Time-Frequency Searches and Supernovae

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Unmodeled Bursts

Pragmatic, data-analysis definition:

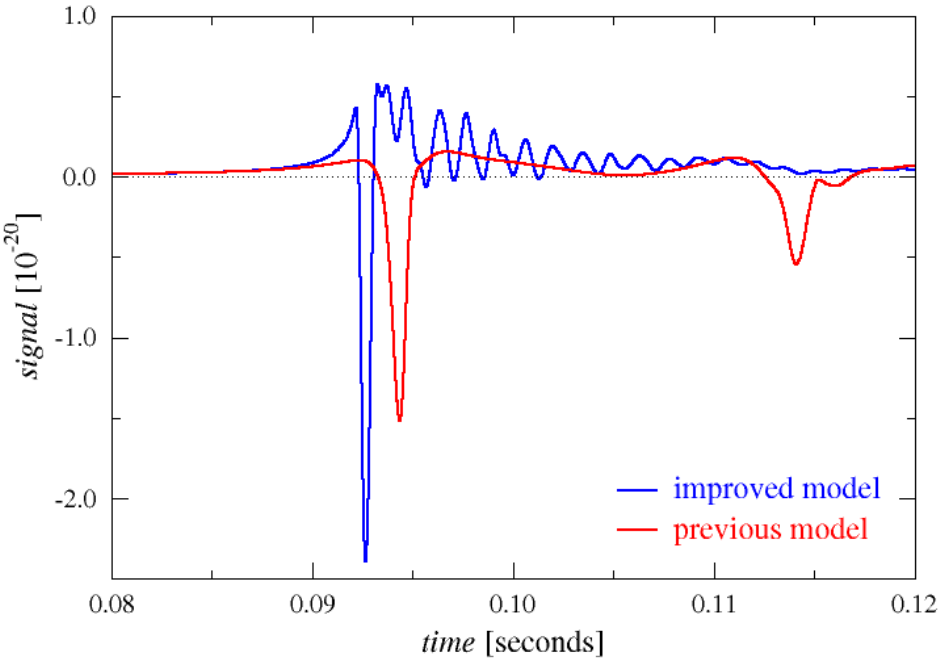
Unmodeled - space of waveforms too large for template bank to be practical:

- uncertainty in waveforms
- huge physical parameter space
- limited computing resources

Bursts - defined by instrumental/algorithmic considerations:

- sufficient energy at frequencies to which detector is sensitive.
- duration greater than a few data samples (LIGO $\rightarrow\sim$ ms).
- duration less than one “analysis segment” (LDAS $\rightarrow\sim$ 100 s)

