

Creating semiclassical black holes in collider experiments and keeping them on a string

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in collaboration with Gia Dvali



A radical resolution of the hierarchy problem: the fundamental scale $M_* \sim \text{a few (tens) TeV}$

Arkani-Hamed et. al., 1998

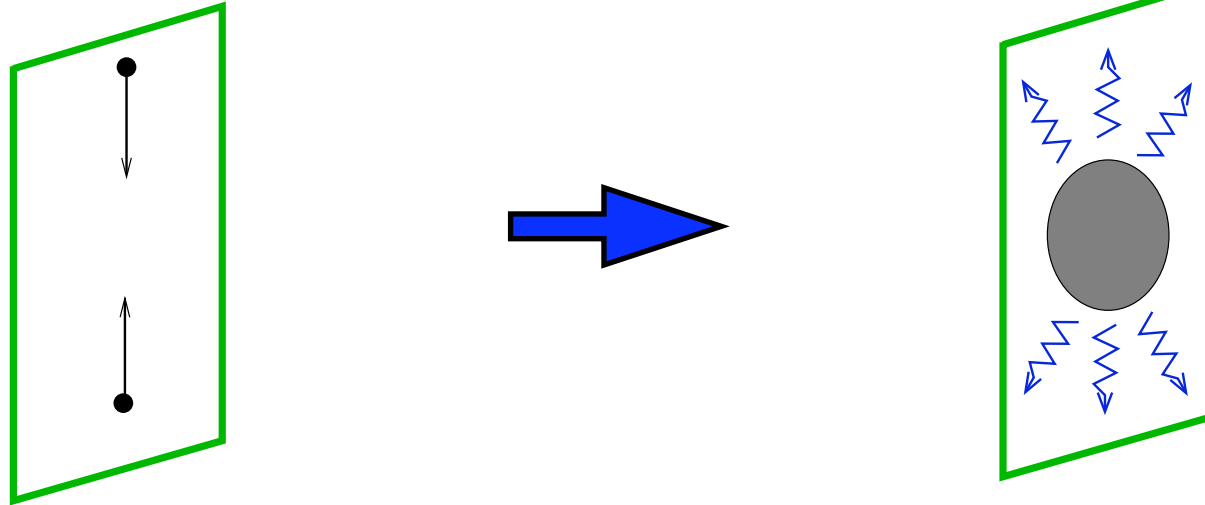
Opportunity to probe (quantum) gravity in the ultrarelativistic regime at colliders

Black hole production is one of the most spectacular possibilities

Giddings & Thomas, 2001

Dimopoulos & Landsberg, 2001

Direct BH production



- **pro:** model independent
softening and isotropization of reaction products
- **contra:** semiclassical regime unattainable → hard to describe
limitation $M_* \lesssim 10 \text{ TeV}$

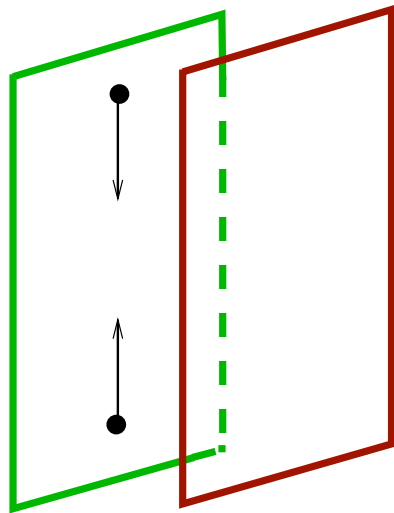
Is it the only possible scenario?

