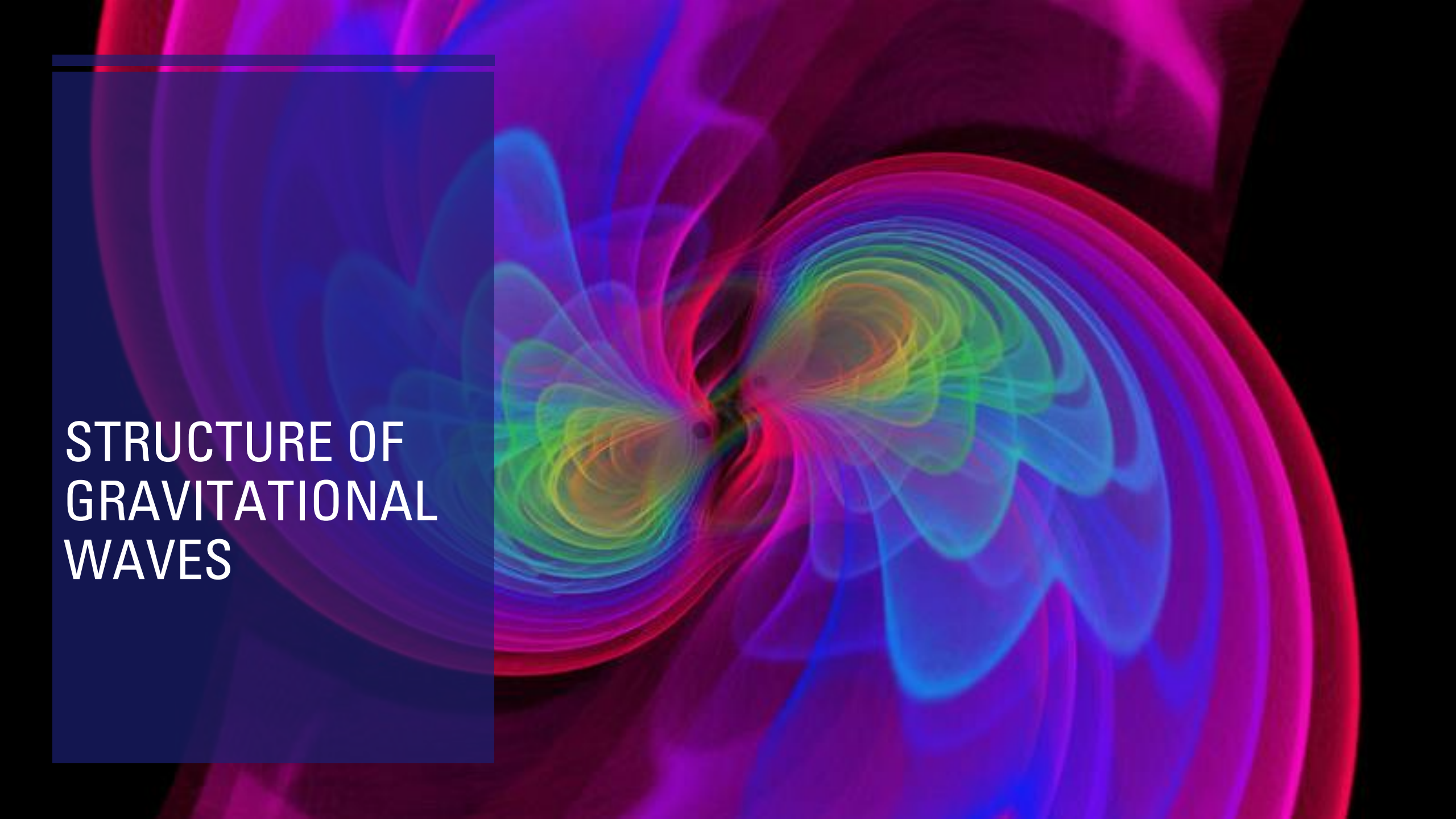
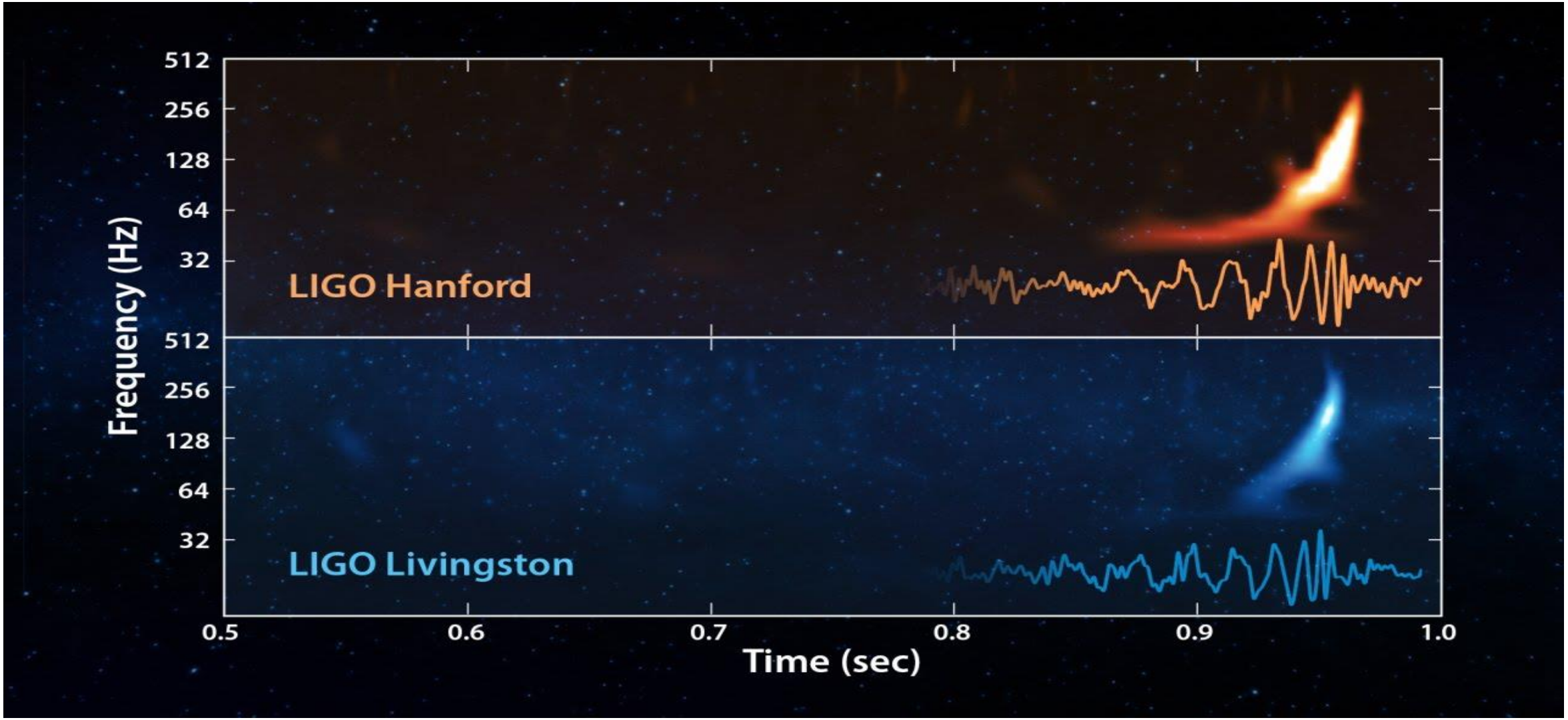
IMPLICATIONS OF GRAVITATIONAL WAVES

