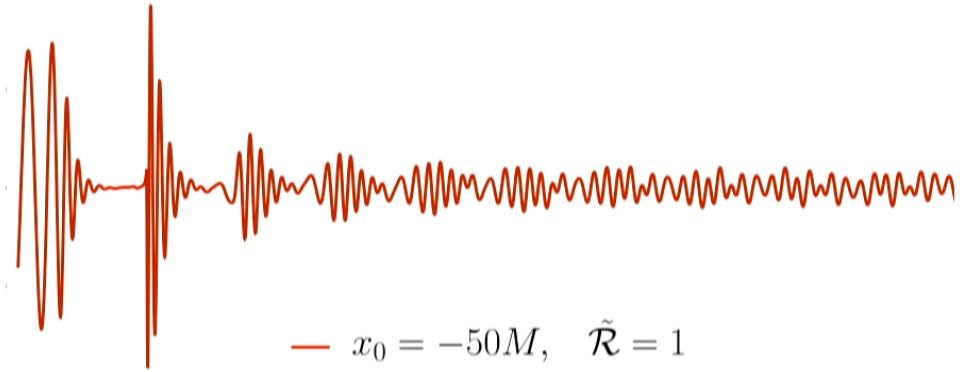
Title: A Recipe for Echoes

Date: Nov 08, 2017 02:20 PM

URL: http://pirsa.org/17110076

Abstract:

