

Title: Observing supernova neutrinos to late times

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URL: <http://pirsa.org/17070022>

Abstract:



THE OHIO STATE  
UNIVERSITY

# Observing Supernova Neutrinos to Late Times

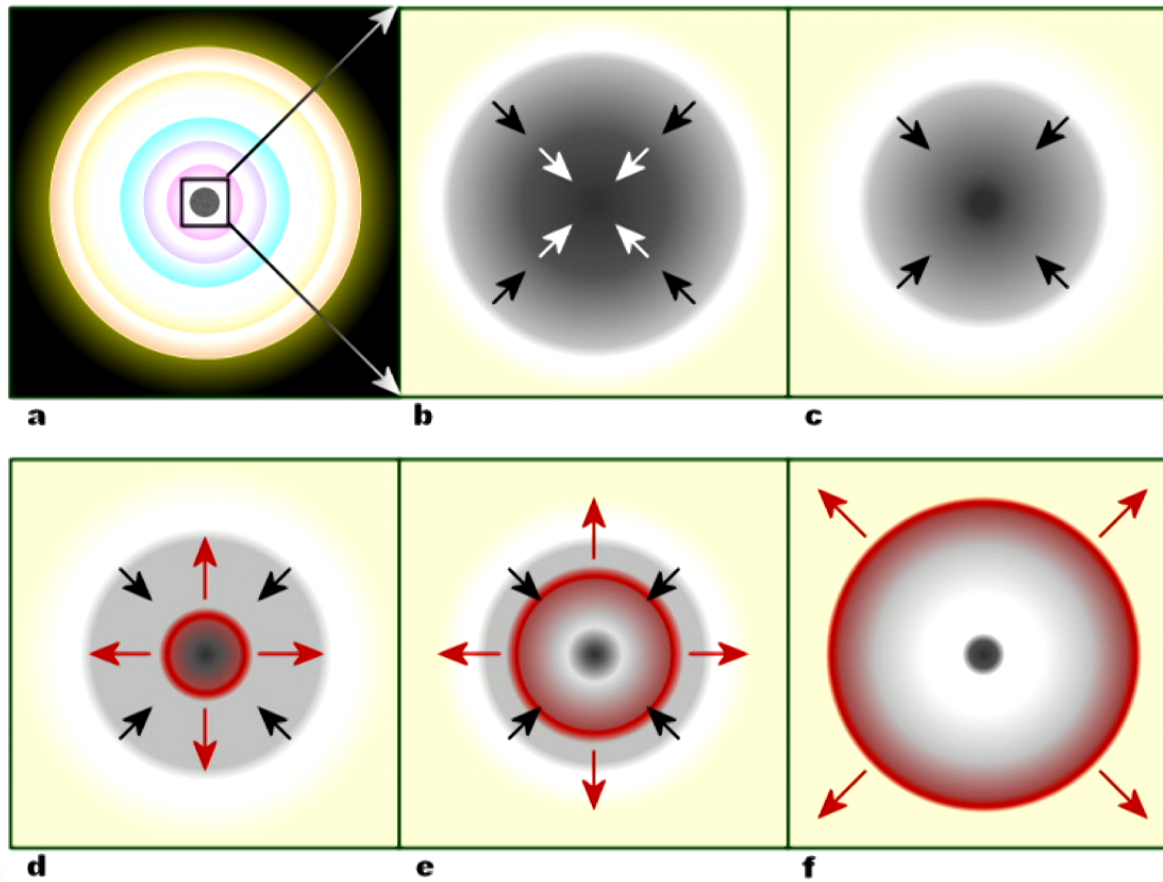
Shirley Li

The Ohio State University

