

# New Instability of Non-Extremal Black Holes

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ArXiv:[1110.5641](https://arxiv.org/abs/1110.5641) with Borun Chowdhury (Amsterdam)

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# Outline

1. Motivation

2. Results

3. Outlook

# Motivation

## Non-extremal multi-center solution in supergravity (5D)

- ▶ SUSY/extremal – explicit solutions
- ▶ Non-extremal Black holes, black rings, multi-rings, saturns...
  - Extension of  $R_{\mu\nu} = 0$  BH phase structure  
→ electric/magnetic charges see also [Obers' session]
- ▶ Black hole microstates

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## Method: one center = probe

- ... SUSY background – SUSY broken by orientation [Talk Puhm]
- ... Non-extremal background – [This talk] + [Talk Denef]

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**M-theory**

$$\mathcal{M}_{1,10} = \mathbb{R}_t \times M_4 \times T^6$$

$T^6$	$y^1$	$y^2$	$y^3$	$y^4$	$y^5$	$y^6$
M2	×	×				
M2			×	×		
M2					×	×

# Results: Probe

Supertube probe cf. [Talk Puhm] – 3 parameters

$$\begin{array}{l|l} q_1, q_2 & \text{electric charges} \\ d_3 & \text{dipole charge} \\ j_1^{tube} = q_1 q_2 / d_3 & \text{angular momentum} \end{array}$$



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M2						×	×
M2		×	×				
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M5	×	×	×	×	×		

# Results: Probe

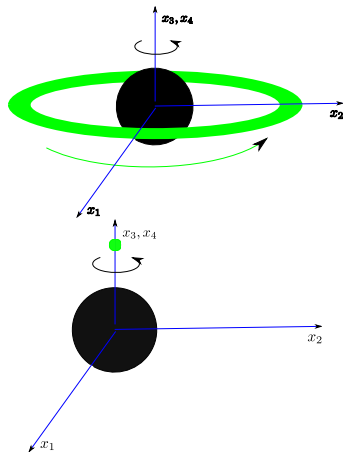
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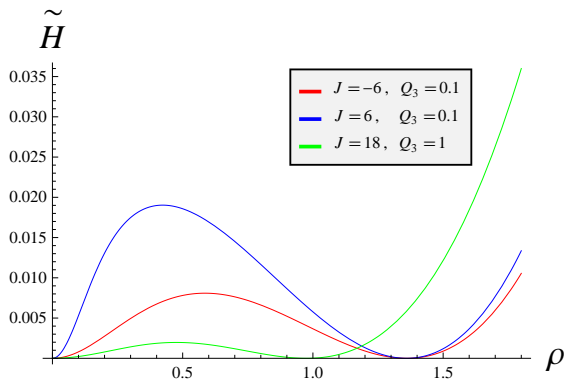
## Potential $V$ from supertube DBI + WZ action

- ▶ Supersymmetric limit of background (BMPV)  
[Marolf, Virmani; Bena, Kraus; Puhm Talk]
- ▶  $(Q_1, Q_2) = (30, 20)$ ,  $(q_1, q_2, d_3) = (1.5, 1.3, 1)$

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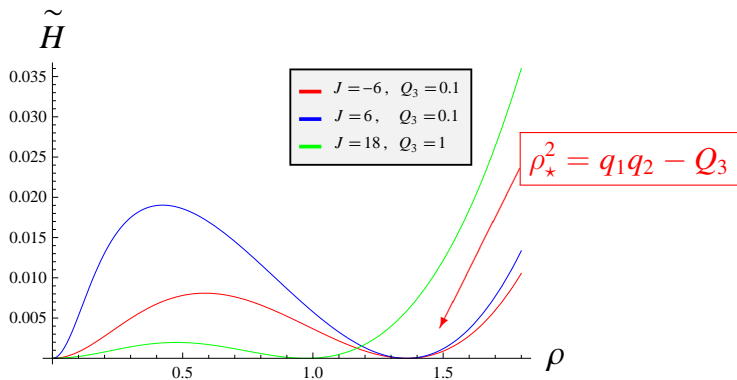
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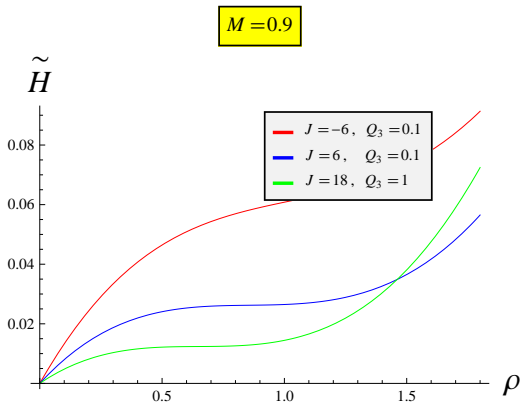
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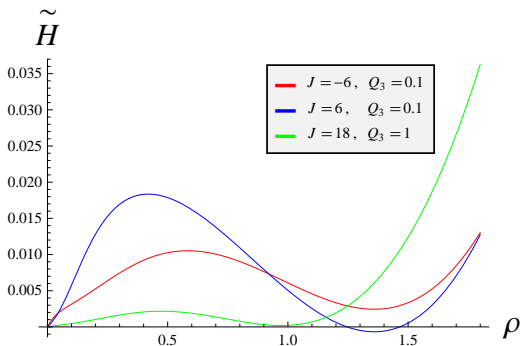