A recipe for echoes

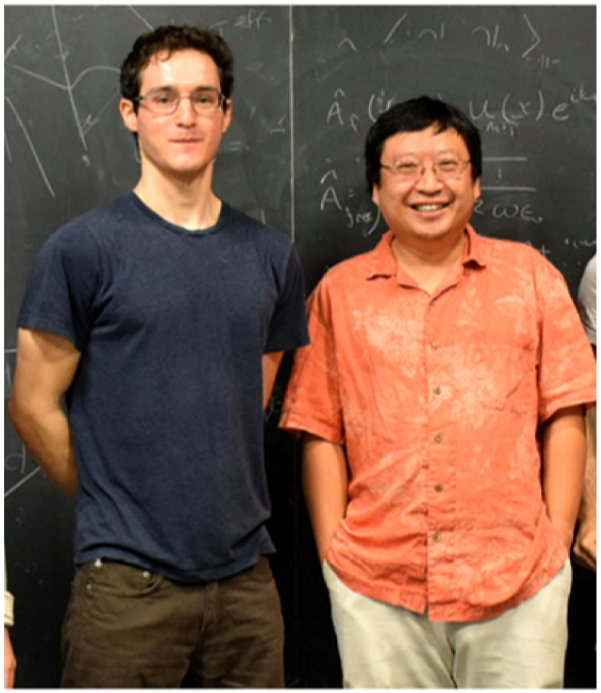


Aaron Zimmerman
Zachary Mark, Song Ming Du, Yanbei Chen

Quantum BHs in the Sky?
November 8, 2017


Chen
1
CAUTION

Collaborators

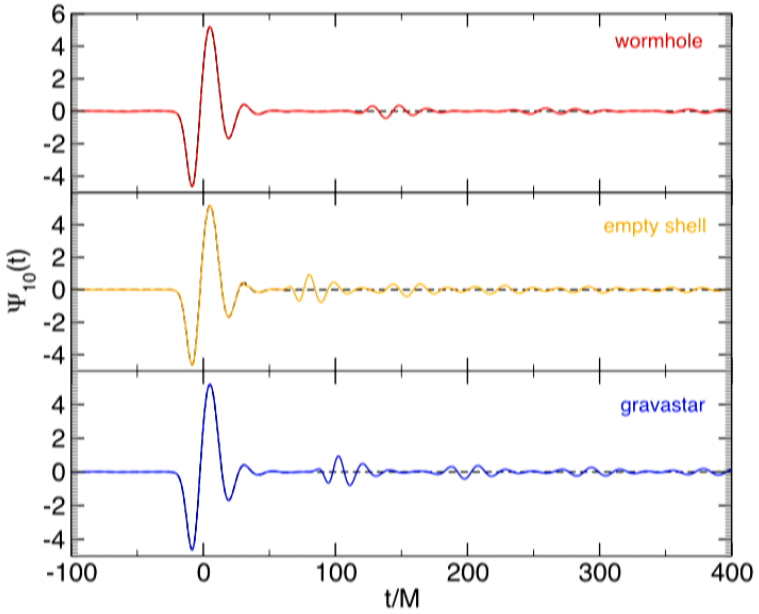


Zachary Mark Yanbei Chen

Song Ming Du

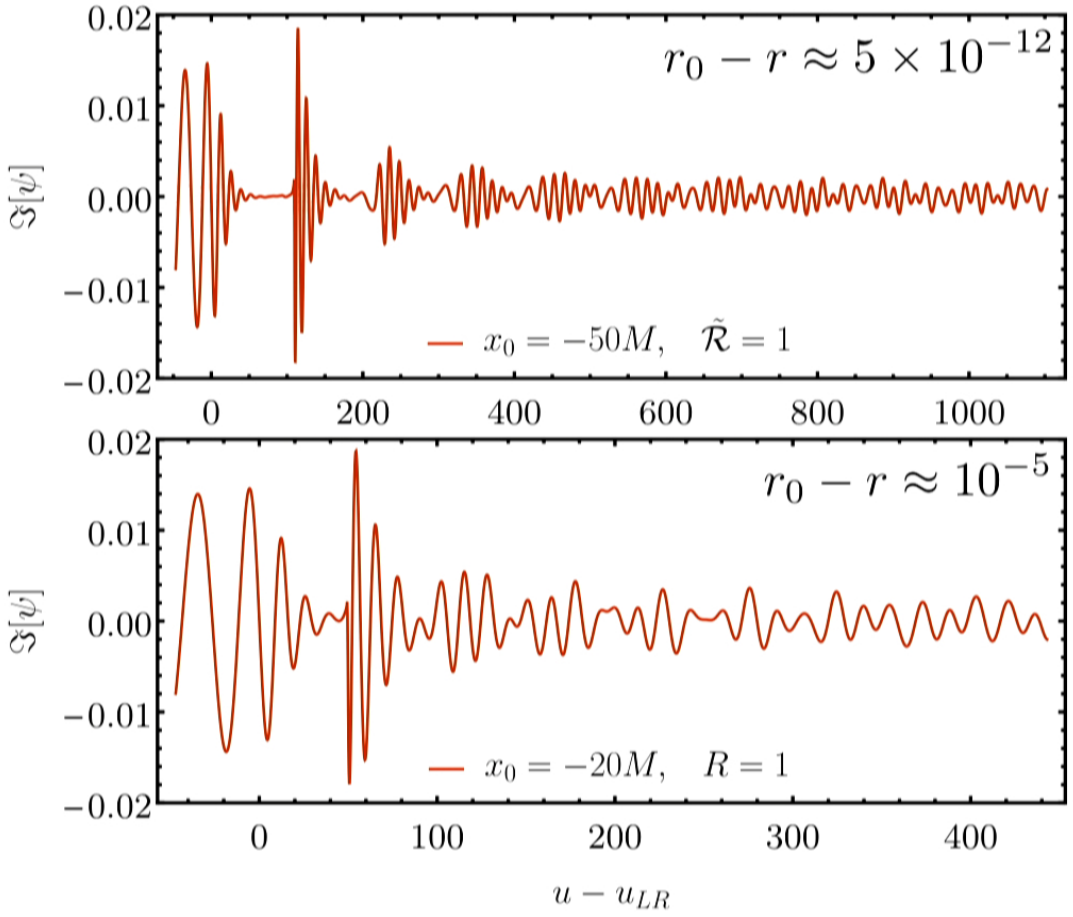
Echoes from compact objects

- Cardoso, Franzin, Pani, arXiv:1602.07309
- Ringdown doesn't guarantee BH
- But these spacetimes produce "echoes"
- Holds across many example cases