Collaborators: Luke Roberts, John Beacom

Perimeter Institute, July 2017

# Timescale of a SN

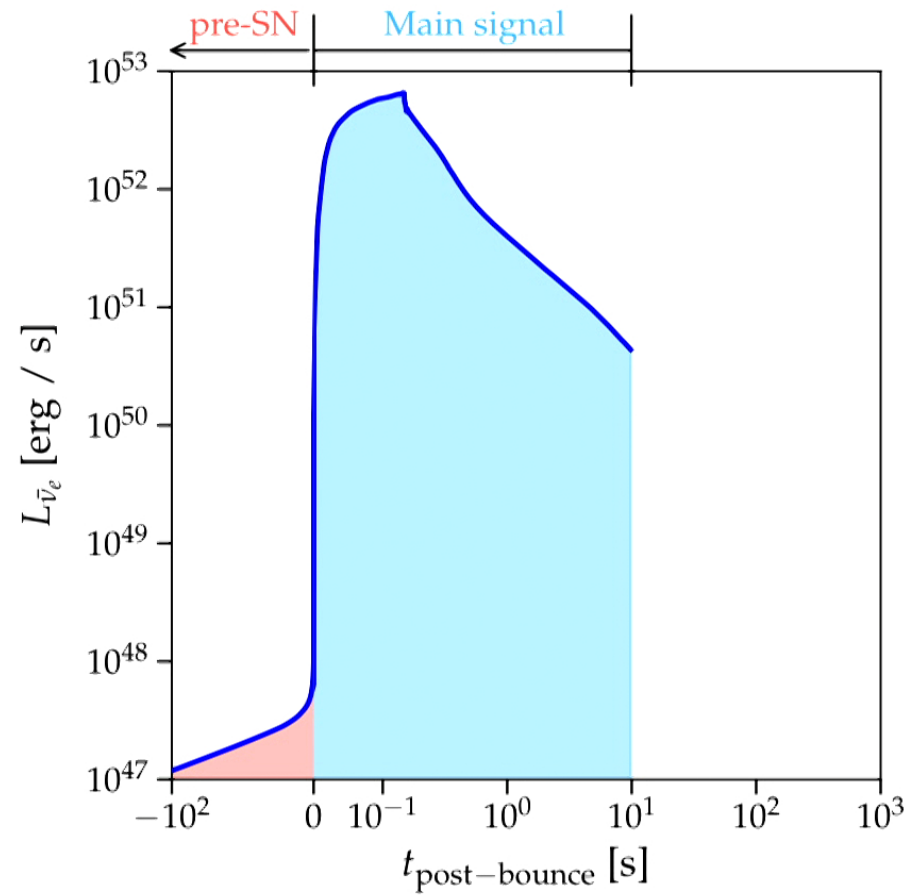


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Figure credit: R.J. Hall

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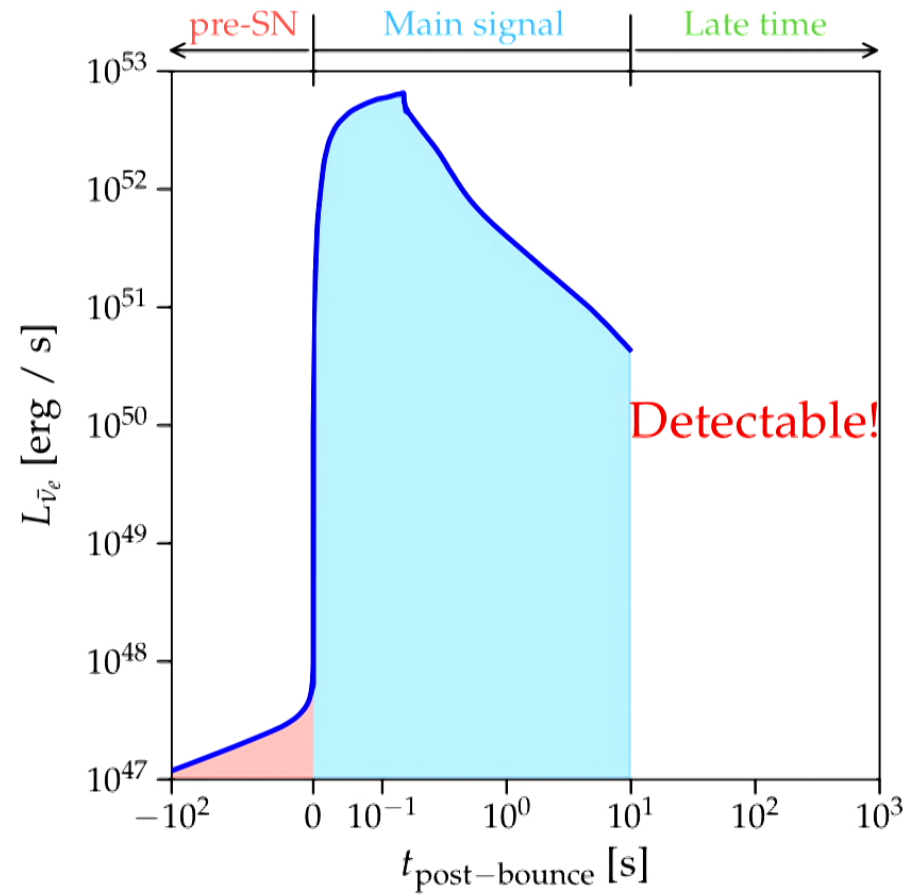
# Timescale of a SN