There are many more possibilities

Creation of BH can take place away from our brane

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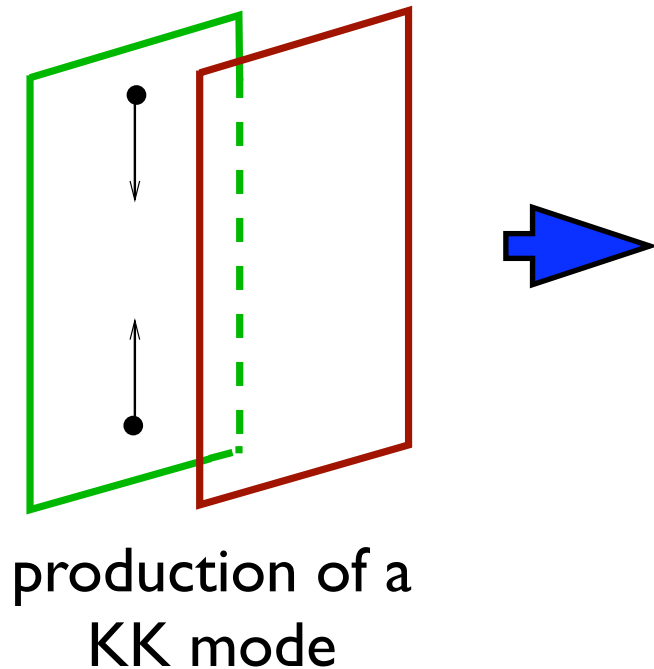
Creation of BH can take place away from our brane



production of a
KK mode

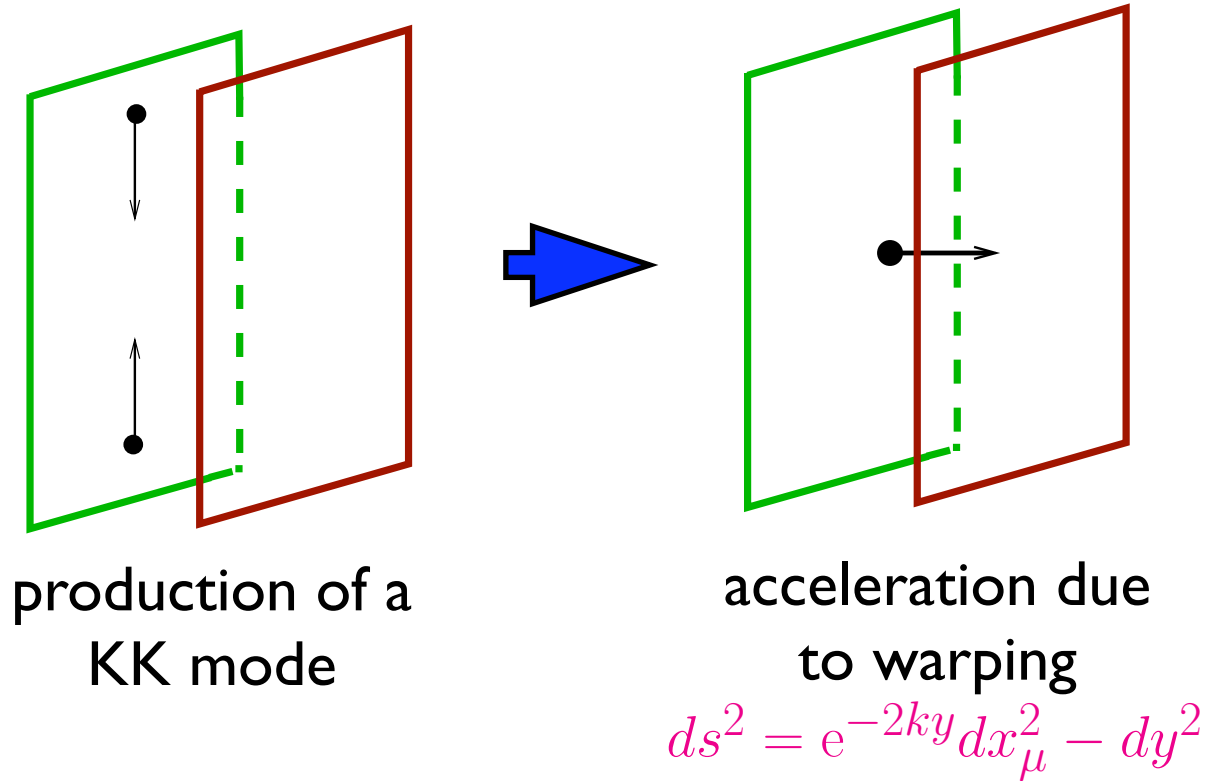
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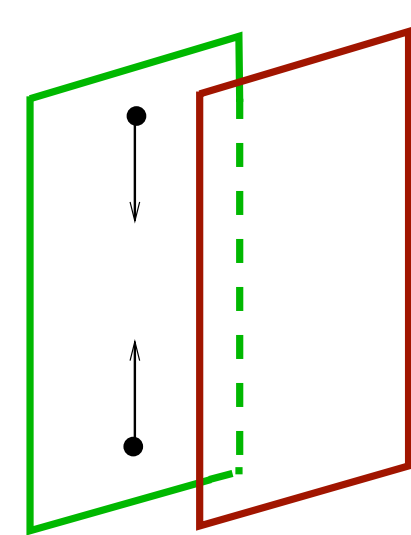
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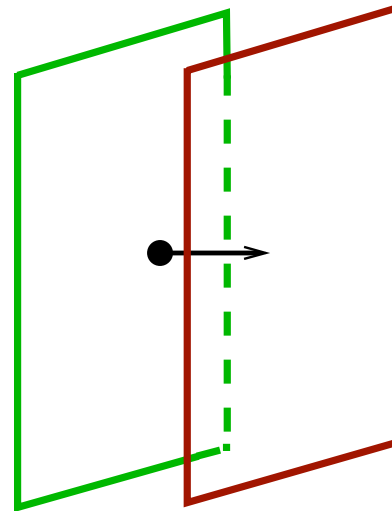
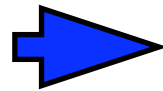