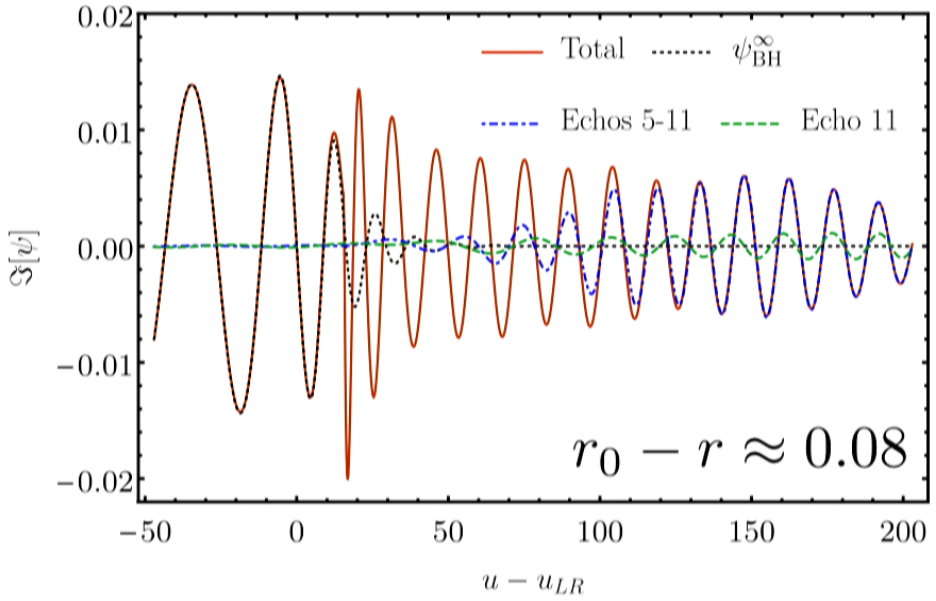
Cardoso et al. 1608.08637

Echo sum: constant R



QNMs of ECO?

- Scattering potential indicates we should have slowly decaying QNMs. BH QNMs not poles!
- For bdry farther from horizon, excite ECO mode:

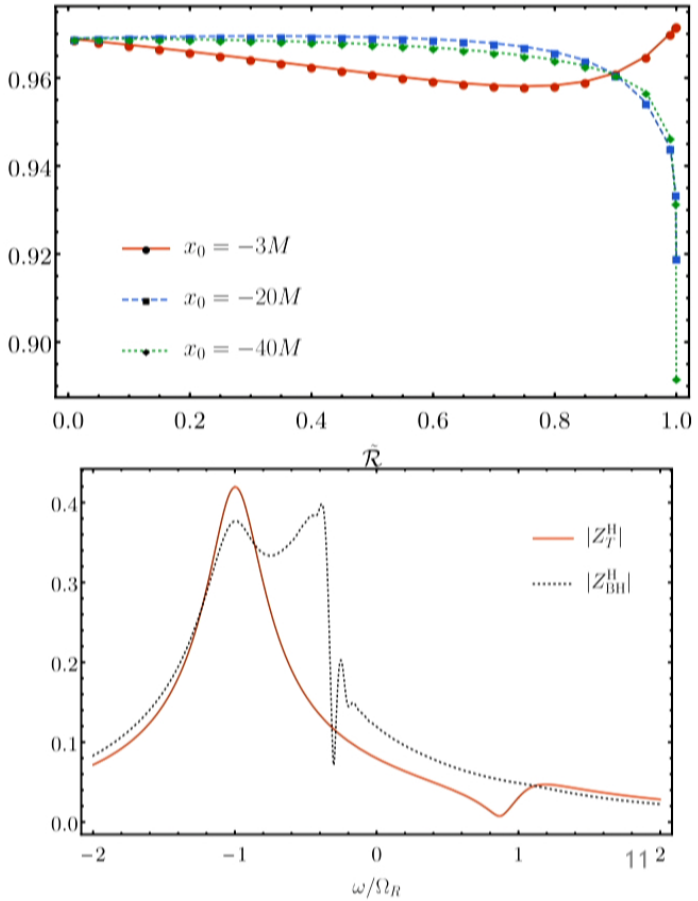


QNM echo template

- Frequency domain:

$$Z_{\rm T}^{\rm H} = e^{i\omega t_s} e^{-\omega^2/(2\beta^2)} \left(\frac{\alpha_+}{\omega - \Omega_+} + \frac{\alpha_-}{\omega - \Omega_-} \right) \rho$$

- Maximize overlap by varying template params at fixed $\tilde{\mathcal{R}}$, x_0
- Simple template recovers full waveform well
- Difficulties at large $\tilde{\mathcal{R}}$



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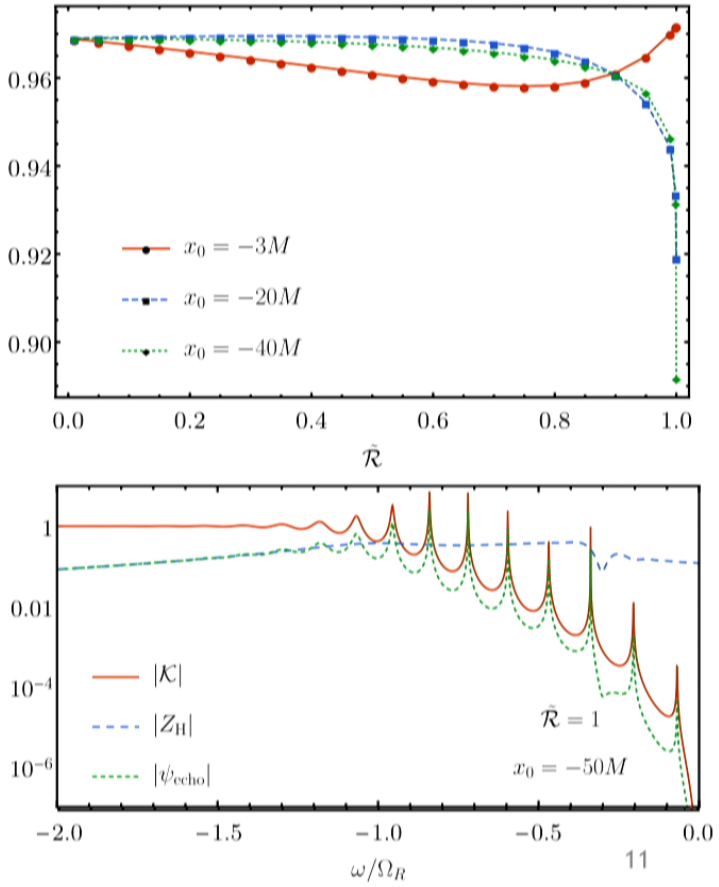
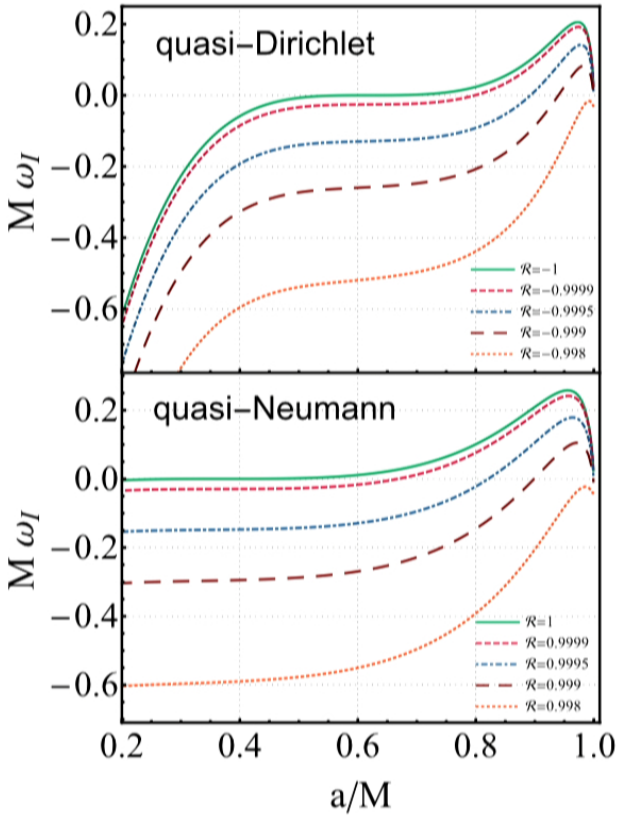