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# Timescale of a SN



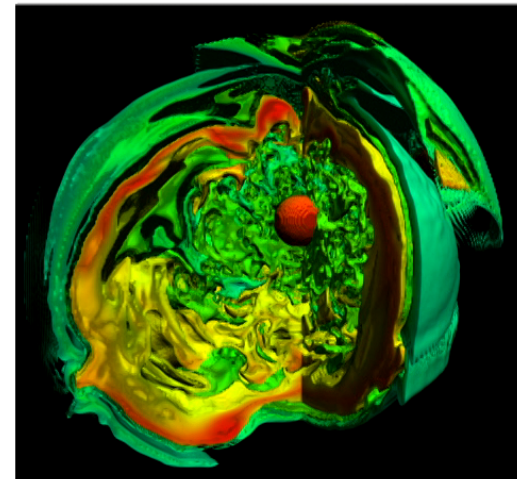
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# First input -- simulation



Luke Roberts



Blondin et al., 2003

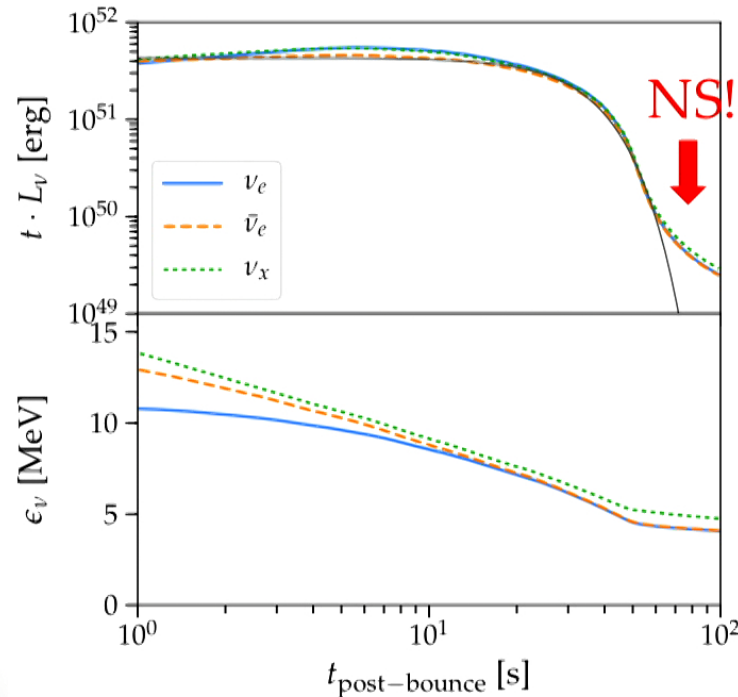
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# Late-time neutrinos

## Neutrino luminosity and energy



- $1/t$  behavior surprising
- Connects SN and NS
- Moderate mixing effect

Preliminary

Late-time neutrinos are interesting & robust!

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# Supernova neutrino detection

Large cross sections

Multi-10 kton



Super-K

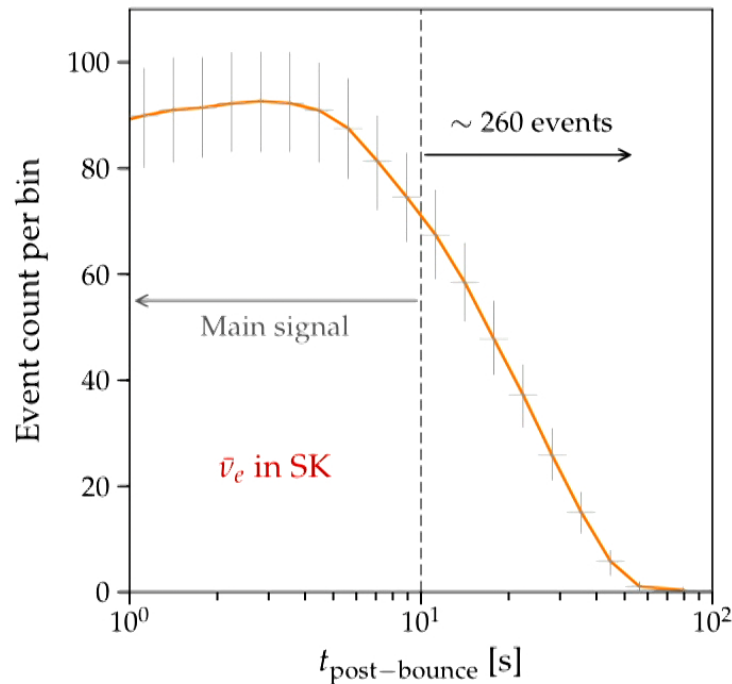
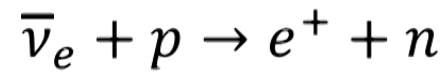