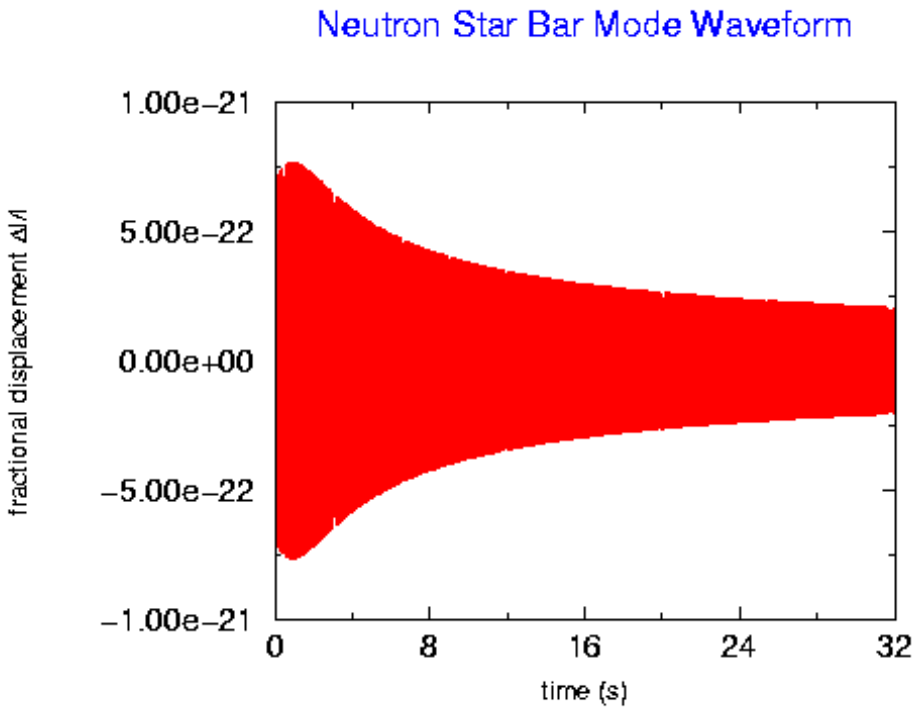
Supernovae Signals - Core Collapse



MPA-Garching Group

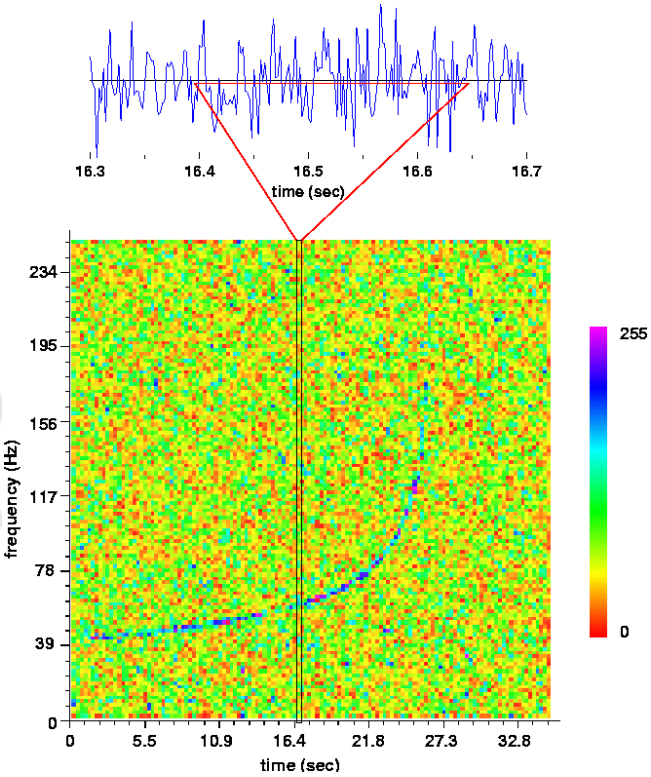
(http://www.mpa-garching.mpg.de/HIGHLIGHT/2001/highlight0111_e.html)

Supernovae Signals - Unstable Modes



1.4 $M_{\odot}$, 1 MPc, Lai gr-qc/9902068

Time-Frequency Representation



TF representations:

- spectrogram
- wavelets
- bilinear transforms

Finding Bursts

Interferometer noise is (ideally):

- broad band (many decades of frequencies).
- quasi-stationary (changes over long time scales).

Supernova signals (and other signals?) are:

- short in duration (core collapse)
- narrow band (instabilities)

Time-Frequency Detection

Several methods have been implemented to find unmodeled bursts:

Curve-Tracking - look for curvilinear features in TF representation (R. Balasubramanian, E. Chassande-Mottin, WGA).

TF-clusters - look for clusters of bright pixels in TF representation (J. Sylvestre).

Stationarity-Monitoring - look for non-stationarity in TF representation (S. Mohanty).

Power-Monitoring - look for rectangular regions in TF plane that have excess energy (P. Brady, J. Creighton, E. Flanagan, A. Vicere, WGA).

Source-Modelling $\longrightarrow$ Data Analysis

- energy $E(f,t)$ would be optimal (for TF).
- the more we know, the better we can do.
- estimated information is better than no information.
- robust features (to modeling errors, to astrophysical parameters) of waveforms are useful.
- a few examples of useful robust information
  - monotonic frequency evolution
  - duration
  - frequency band
  - number of cycles
  - amplitude evolution ($A(t)$)
  - frequency evolution ($f(t)$)
  - ...