Radiazione di Hawking e Backreaction

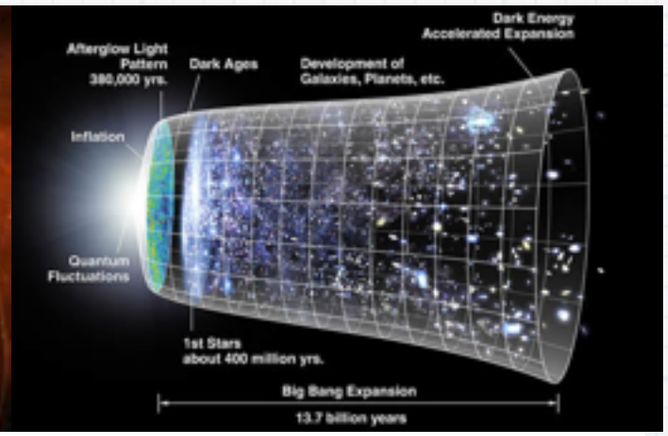
A. Fabbri (Centro Fermi)

Funzioni di correlazione per lo studio della radiazione di Hawking nei condensati di Bose-Einstein (Univ. Bologna / Univ. Paris-Sud)

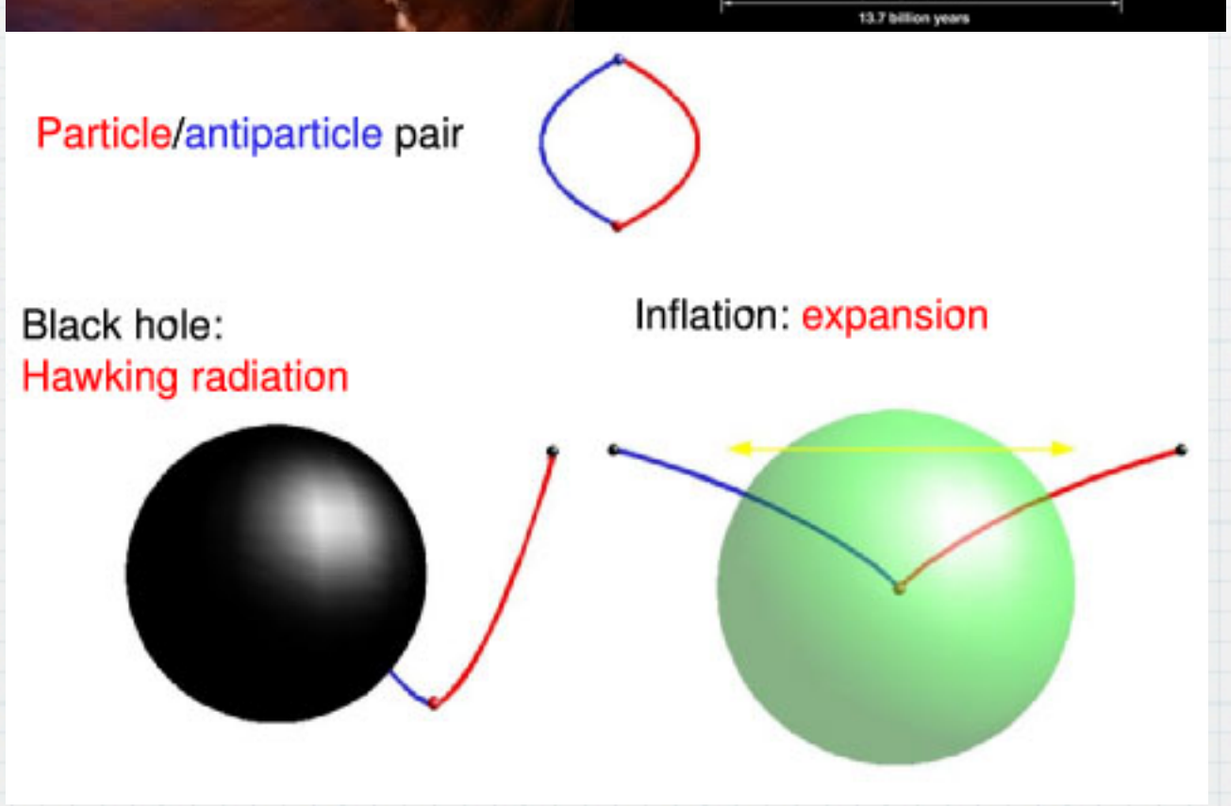
1 Marzo 2017

Quantum effects in gravity