DUNE



JUNO

# $\bar{\nu}_e$ signal rate



## ➤ Inputs:

- 10 kpc SN
- 22.5 kton
- 3.5 MeV threshold

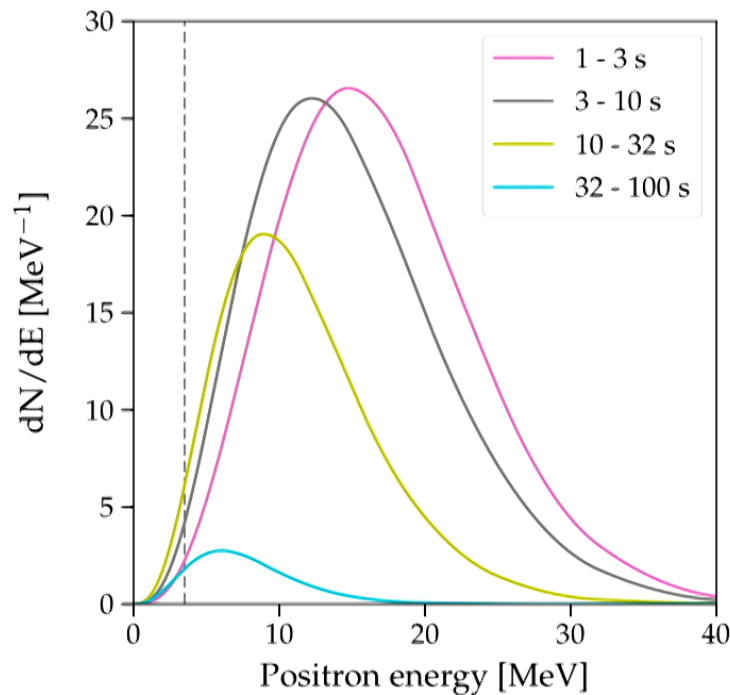
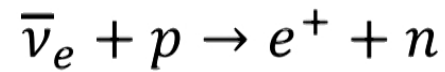
Preliminary

Plenty of events in Super-K!

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# $\bar{\nu}_e$ energy spectrum



➤  $E_{e^+} = E_{\bar{\nu}_e} - 1.3 \text{ MeV}$

➤ --- known detection threshold

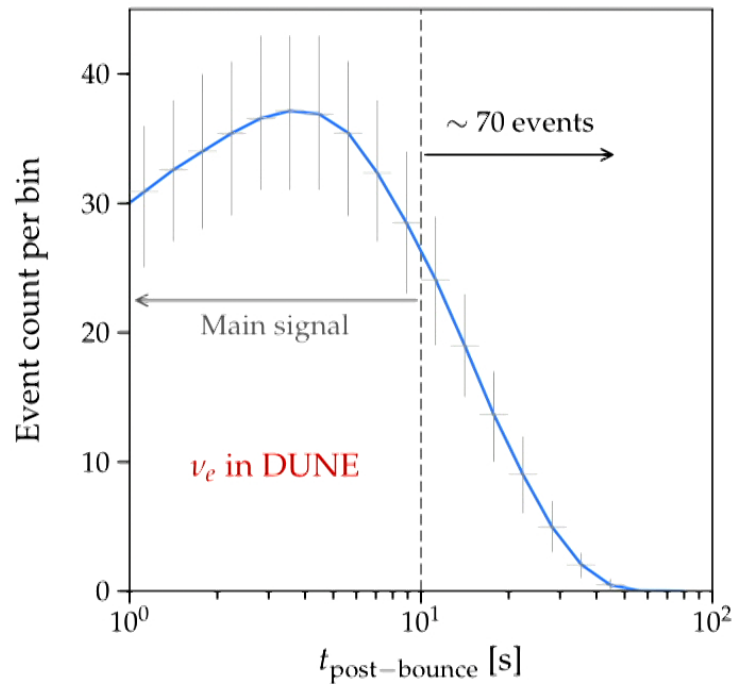
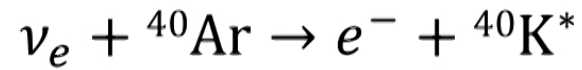
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Easily reconstruct neutrino spectrum