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$$M = 0.01$$



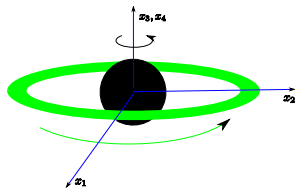


# Results: the potential

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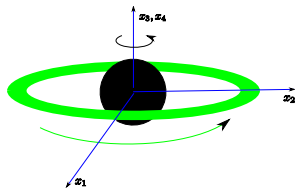
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- ▶ Angular momentum is crucial for the stable bound states
- ▶ Rest talk: rotation in same plane
- ▶ Large parameter space

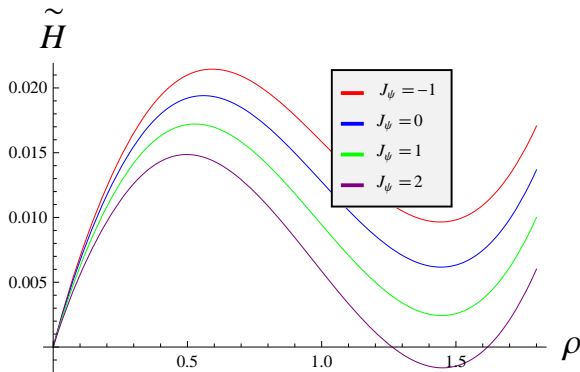


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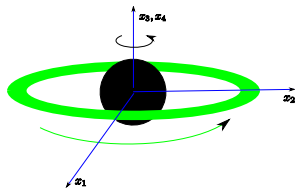


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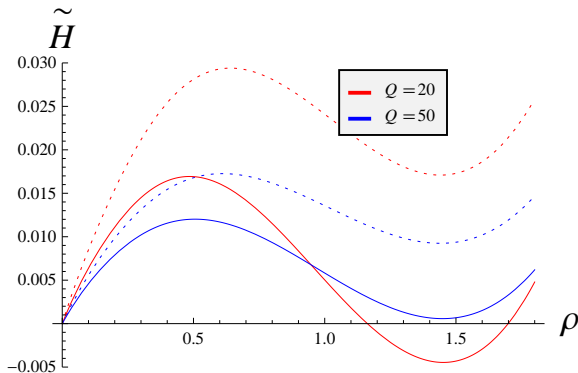


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# Results: moulting revisited

Moulting black holes [Bena, de Boer, **Chowdhury**, El Showk, Shigemori]

- ▶ Supersymmetric: BMPV black hole + supertube (no probe!)
- ▶ ‘Entropy enigma’: 2-centers more entropy than one-center BMPV
- ▶ ‘Thermodynamic instability’ (CFT and bulk)

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## Non-extremal black hole

- ▶ Thermodynamic vs. **dynamic** instability
- ▶ Compare:
  - CFT (bound state dominant – highest entropy)
  - Bulk (bound state stable – lowest energy)

# Results: moulting revisited

Go to D1-D5-P frame

$Q_1, Q_5$  large,  $Q_P$  very small

- ▶ D1-D5 near-horizon decoupling limit of background
- ▶ Small P excitations (non-extremality in P)
- ▶ AdS/CFT: non-supersymmetric P excitations of D1-D5 CFT

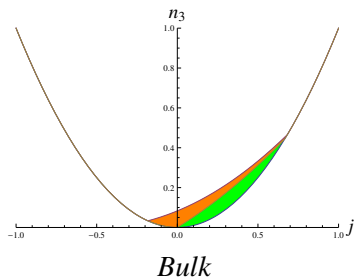
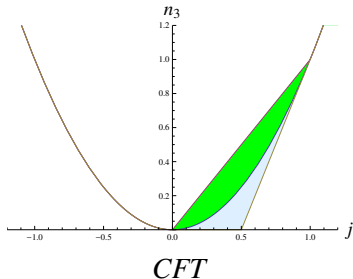
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For overall  $Q_P = 0$ : Similar story as [Chowdhury's talk]





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## Merger?

- ▶ Potential: can shoot supertube in
- ▶ Merger should be Cvetič-Youm black hole (**CTC-free**)
- ▶ Study black hole phases

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## Non-extremal 3-charge **black ring**:

- ▶ Duality transformations along  $T^6$
- ▶ IIA interpretation:
  - D2-D2-D2-D6 BH  $\rightarrow$  D4-D4-D4-D0 BH
  - Supertube  $\rightarrow$  D6 brane

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Blackfold techniques for supergravity?