black holes



early universe



Hawking, '74

thermal radiation

$$T_H \sim 10^{-6} \frac{M_{Sun}}{M} \ ^0K$$

$$<< T_{CMB} \sim 3 \ ^0K$$

amplification of the initial quantum fluctuations

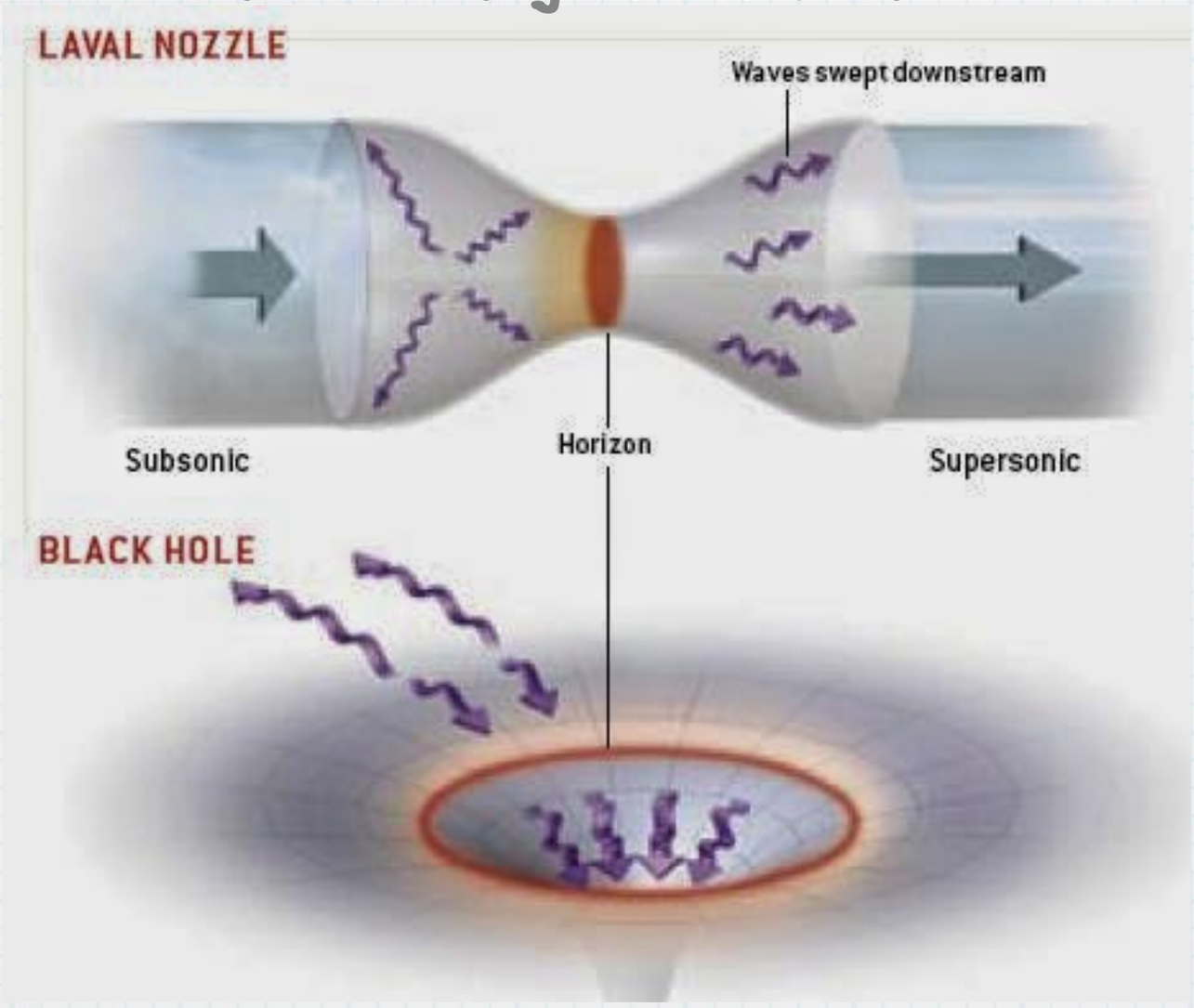
↕

formation of cosmic primordial inhomogeneities

Analog models

Unruh, '81