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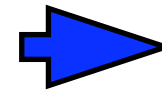


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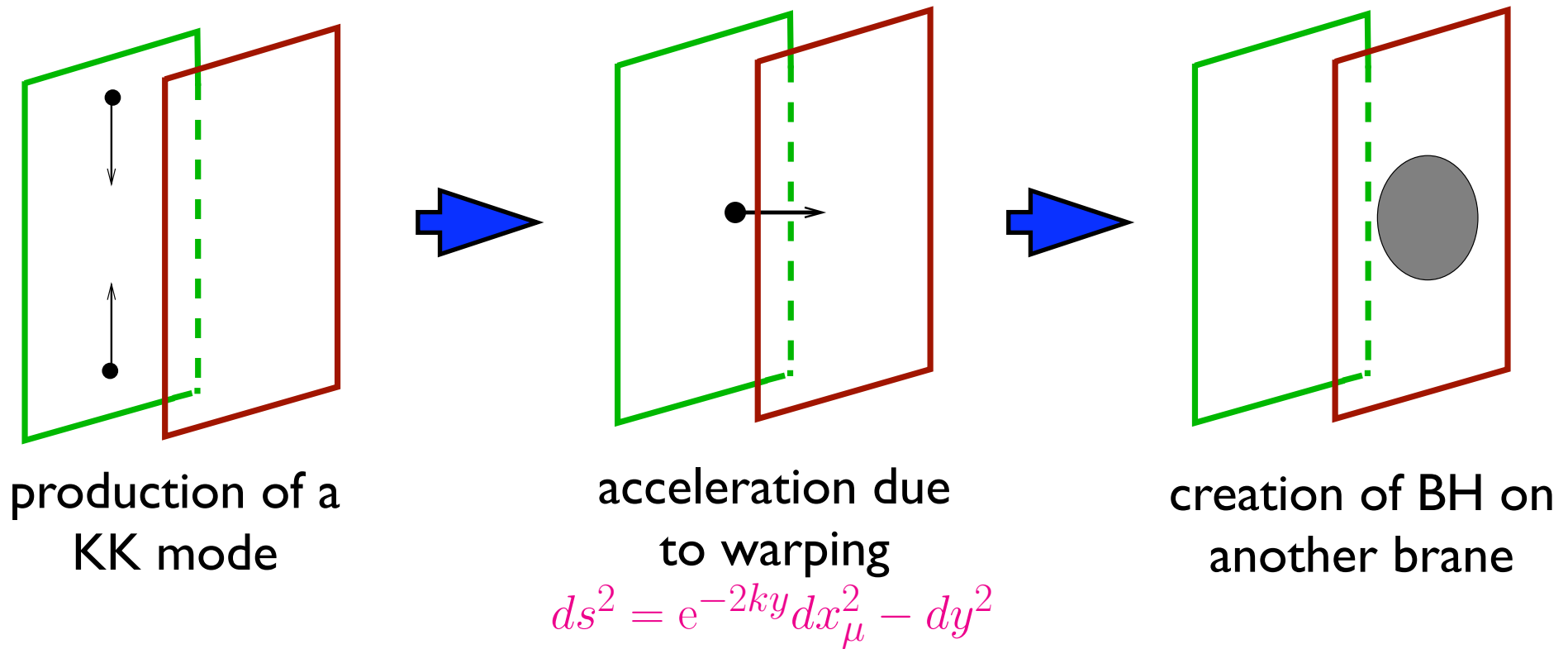
acceleration due
to warping

