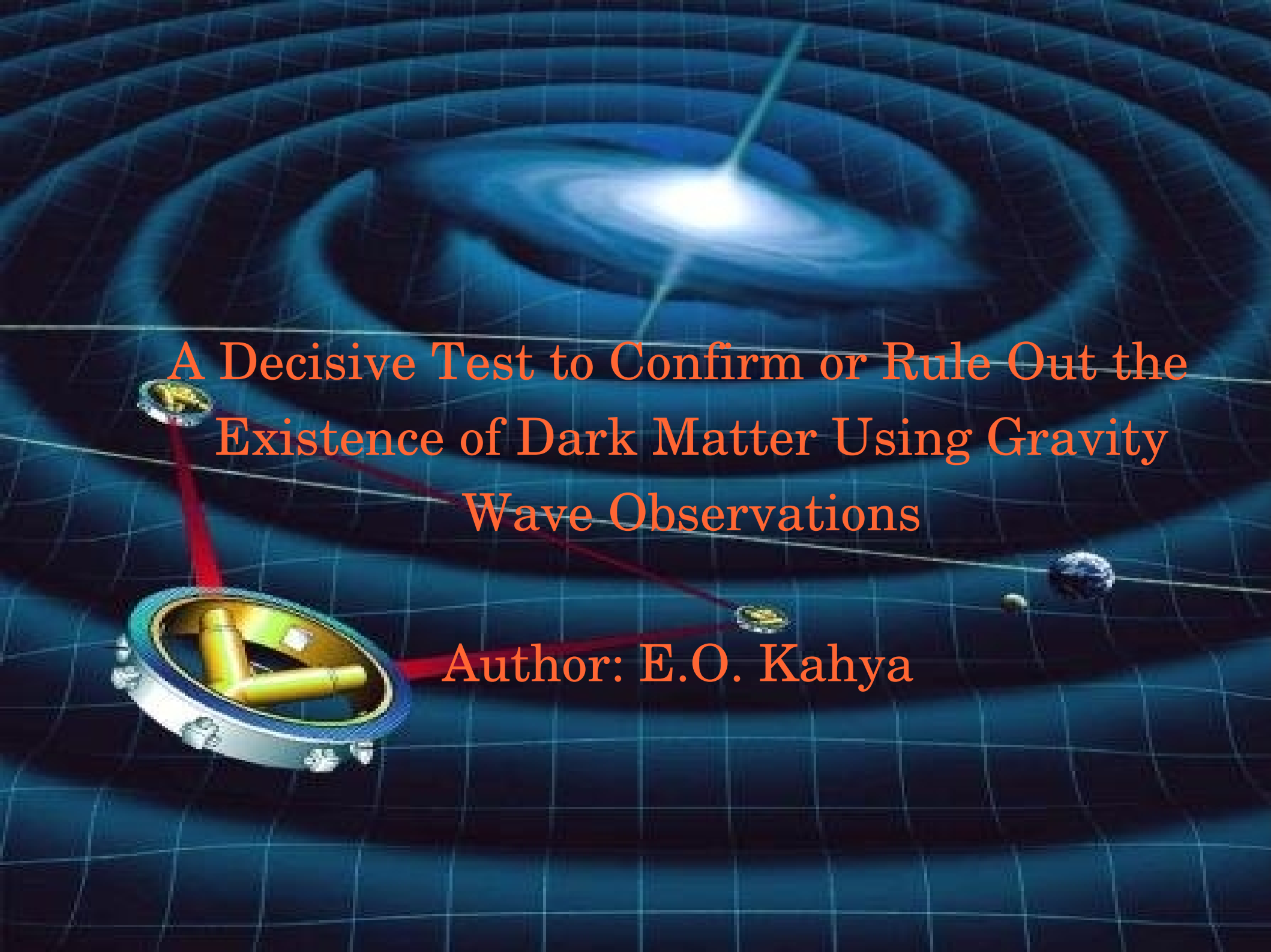


A Decisive Test to Confirm or Rule Out the Existence of Dark Matter Using Gravity Wave Observations

Author: E.O. Kahya

Model of Universe?