YUVRAJ M

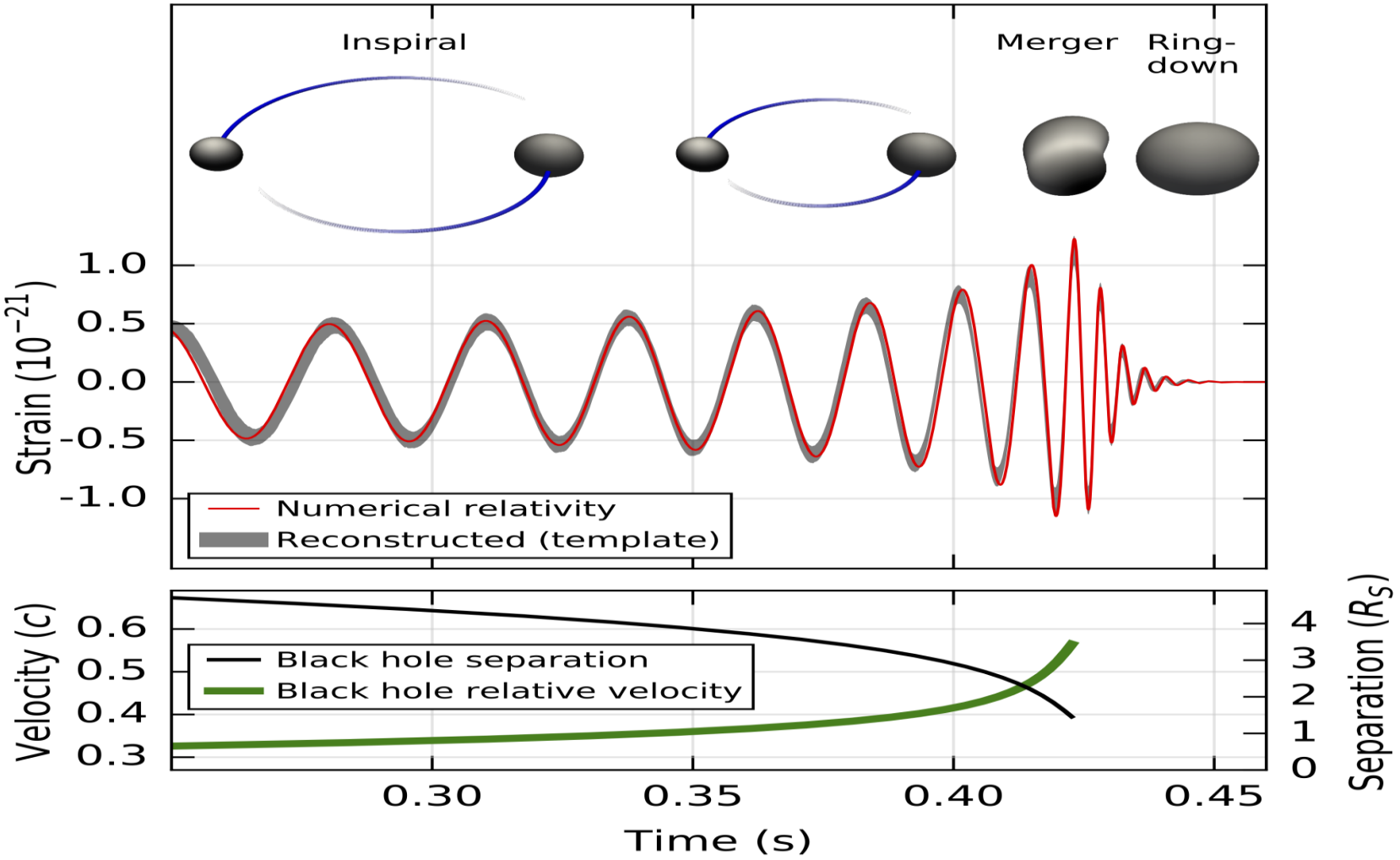
STRUCTURE OF GRAVITATIONAL WAVES

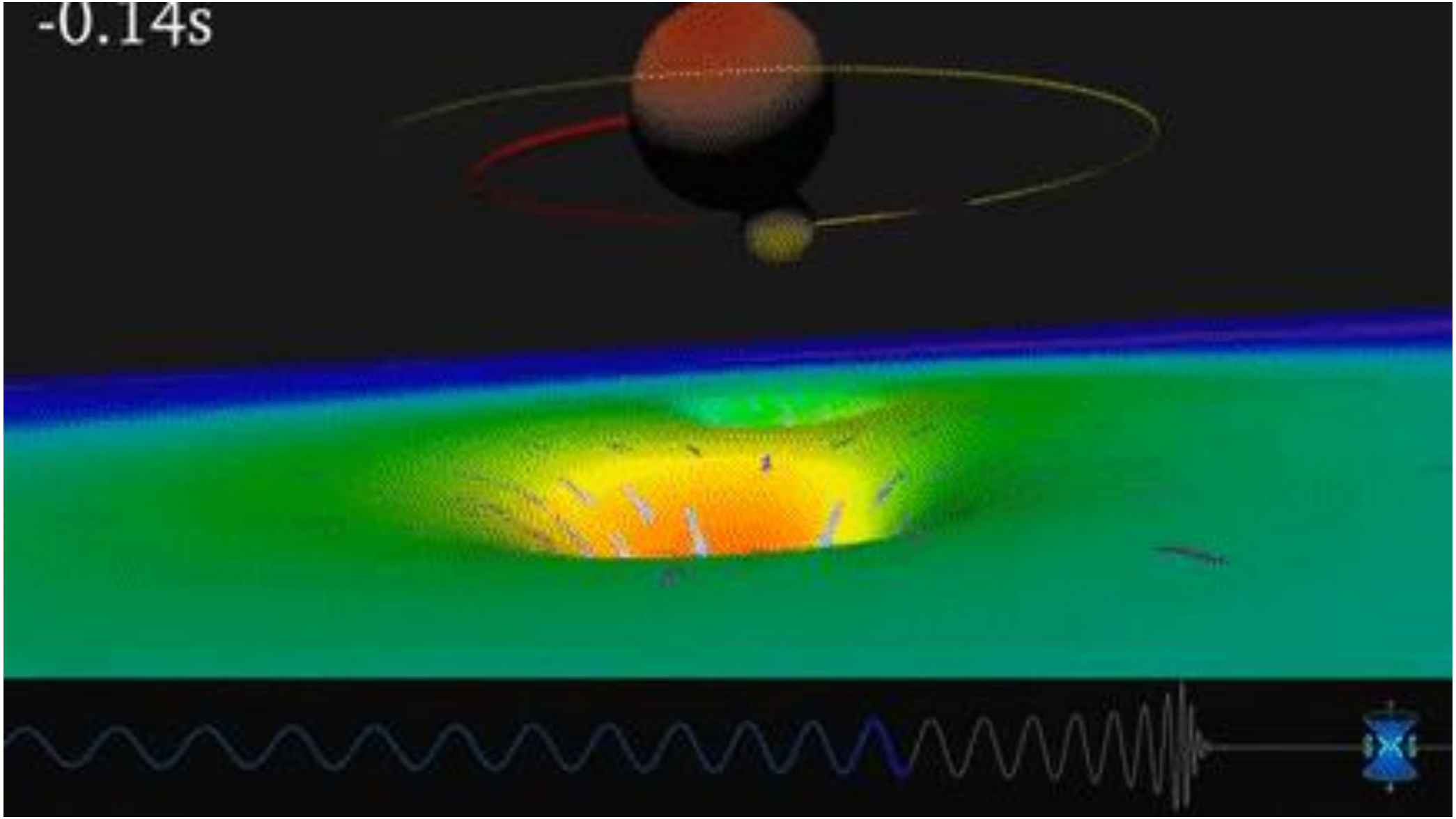