$$ds^2 = e^{-2ky} dx_\mu^2 - dy^2$$



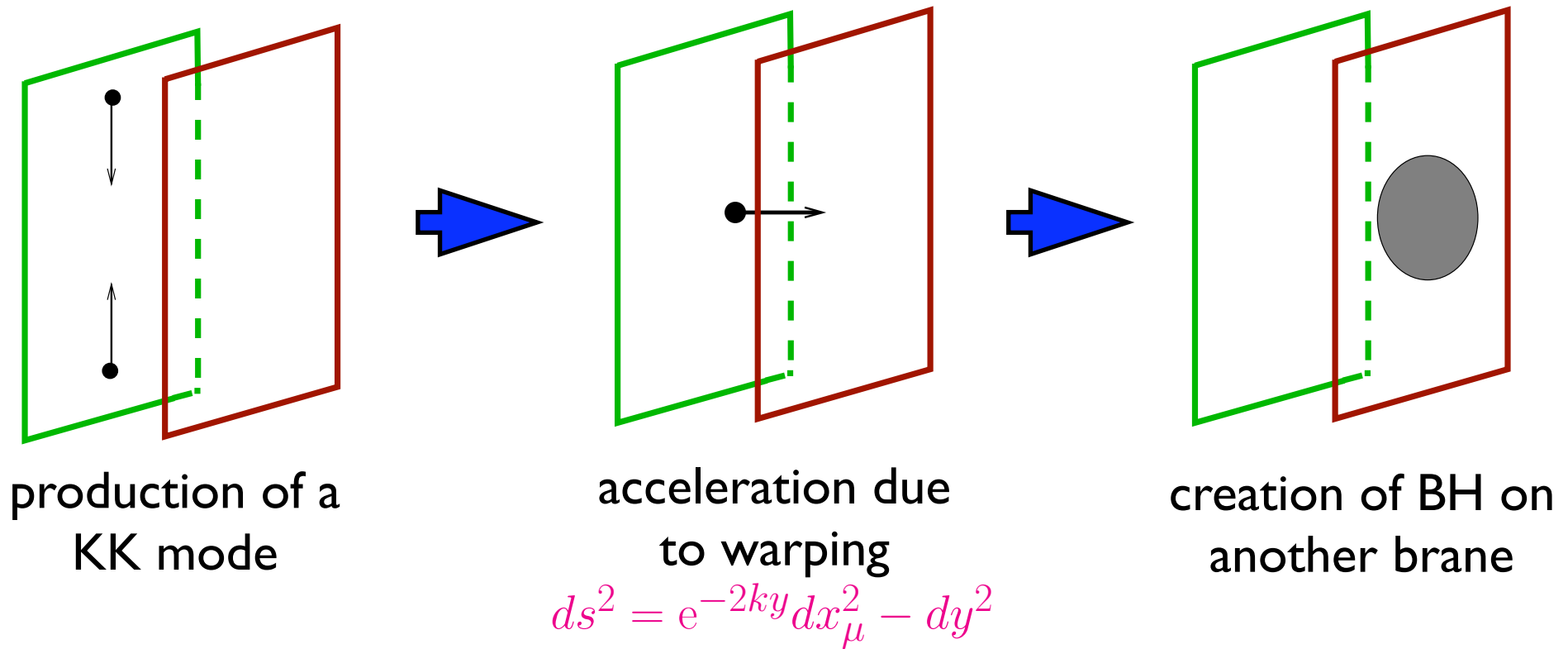
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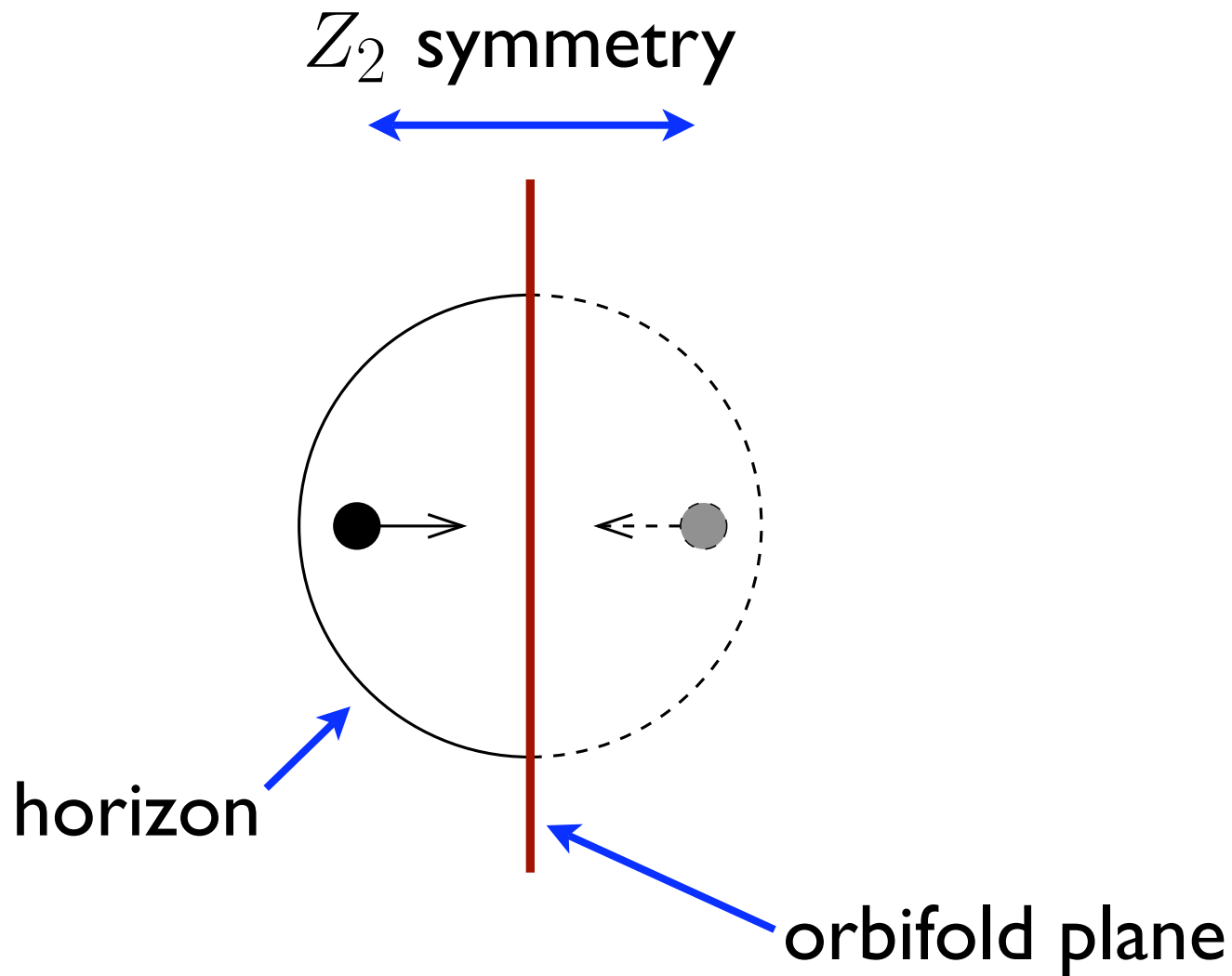
