Probing the strong gravity regime

with GW observations

Some basic points

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1602.03622, 1605.05341

Yunes, Yagi, Pretorius

In order to have consistent quantum evolution of BHs, many have now concluded:

modifications to the semiclassical description are required, *at scales* $\sim R_h$ *or larger.*

Examples:

“Massive (star-like) remnants”: (c.f. hep-th/9203059)

gravastar (Mazur, Mottola)

fuzzball (Mathur, Warner, …)

firewall (Almheiri, Marolf, Polchinski, Sully)

More subtle modifications (e.g. “softer”)

soft graviton condensate (Dvali, Gomez…)

soft quantum structure/couplings (SBG)

+longer distance…

2016/7: New era of observational sensitivity to this regime

Event Horizon Telescope

LIGO/Virgo etc.

Challenge: don't yet have detailed *dynamical* models

(EHT easier…)

Strategies:

1) Discovery: look for departures from GR

carefully analyze residuals

2) Bounds: improve candidate models for departures

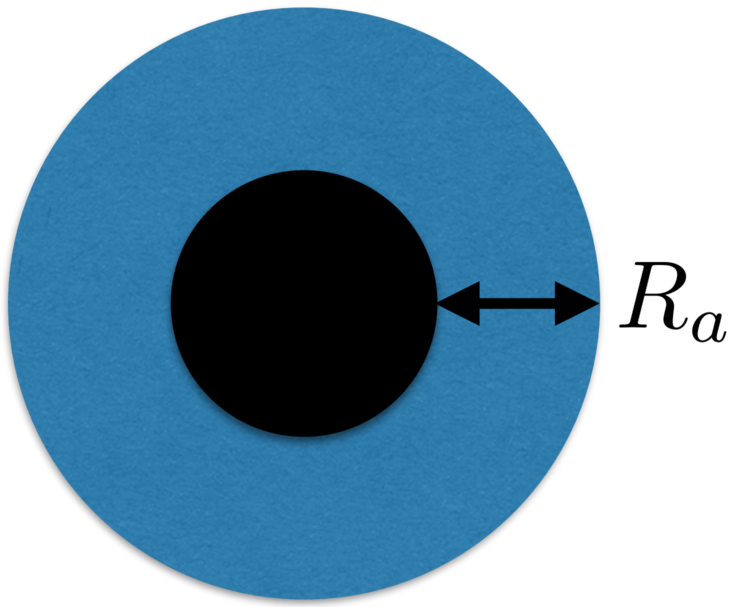
e.g. some fuzzball models probably ruled out, w/ certain parameters

First steps (though really want evolution):

Parameterize ignorance, e.g.