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# $\nu_e$ signal rate



## ➤ Inputs:

- 10 kpc SN
- 40 kton
- 5 MeV threshold

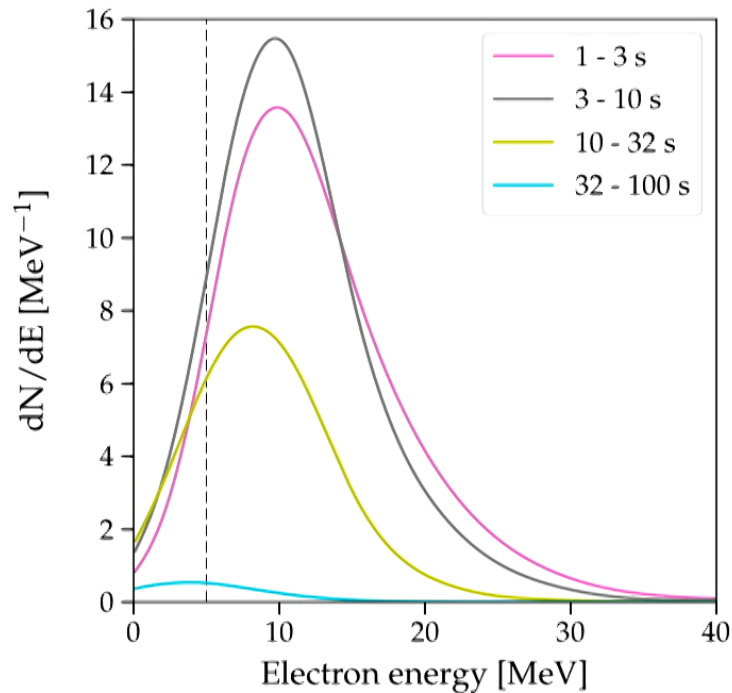
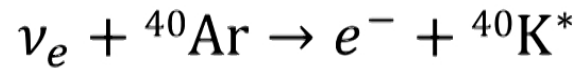
Preliminary

Plenty of events to late time in DUNE!

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# $\nu_e$ energy spectrum



➤  $E_e = E_{\nu_e} - 5.8 \text{ MeV}$

➤ --- unknown  
detection threshold

Preliminary

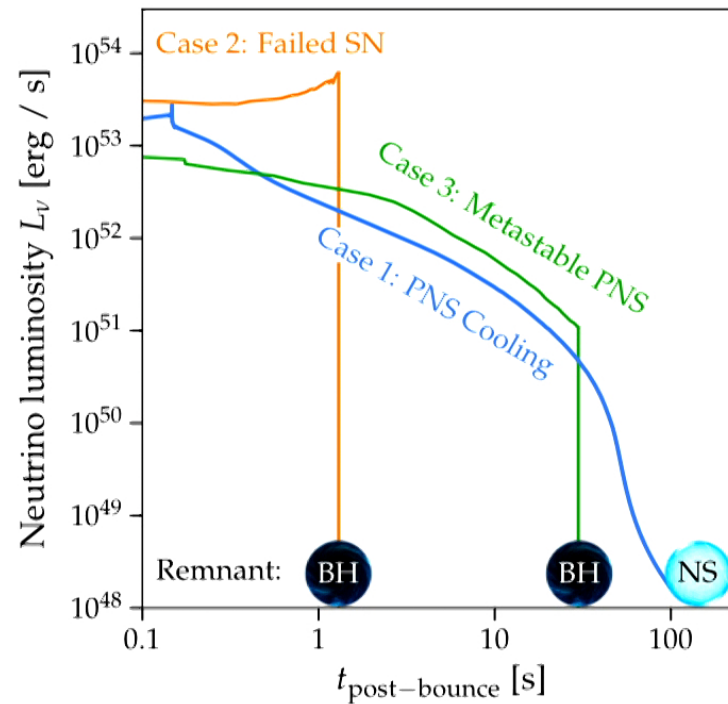
Detection threshold needs to reach  $\sim 5 \text{ MeV}$