- **Favorite Model**:
  - General Relativity Metric + Dark Matter
- **Competition**: "Dark Matter Emulators" (F(r) models with no dark matter)
  - MOND – (fits Tully Fisher Relation: $L \sim v^4$)
  - TeVeS – (Tensor – Vector – Scalar)
    - extends MOND to give information about cosmology and weak lensing
  - SVTG – (Scalar-Vector-Tensor-Gravity)
- All provide metrics

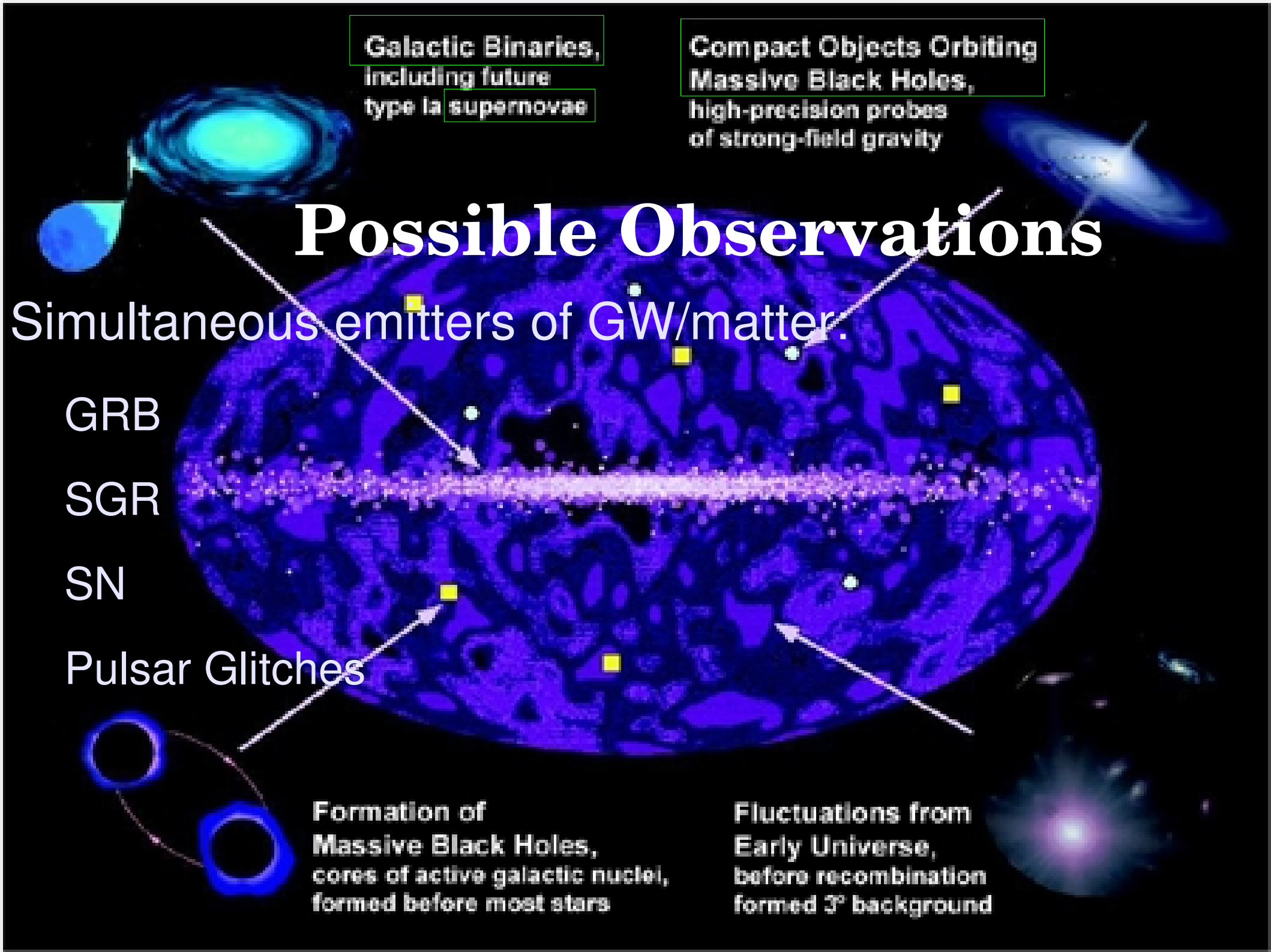
Bi-metric Feature

- Dark Matter Emulator Metrics:
  - 1) Ordinary Matter
    - What GR predicts with Dark Matter
  - 2) Gravity Waves (ripples in space-time) in Weak Field Limit
    - What GR predicts without dark matter
- **!=>** Matter (massive or massless) follows different geodesics than gravity waves in weak field limit
- ∴ Matter and GW arrival times have time lag
- GR: Massless particles on same geodesics as GW and predict simultaneous arrival of both signals