acoustic black holes emit (analog) Hawking radiation



even in the most favourable system,BECs, $T_C \geq 10 T_H$ and a direct detection of HR is still problematic

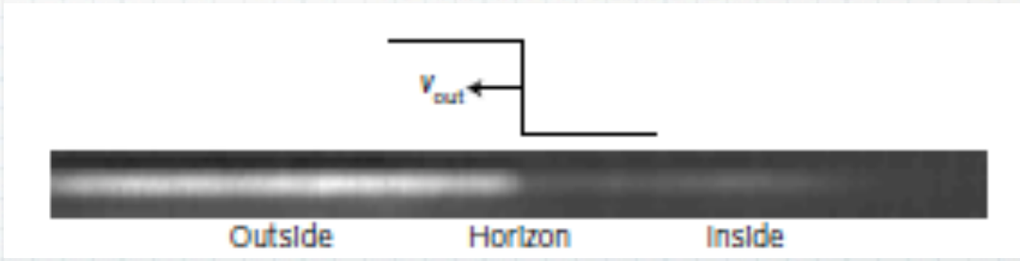
acoustic white holes

circular hydraulic jump

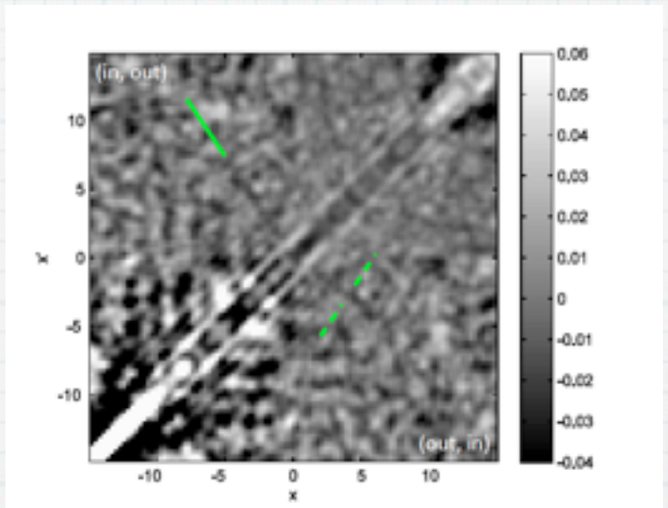
Hawking radiation in Bose-Einstein condensates

