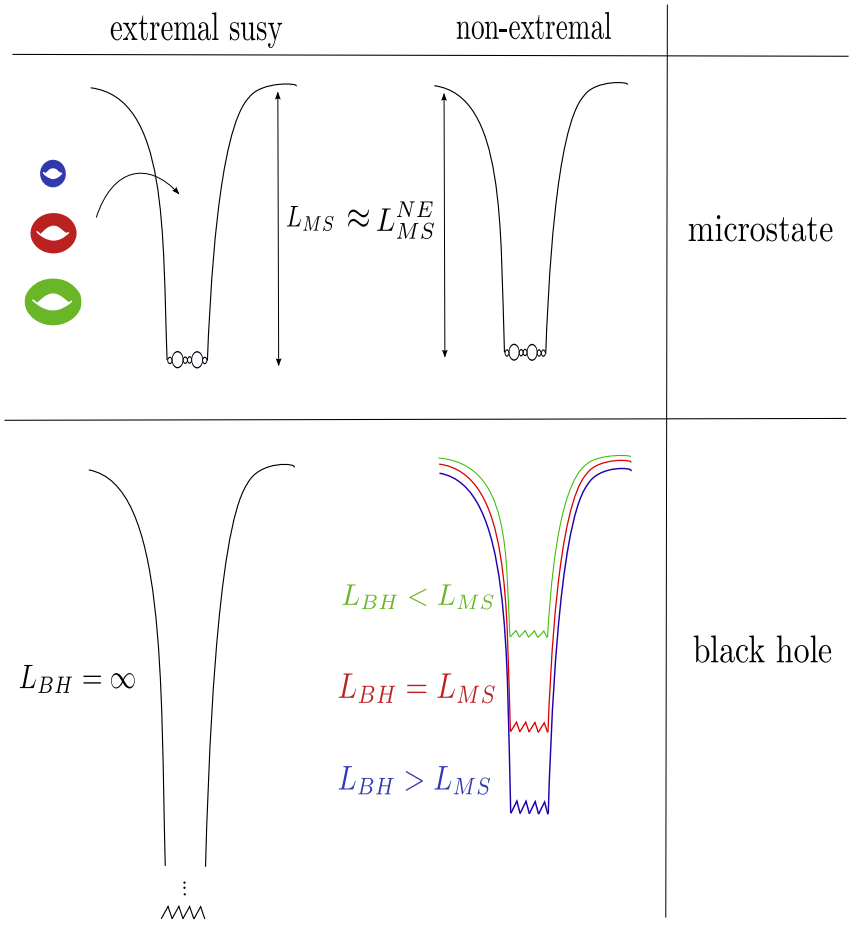

Figure: *By varying the supertube charges we obtain microstates that shallower, deeper or of equal depth as the corresponding black hole.*

Singularity resolution scale

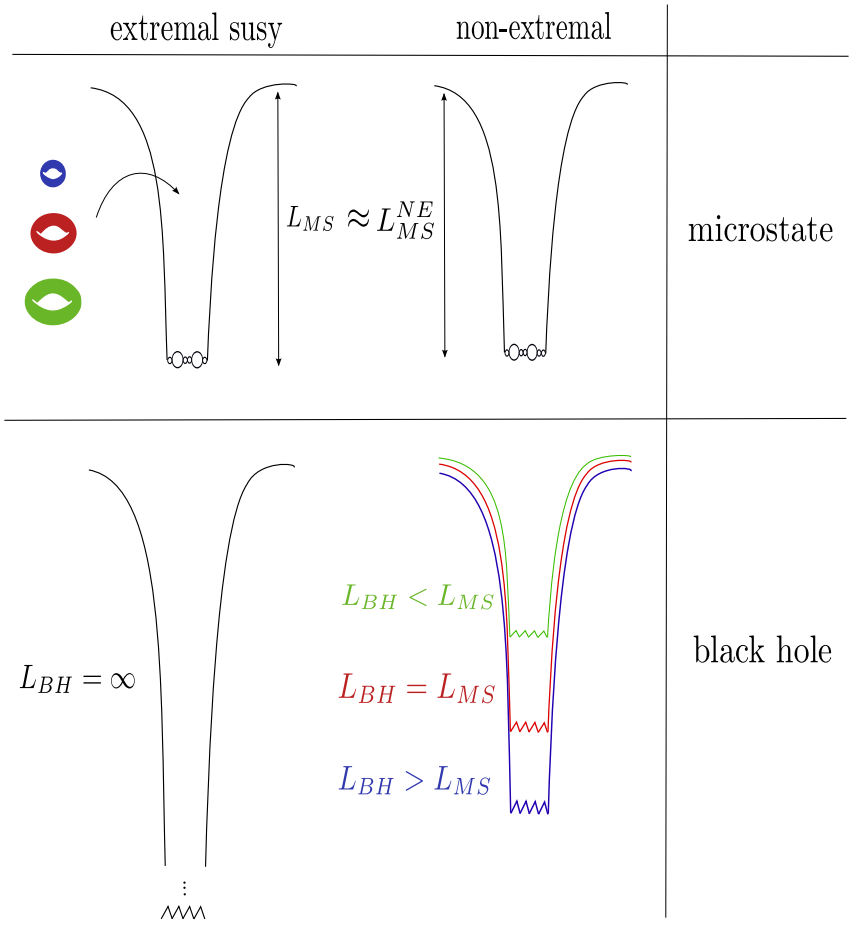

Figure: *By varying the supertube charges we obtain microstates that shallower, deeper or of equal depth as the corresponding black hole.*

→ **This provides a systematic way to construct a huge class of near-extremal black hole microstates.**