Strings & Gravity at University of Barcelona

Higher-dimensional black holes [R. Emparan, M.J. Rodríguez, J. Camps, M. Caldarelli, M. Ortaggio, B. Fiol, O. Dias]

Microscopic description of black holes [R. Emparan, O. Dias, A. Maccarrone]

Classification of SUGRA solutions [D. Roest, A. Celi, M. Caldarelli]

Non-relativistic strings [J. Gomis]

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AdS/CFT [AdS/QCD: J.M. Pons; Wilson loops: B. Fiol; etc]

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Microscopic analysis of Black Hole superradiance

Alessandro Maccarrone

3rd RTN Workshop, Valencia 2007

Based on work with R. Emparan & O. Dias

Motivation

String theory provides a microscopic description of some properties of BHs:

- Entropy matching [A. Strominger & C. Vafa (1996),etc]
- Hawking radiation [C.G. Callan & J.M. Maldacena (1996)]

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String theory provides a microscopic description of some properties of BHs:

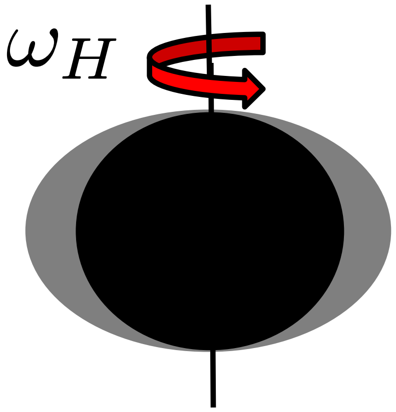
- Entropy matching [A. Strominger & C. Vafa (1996),etc]
- Hawking radiation [C.G. Callan & J.M. Maldacena (1996)]
- Superradiance?

Superradiance

- Classical effect in rotating BHs due to the presence of an Ergoregion, so negative energy states are allowed.
- A wave can be scattered off the BH with a reflection coefficient greater than one (Superradiance)

If $\Psi(x^\mu) \sim f(r,\theta)e^{-i(\epsilon t - m\phi)}$

SR condition: $\epsilon < \omega_H m$



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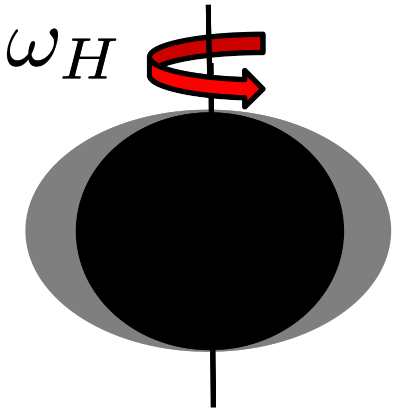


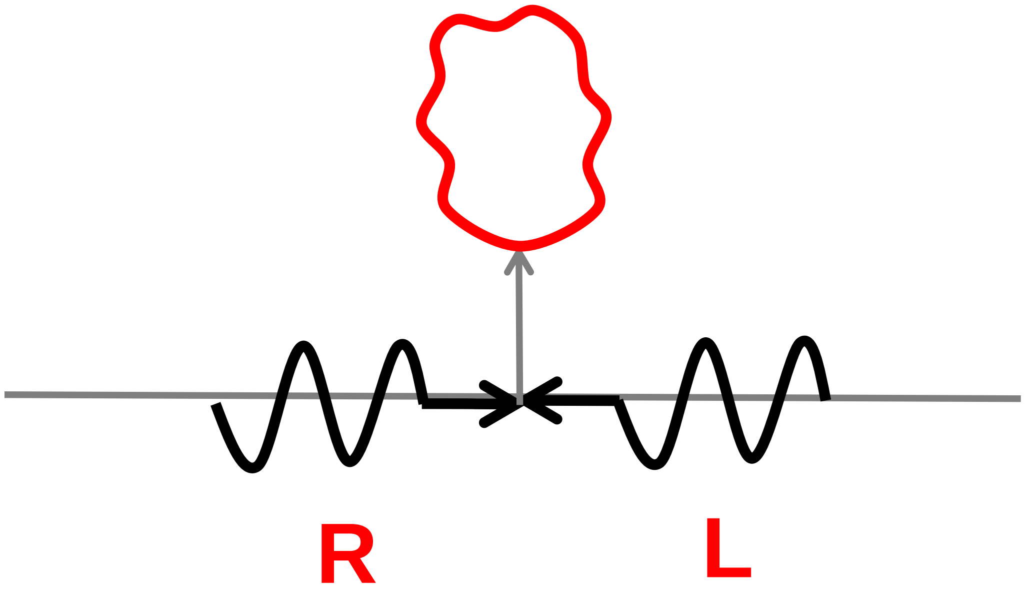
This is the stimulated process, but there is also superradiant spontaneous emission.