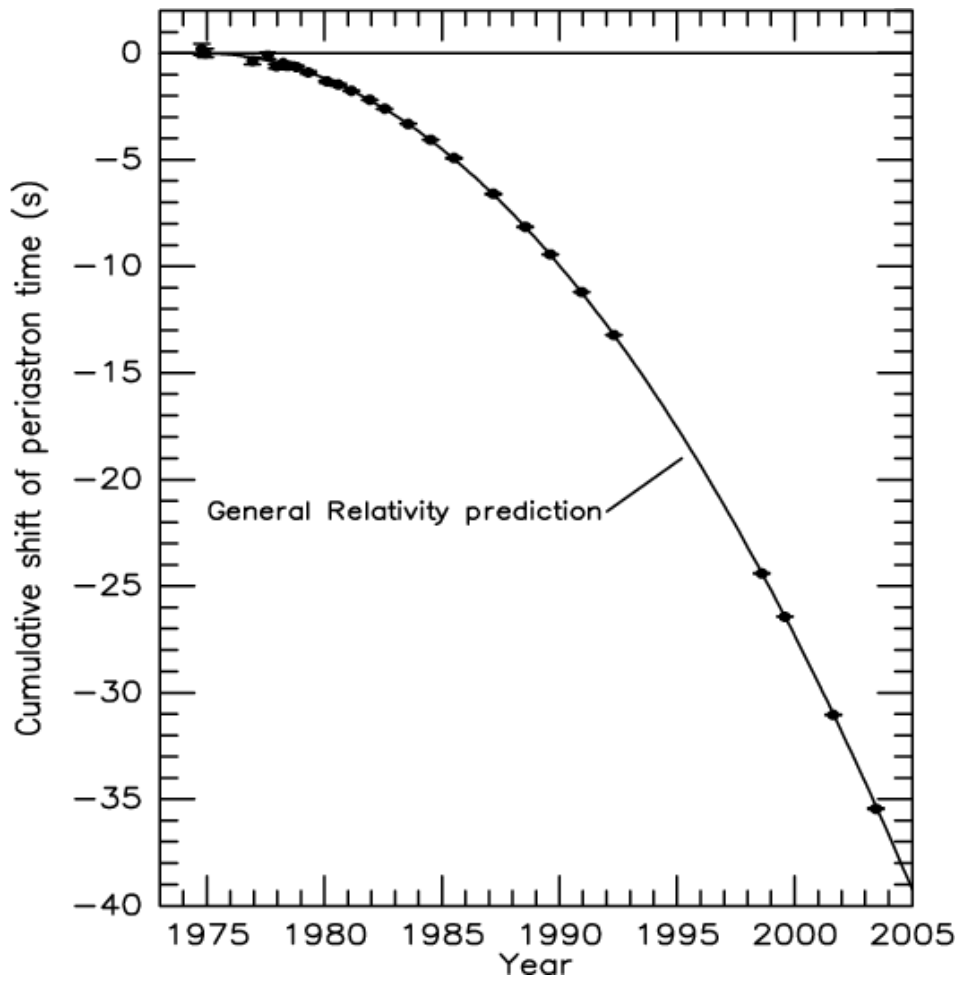
THE "CHIRP" FORM OF GRAVITATIONAL WAVES:

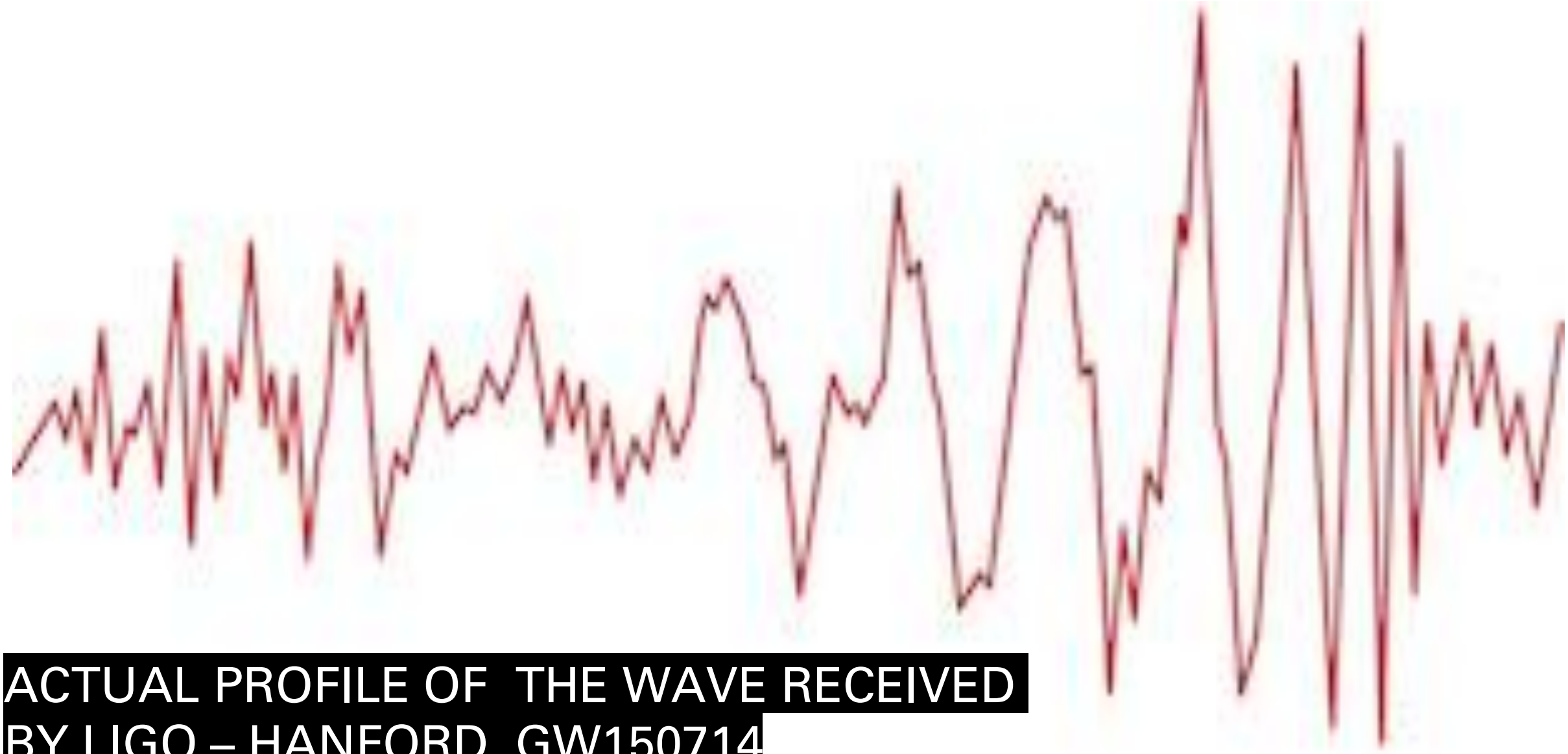


STUFFS TO INFER

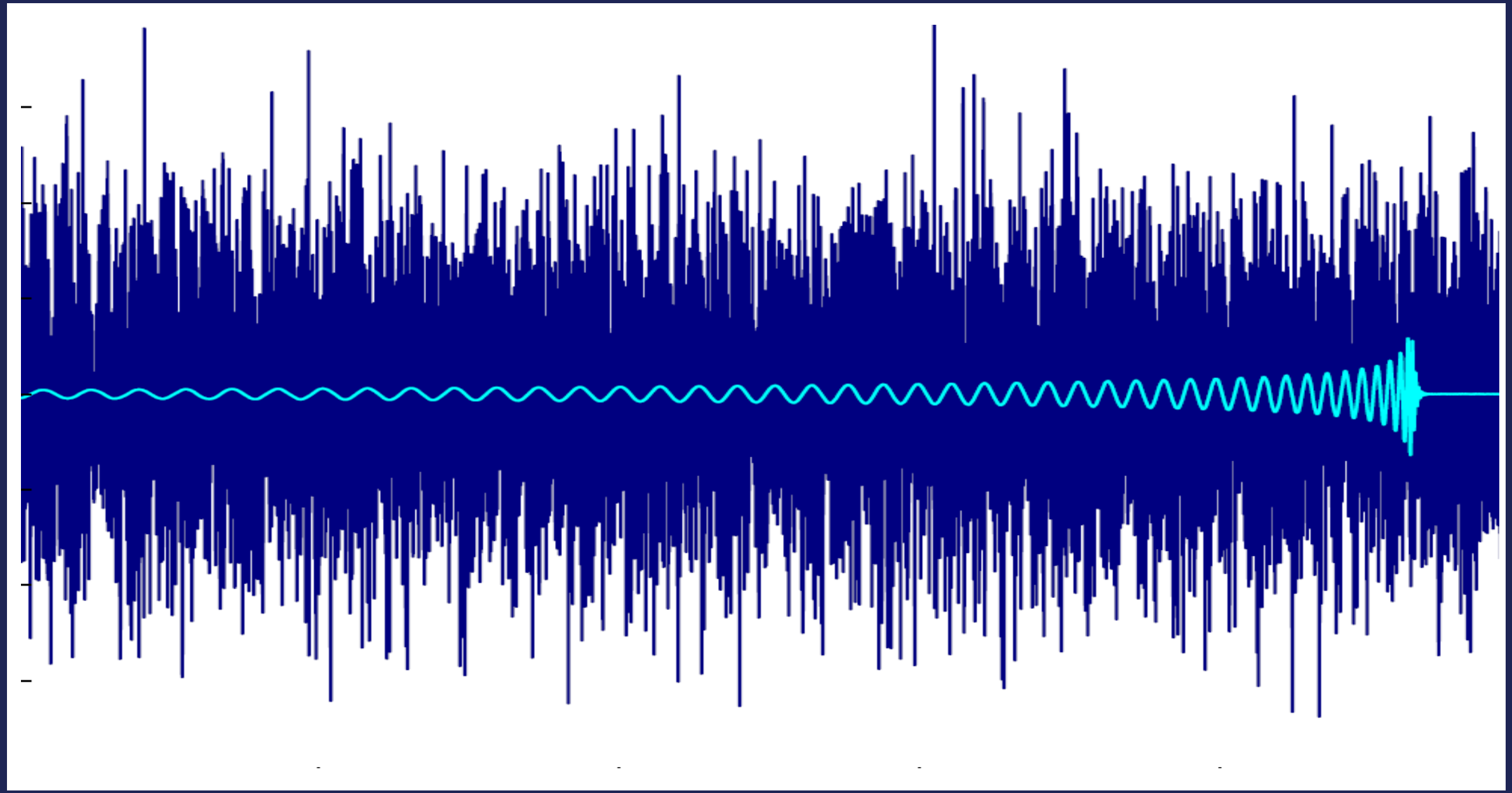

Inspiral
Merger
Ring-down
Strain (10^{-21})
1.0
0.5
0.0
-0.5
-1.0
Numerical relativity
Reconstructed (template)
Velocity (c)
0.6
0.5
0.4
0.3
Black hole separation
Black hole relative velocity
Separation (R_S)
4
3
2
1
0
0.30
0.35
0.40
0.45
Time (s)