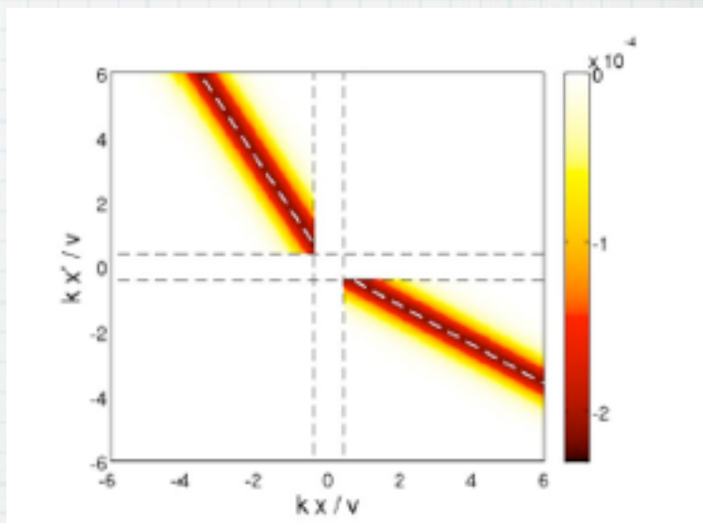
Steinhauer, Nat. Phys. 2016

* An acoustic in a BEC was created with a (moving) step potential



* He measured the Hawking quanta- partner peak in the density correlator





Balbinot, F., Fagnocchi, Recati, Carusotto, PRA 2008

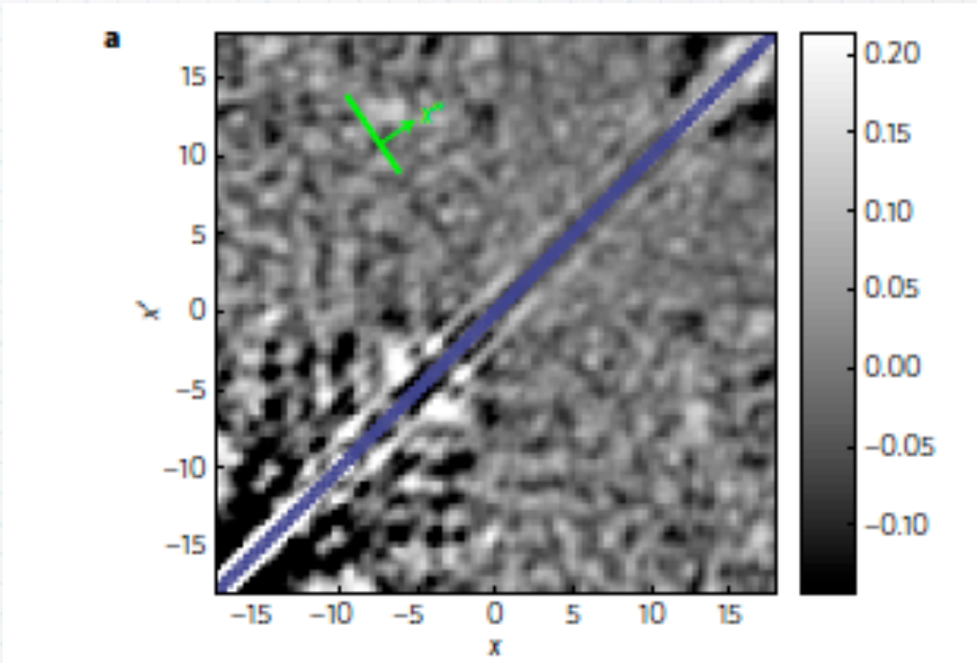
* He provided evidence of the entanglement of the produced pairs