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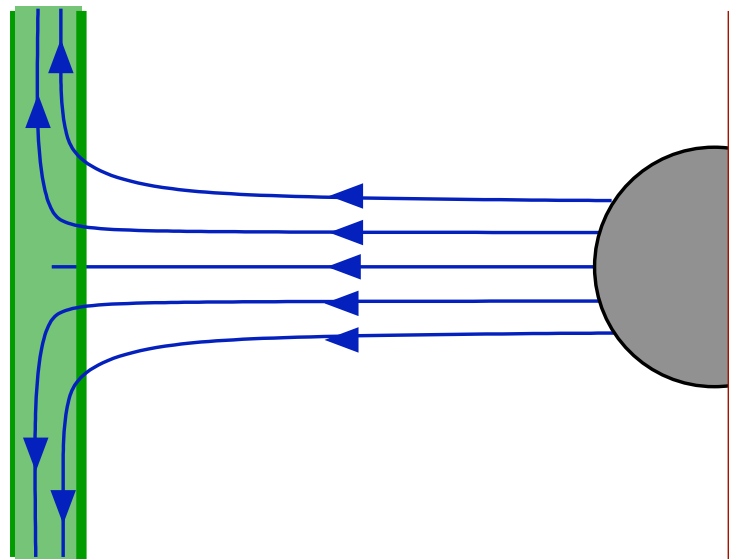
May happen even for $M_* > 10 \text{ TeV}$