-0.14s


0
−5
−10
−15
−20
−25
−30
−35
−40
Cumulative shift of periastron time (s)
General Relativity prediction
1975
1980
1985
1990
1995
2000
2005
Year



ACTUAL PROFILE OF THE WAVE RECEIVED BY LIGO – HANFORD, GW150714



$$T = kC$$

T = *Stress Energy Tensor*

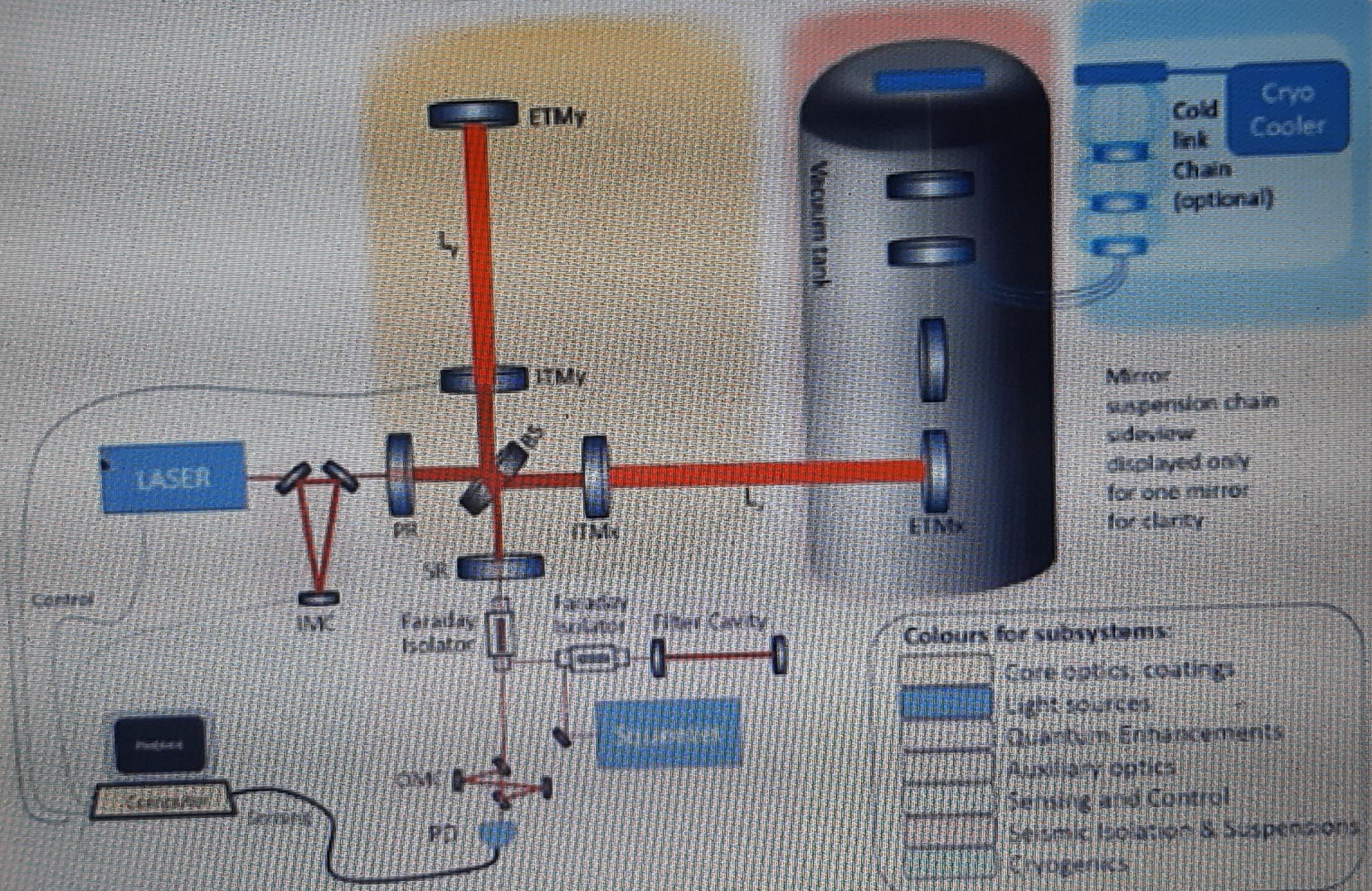
$$K = \frac{c^4}{8\pi G}$$