D1-D5-P system

- For concreteness let us focus on D1-D5-P rotating BHs.
- The system can be described in terms of the CFT of an effective string carrying momentum excitations in two sectors (Left & Right).
- Bulk angular momentum is provided by coherent polarization of the fermionic excitations on the string.

Microscopic Hawking radiation

- In this picture Hawking Radiation is explained as emission of closed strings due to the collision of a Right and a Left mode.



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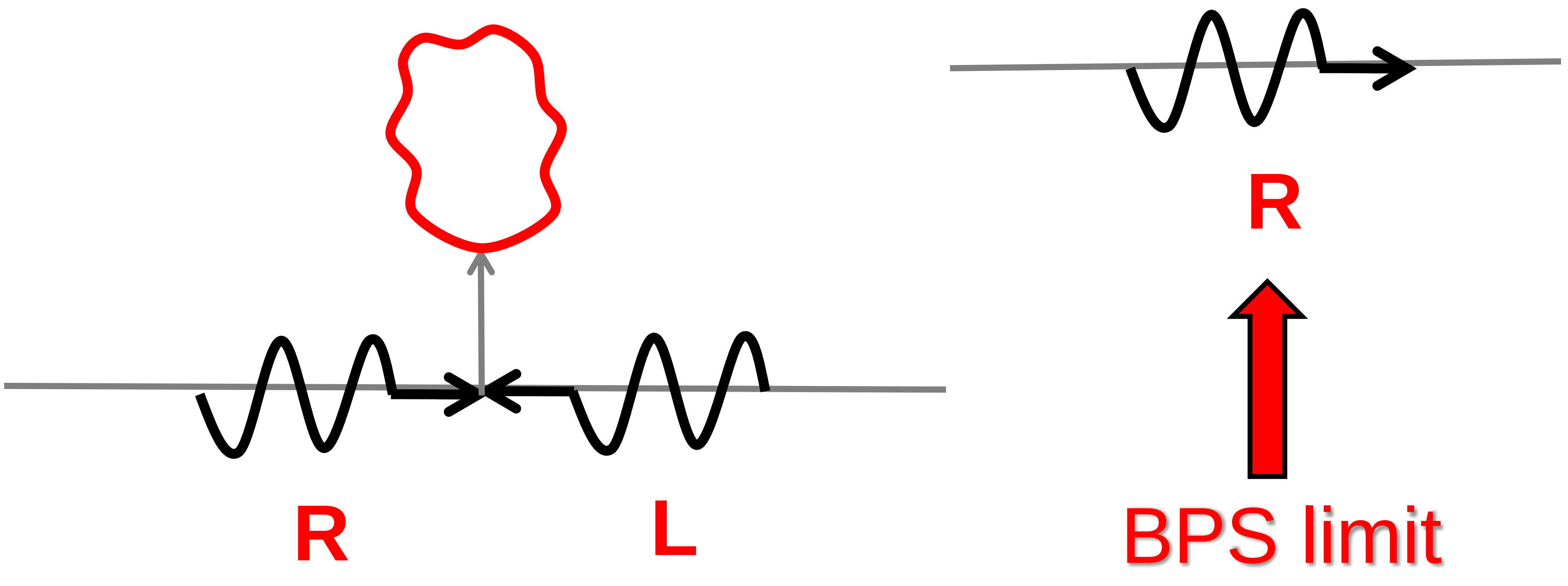

Hawking vs. Superradiant emission

- The same mechanism allows to describe Superradiance.
- In rotating black holes, Hawking and superradiant emission are highly entangled.
- Extremal ($T_H = 0$) solutions are a suitable set-up to focus on superradiance, since Hawking radiation is not present in these backgrounds.

<u>Non-BPS</u> Extremal Black-Hole

Rotating solution $\omega_H \neq 0$

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One sector described by polarized fermionic excitations filling up a Fermi Sea $T_H \to 0$

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Superradiance condition

Fermi Sea is described by a distribution of the form:

$\rho_F(\epsilon, m) \underset{T_H \to 0}{\longrightarrow} \theta(\omega_H m - \epsilon)$ ($\omega_H m$ is the Fermi Energy)

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This is the Superradiance condition.

Thanks for your attention.