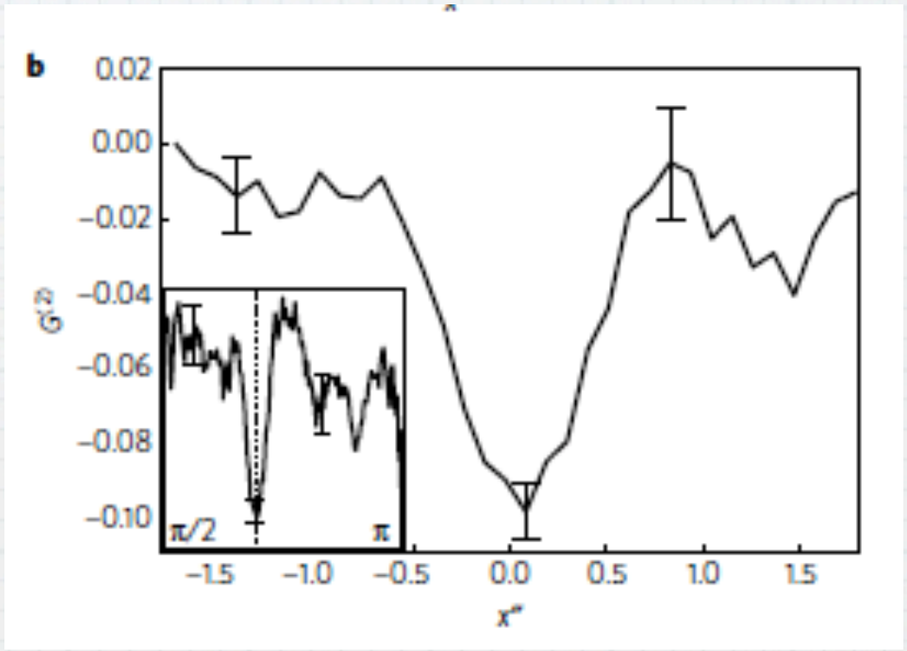
Comparing with Steinhauer's data

* It is necessary to have a meaningful comparison of Steinhauer's data with analytical results

* a nontrivial acoustic bh model has been constructed, which will allow to compute analytically the main peaks in the density correlator

density correlator

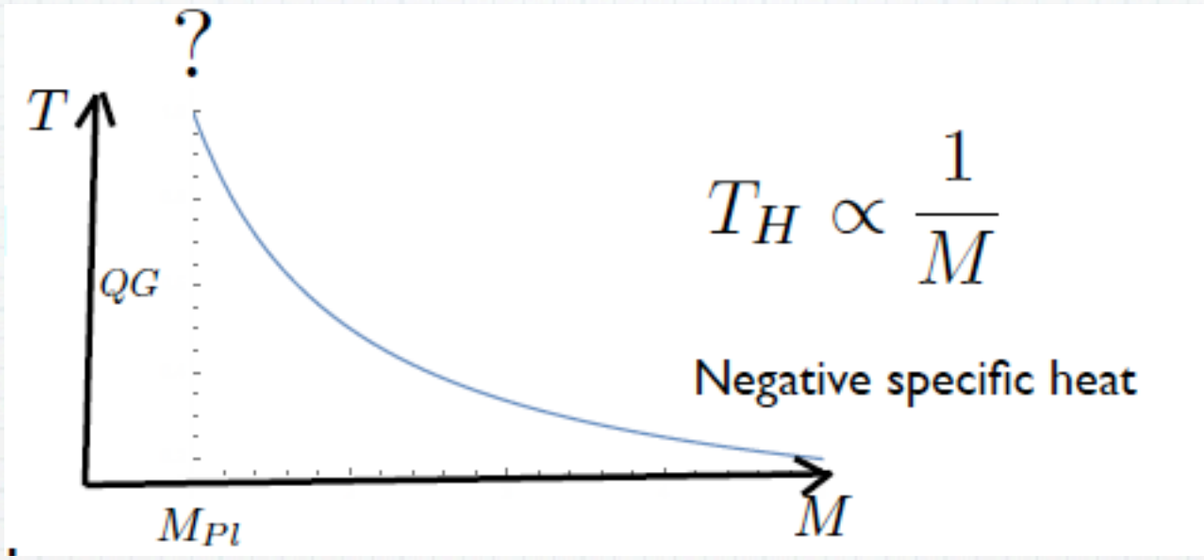




F., Balbinot, Anderson, PRD 2016

How do black holes evaporate?