C = *Curvature Tensor*

TYPES OF NOISES IN DETECTION AND WHERE DO THEY ORIGINATE

LIGO INDIA

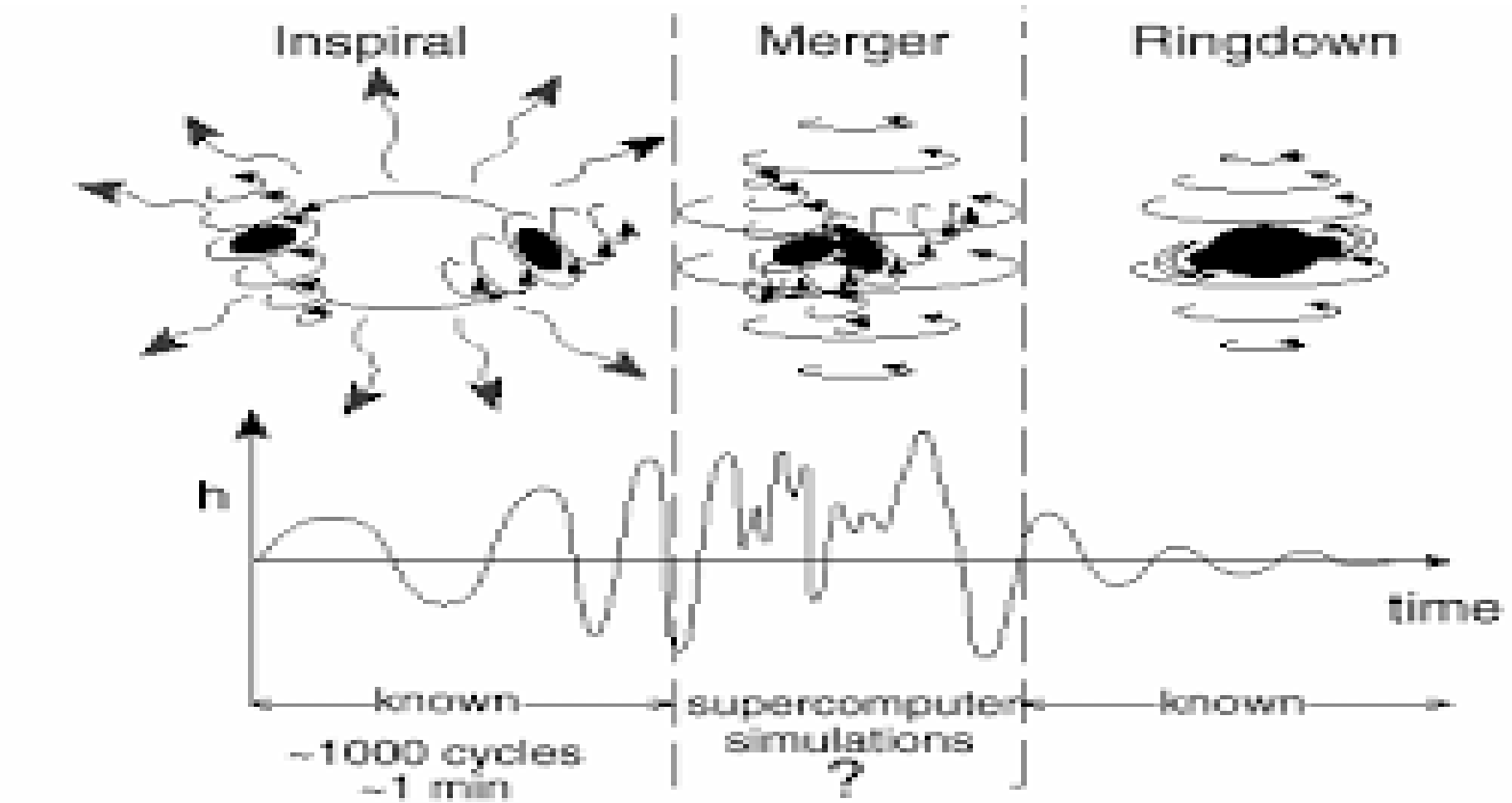
LIGO detector (in broad strokes)



Ref: GWIC 3G R&D Subcommittee report July 2019

THINGS THAT ARE OUT OF OUR CONTROL

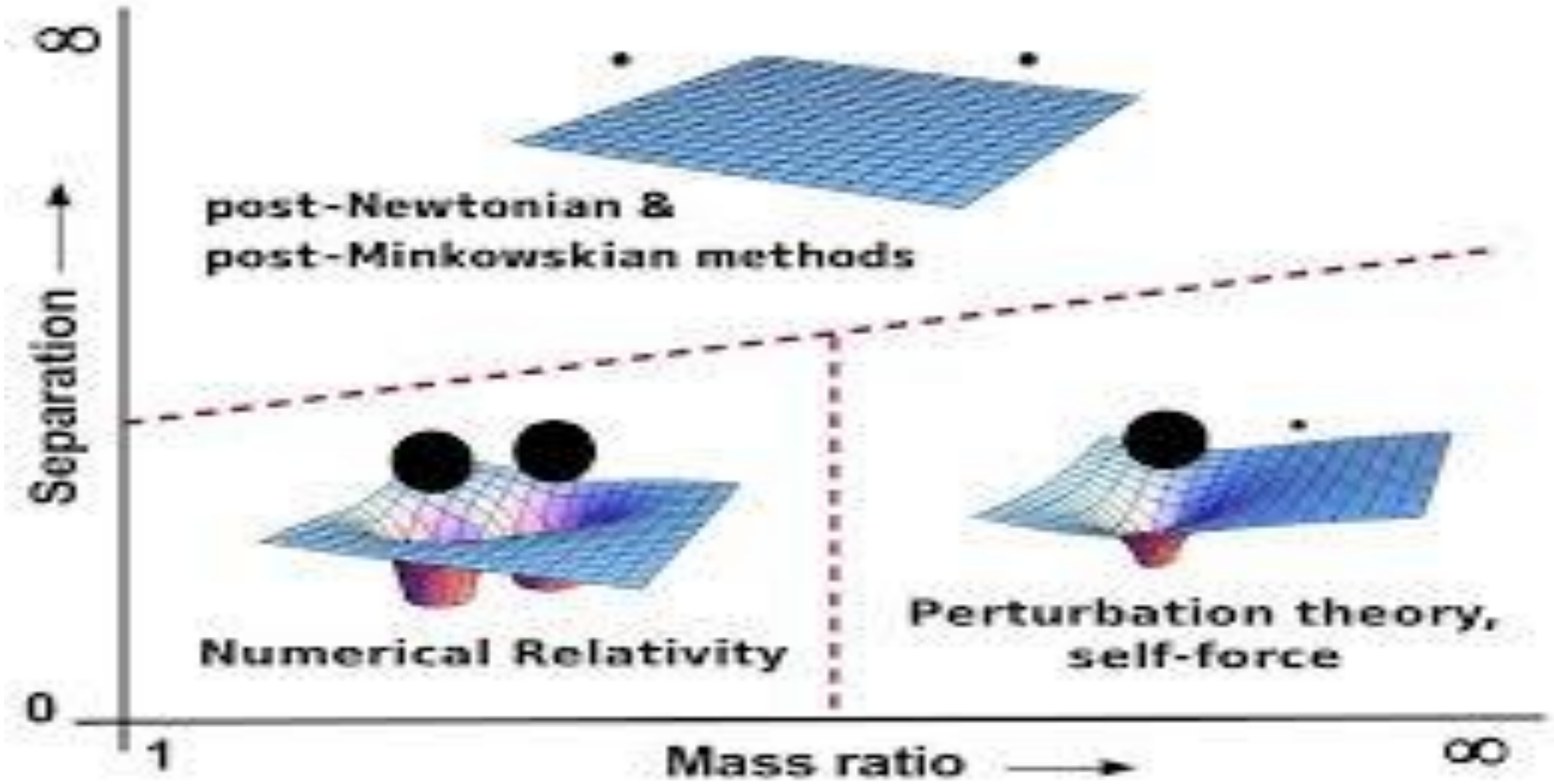
MACHINE LEARNING TO THE RESCUE!