What's next: Kerr

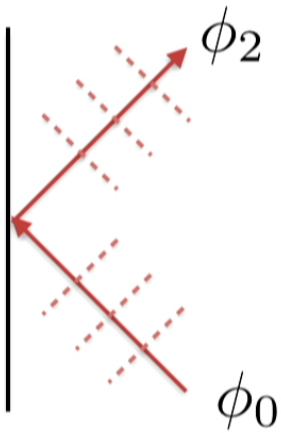
- For scalar fields, extension is straightforward
- New features: superradiant instability of modes
- Spins down hole until instability shuts off
- Easily quenched by some decay of echoes



Maggio et al. 1703.03696

What's next: GWs

- Extension to gravitational perts not trivial (Price & Khanna 1702.04833)
- Need BCs on multiple scalar fields
- Or convert to complicated BCs
- Simplification should be possible

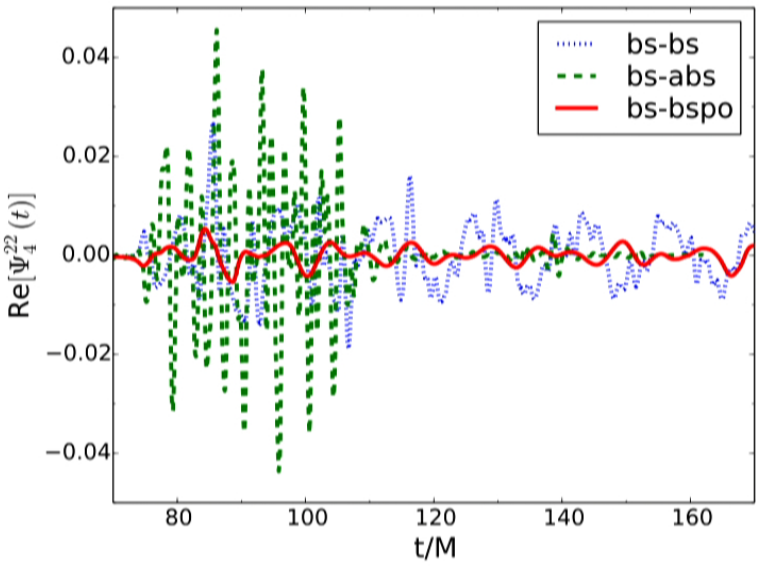


$$E^{\hat{\theta}} = 0$$

$$E^{\hat{\theta}} = \frac{\sqrt{1-2M/r}}{\sqrt{2}}\mathrm{Re}[\phi_0] - \frac{\sqrt{2}}{\sqrt{1-2M/r}}\mathrm{Re}[\phi_2]$$

What's next: beyond test field

- To date: all results for test fields in fixed backgrounds
- Exception: boson star collisions
- Extension to comparable mass mergers?
- Full numerical simulations of ECOs?



Cardoso et al. 1608.08637