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# Alternative outcome -- BH

Different mechanisms for BH formation



Preliminary

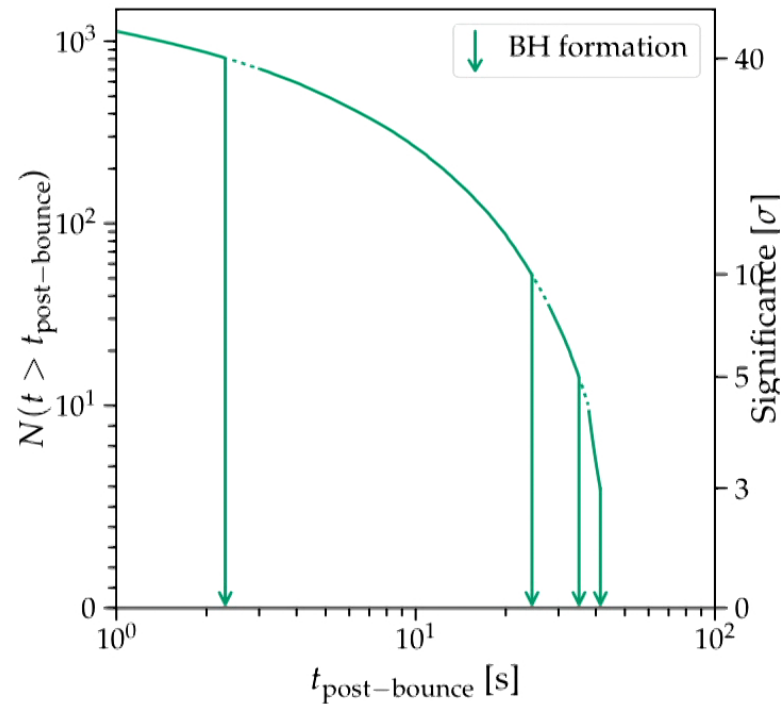
BH may form at late times

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# Detecting BH formation

## Detection significance of BH formation



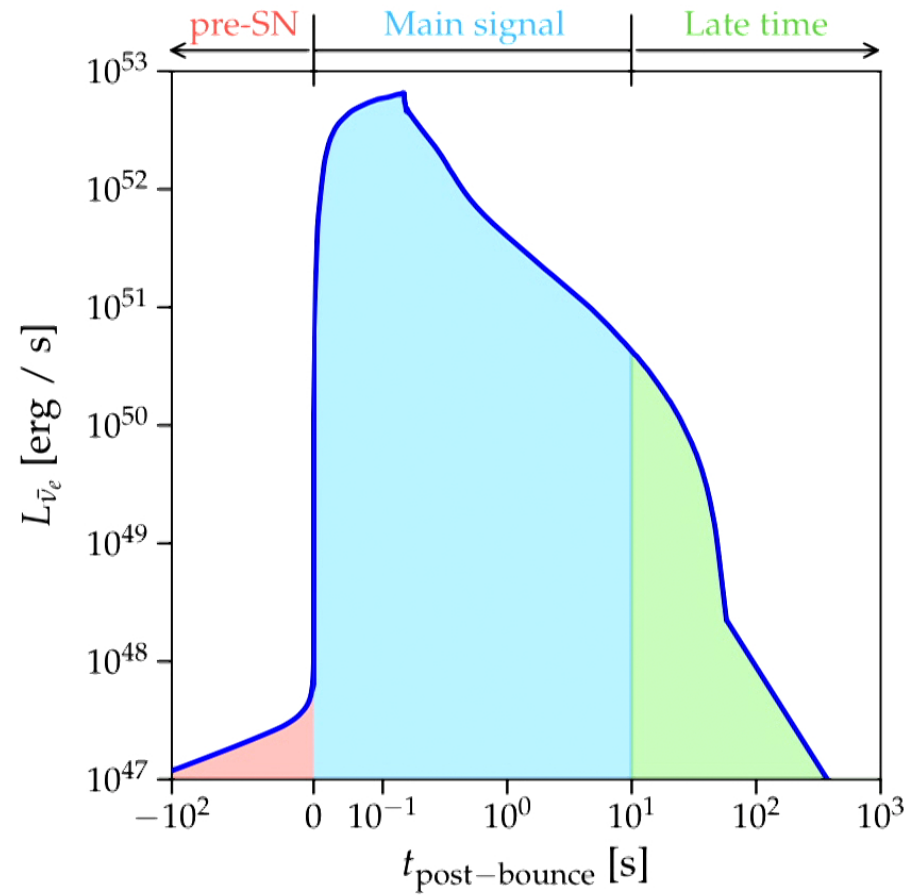
Preliminary

We can detect BH formation at late times

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# Conclusions



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