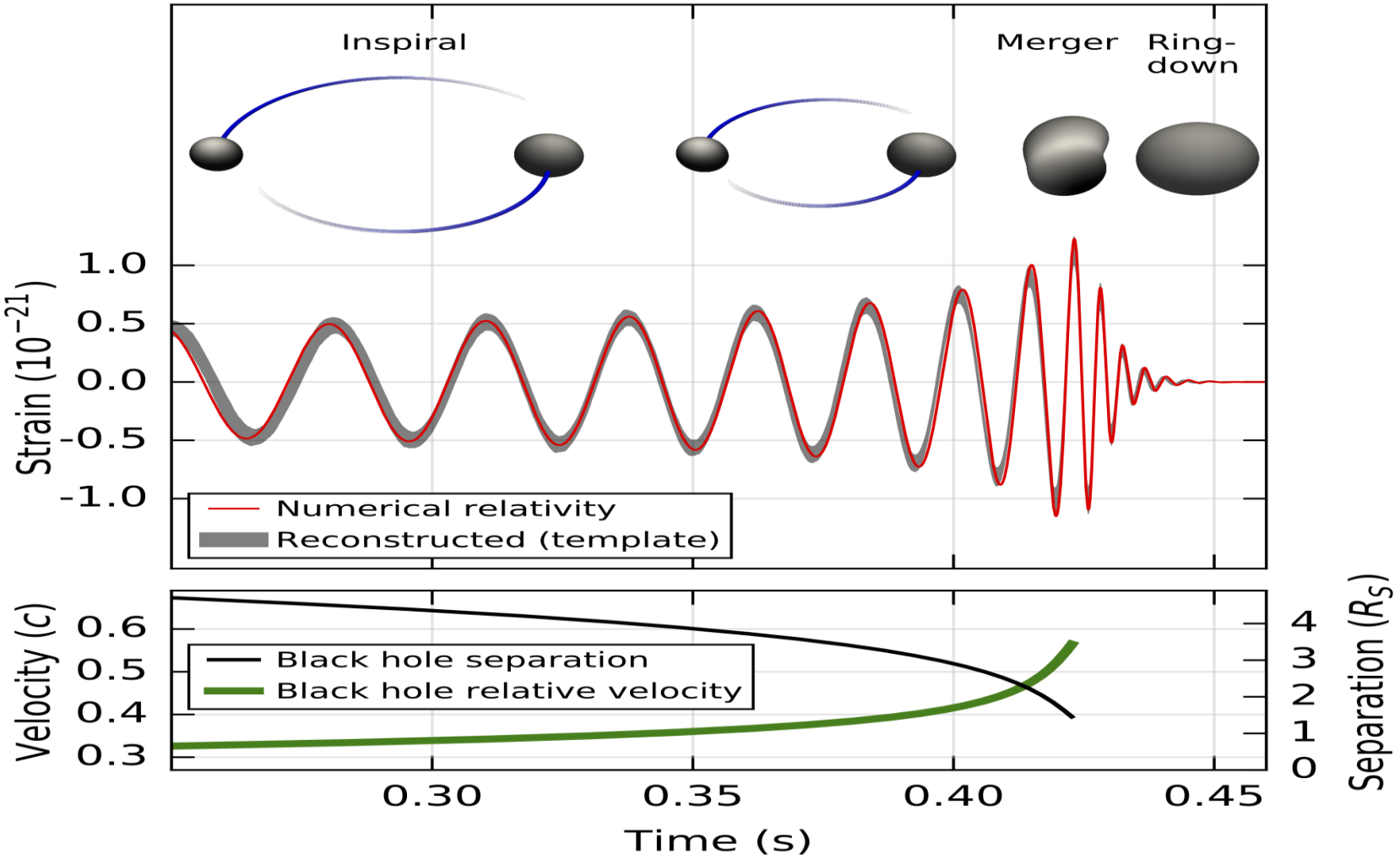

Inspiral
Merger
Ringdown
h
time
known
~1000 cycles
~1 min
supercomputer
simulations
?
known

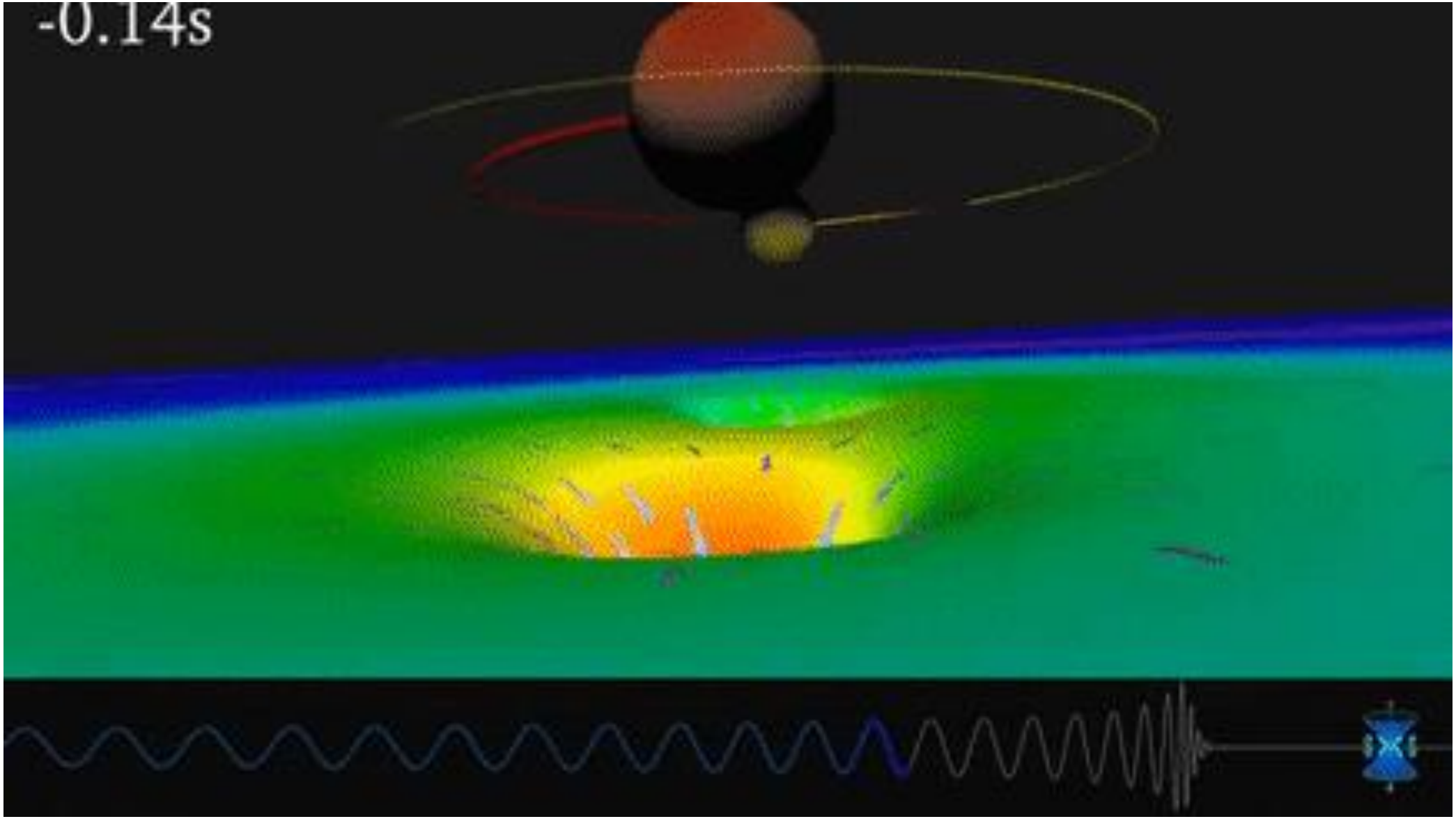
WITH FOURIER SERIES, THEY TURN TO BE A USEFUL COMPONENT RATHER THAN A HURDLE!