Creation of BH in collision with an orbifold plane



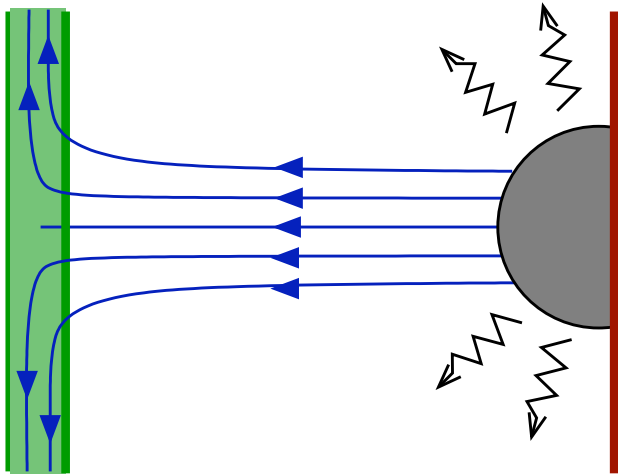
Is such a BH observable?

Yes, if it carries a SM gauge charge

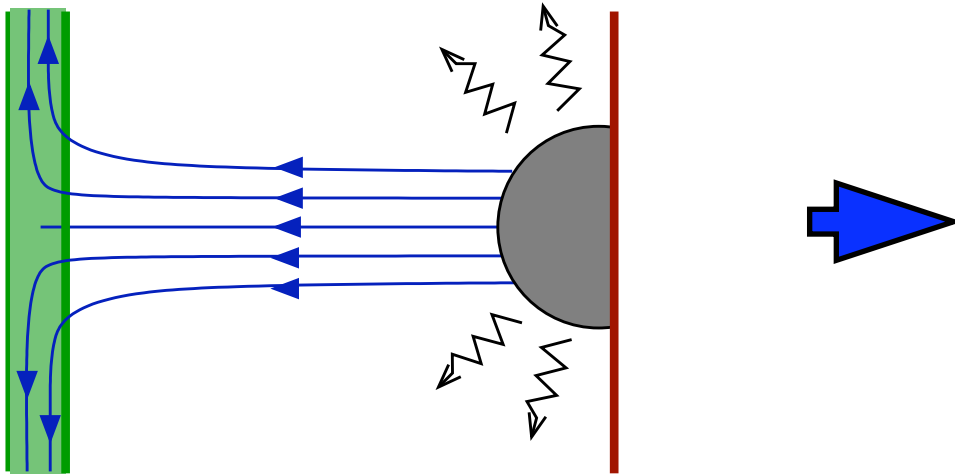


NB. Assume existence of a mass gap in bulk gauge theory

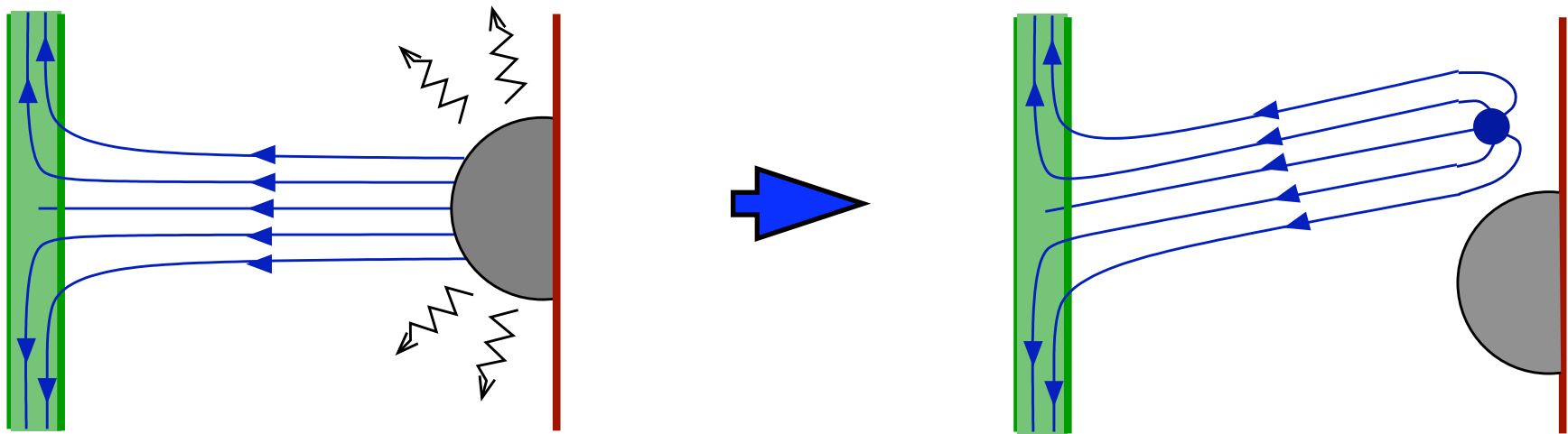
The system appears as a heavy charged bound state



- BH evaporates = the mass of the bound state decreases with time!



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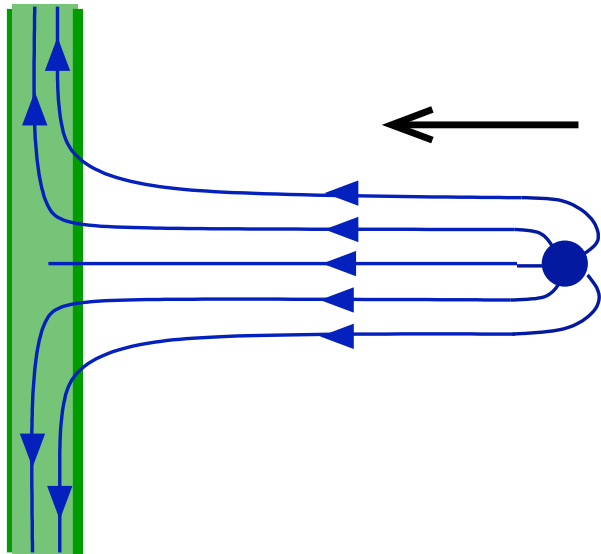