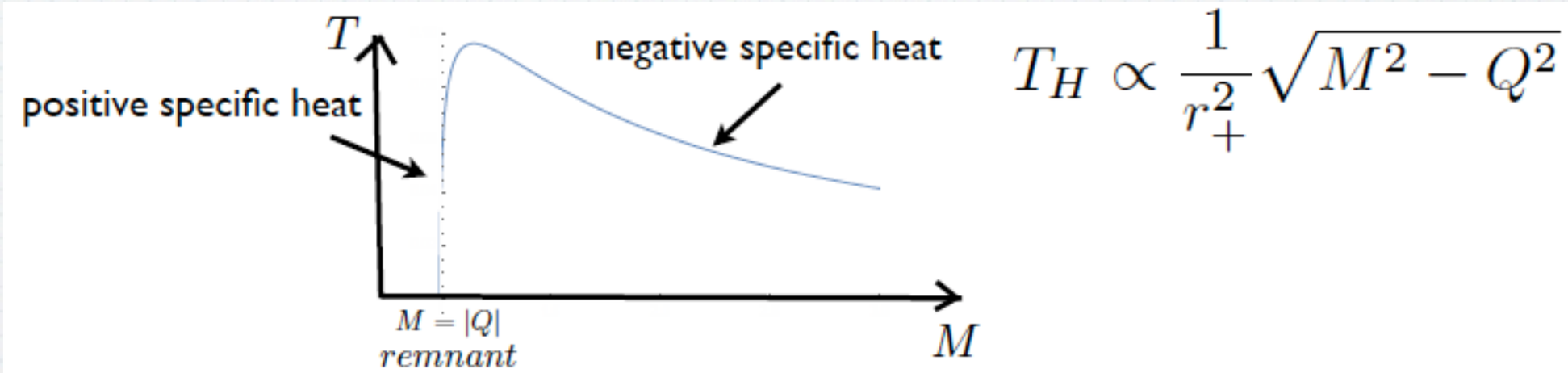
uncharged bhs



information loss paradox

Hawking `76

charged bhs



We need to solve the
semiclassical Einstein (or backreaction) eqs.

$$G_{\mu\nu} = 8\pi \langle T_{\mu\nu} \rangle$$

Backreaction

* In 2+1 dimensions we have solved the bakreaction eqs. **analytically**
* Quantum effects act as **cosmic censor** by creating a (small) horizon around naked singularities Casals, F., Martinez, Zanelli, PLB 2016
* For the 1st time, **quantum corrected rotating black holes** have been obtained: bhs grow and their rotation slows down

Casals, F., Martinez, Zanelli, PRL 2017

Can we attack the same problem for Kerr bhs in 3+1D?

Open problem

$$i\hbar\partial_t\Psi_0 = \left(-\frac{\hbar^2}{2m} + V_{ext} + g|\Psi_0|^2\right)\Psi_0 +$$ quantum corrections

* We are working on writing down the analog of the semiclassical Einstein equations for BECs
* The solutions to these equations will tell us how acoustic black holes evaporate

Recent Publications

M. Casals, A. F., C. Martinez, J. Zanelli, gr-qc/1608.05366, Phys. Rev. Lett. (2017), in press

M. Casals, A. F., C. Martinez, J. Zanelli, Phys. Lett. B760 (2016), 244

A. F., P. Anderson, R. Balbinot, Phys. Rev. D93 (2016) 6, 064046

G. Clement, A. F., Nucl. Part. Phys. Proc. 273-275 (2016), 1499

S. Mauro, R. Balbinot, A. F., I. Shapiro, Eur. Phys. J. Plus 130 (2015), 135

P. Anderson, A. F., R. Balbinot, Phys. Rev. D91 (2015) 6, 064061

D. Boiron, A. F., P. Larre', N. Pavloff, C. Westbrook, P. Zin, Phys. Rev. Lett. 115 (2015) 2, 025301

G. Clement, A.F., Class. Quant. Grav. 32 (2015) 9, 095009

A. F., J. Phys. Conf. Ser. 600 (2015) 1, 012008