PREDETERMINATION OF WAVE PROFILE

- ***POST – NEWTONIAN METHOD***
- ***NUMERICAL RELATIVITY***
- ***BLACK HOLE PERTURBATION THEORY/ SELF FORCE***

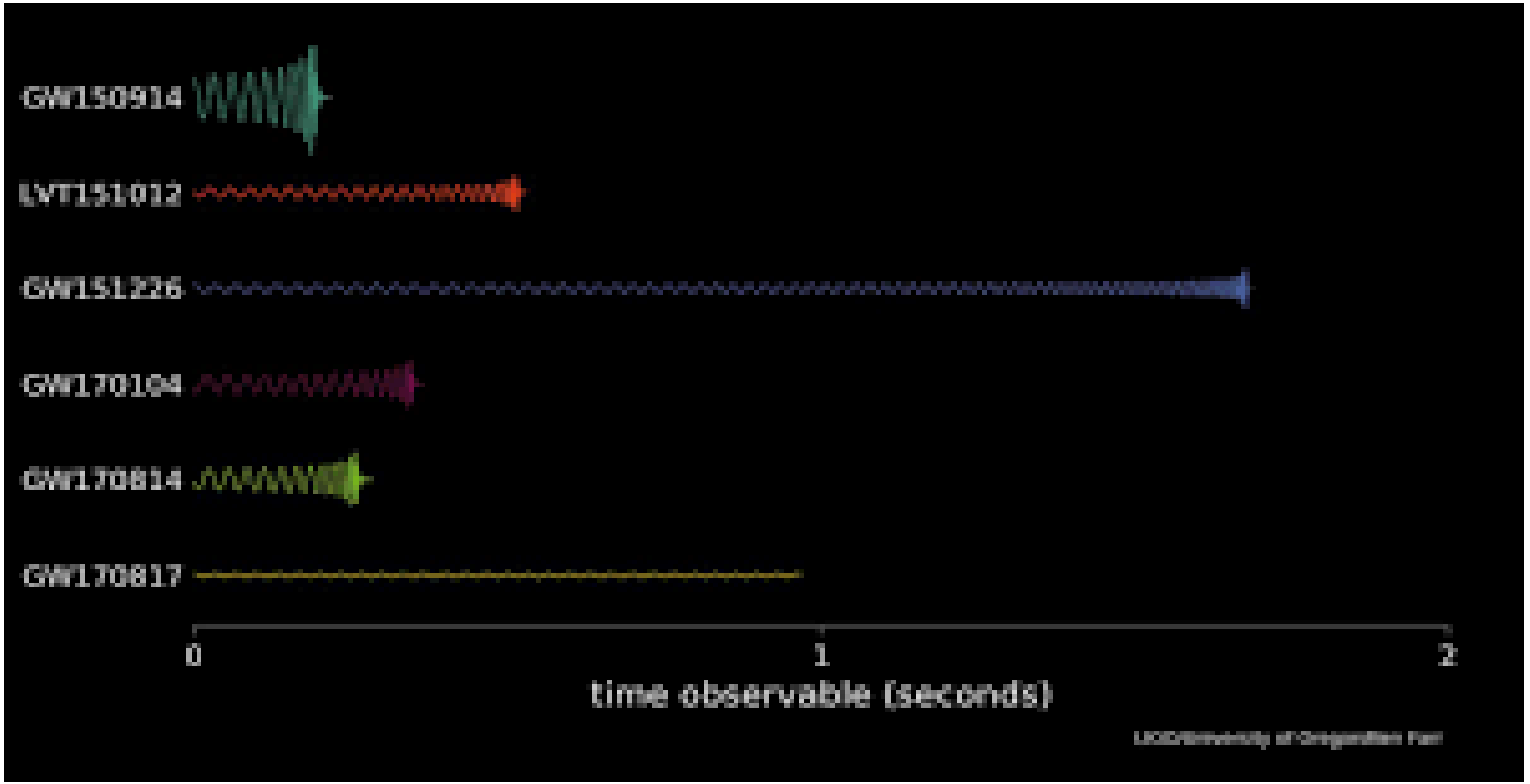

∞
Separation
post-Newtonian &
post-Minkowskian methods
Numerical Relativity
Perturbation theory,
self-force
0
1
Mass ratio
∞


Inspiral
Merger
Ring-down
Strain (10^{-21})
1.0
0.5
0.0
-0.5
-1.0
Numerical relativity
Reconstructed (template)
Velocity (c)
0.6
0.5
0.4
0.3
Black hole separation
Black hole relative velocity
Separation (R_S)
4
3
2
1
0
0.30
0.35
0.40
0.45
Time (s)


-0.14s

NOW, HOW DO YOU FIND WHAT WAS THE SOURCE?

RELATIVITY!


GW150914
LVT151012
GW151226
GW170104
GW170814
GW170817
0
1
2
time observable (seconds)

Other places where Gravitational Waves are seen!

- Short Gamma Ray burst
- Supernovas and Kilo-novas
- Stochastic Gravitational Waves from the Inflationary Epoch
- Any scenario where there is a short period of acceleration/deceleration is expected

Other ways to observe GW

- Giant Metrewave Radio Telescope
- Pulsar Timing Array

THANK YOU!