- BH evaporates = the mass of the bound state decreases with time!
- BH heats up enough to emit a charged bulk particle = bound state breaks off

NB lifetime is generically large due to:

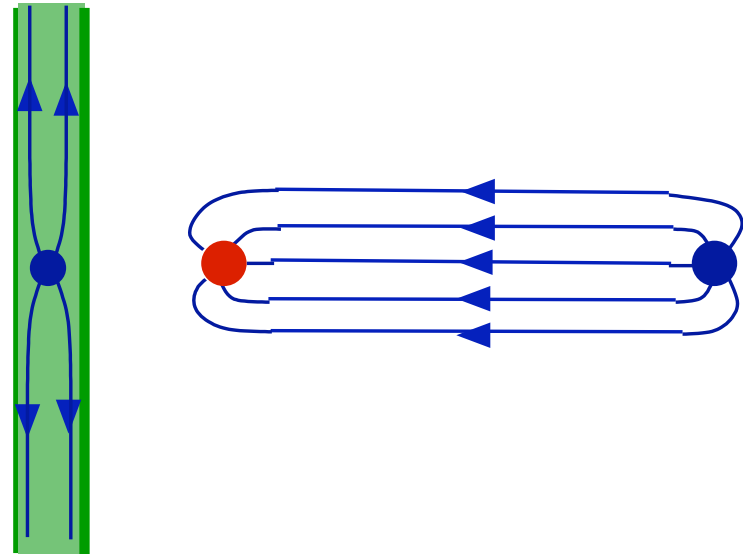
- slow BH evaporation
- time dilation caused by warping

Decay of the charged component



fast

or



exponentially
suppressed

Conclusions

- Production of BH at colliders (LHC) may proceed in (many) unexpected ways
- Exotic signatures: long-lived heavy charged bound states with slowly decreasing mass, subsequent decay of the charged component, ...