R_a Range of departures from GR

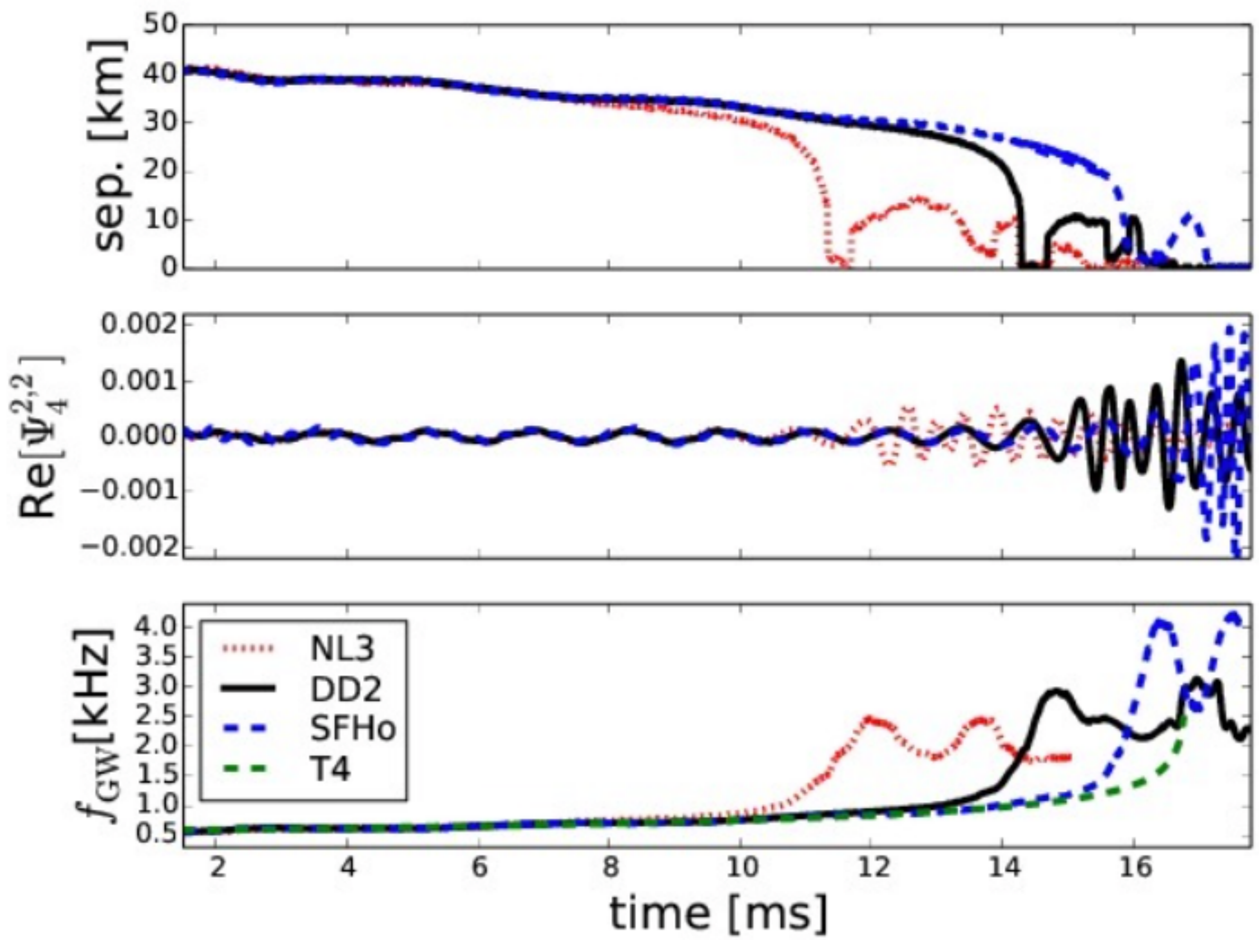
L "Hardness" scale of departures



Effective approach: Model equation of state?

Example of sensitivity:

Suppose GW150914 was coalescence of exotic star-like remnants, e.g. ~scaled up neutron stars



1505.01607, Palenzeula et al

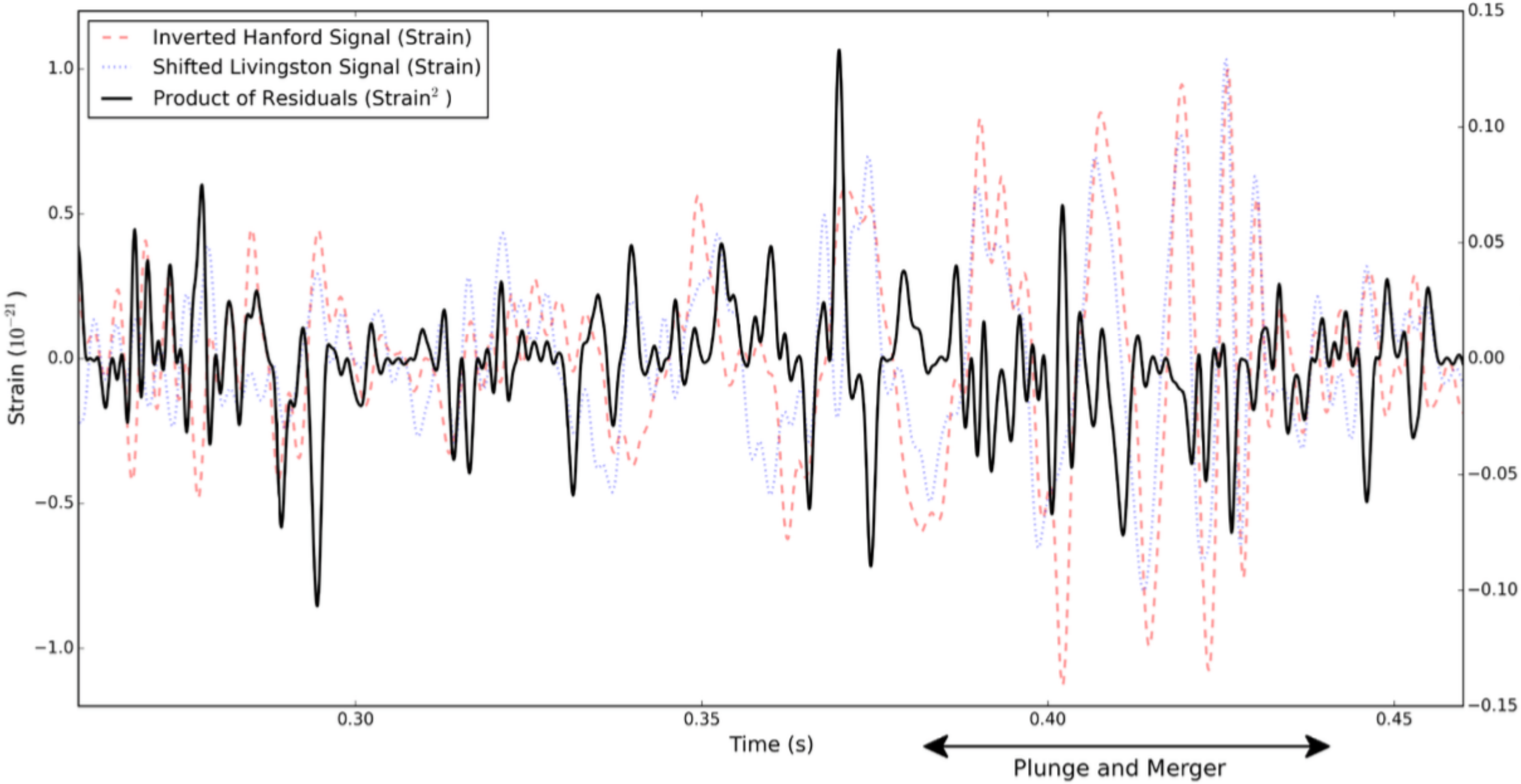
e.g. $R_a \sim$ few R_h

$L \sim$ microscopic

Basic message:

Look closely at GW signal (or other) from plunge, merger

not just from inspiral, ringdown



Inverted Hanford Signal (Strain)
Shifted Livingston Signal (Strain)
Product of Residuals (Strain^2)
Strain (10^{-21})
Strain^2 (10^{-42})
1.0
0.5
0.0
−0.5
−1.0
0.15
0.10
0.05
0.00
−0.05
−0.10
−0.15
0.30
0.35
0.40
0.45
Time (s)
Plunge and Merger