Time Delay Comparison = Test For Model of Universe

- F(r):
  - GW signal arrives before Matter (gamma rays or neutrinos)
- GR:
  - GW and Neutrino/Gamma Rays arrive simultaneously
- Order of time Delay
  - F(r)
    - LMC ~ few days
    - Andromeda ~ months
  - GR
    - 0

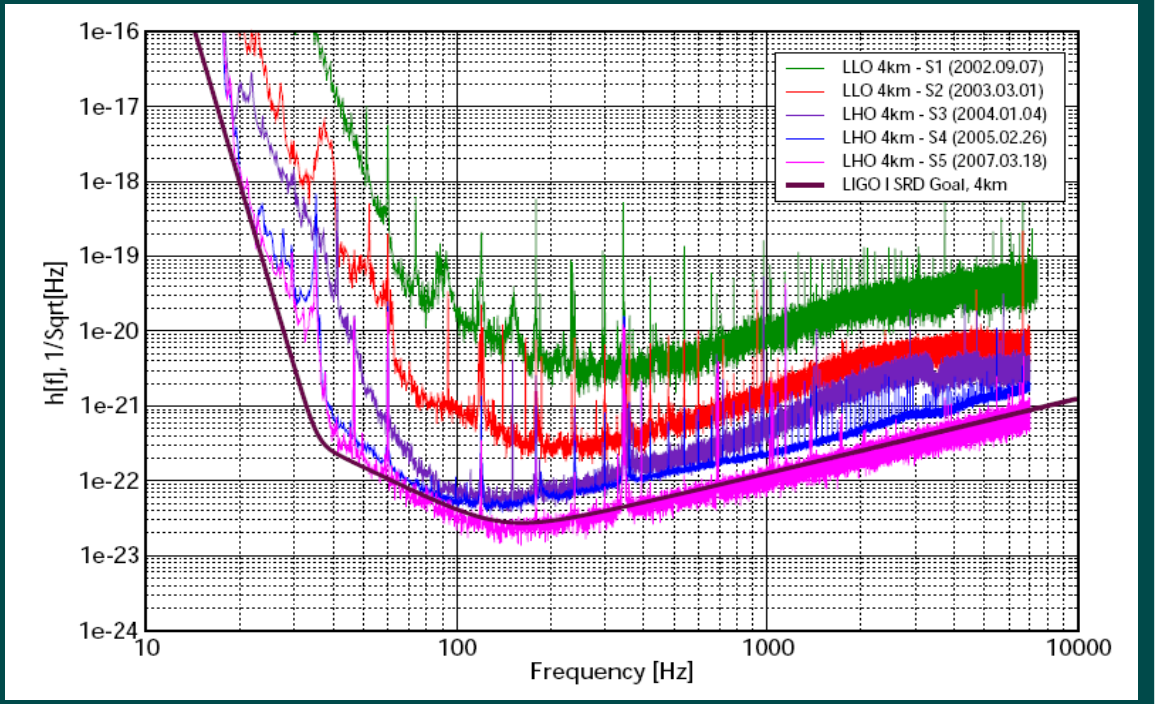
Very Tractable!


Galactic Binaries,
including future
type Ia supernovae
Compact Objects Orbiting
Massive Black Holes,
high-precision probes
of strong-field gravity
Possible Observations
Simultaneous emitters of GW/matter:
GRB
SGR
SN
Pulsar Glitches
Formation of
Massive Black Holes,
cores of active galactic nuclei,
formed before most stars
Fluctuations from
Early Universe,
before recombination
formed 3° background

Δt Calculations + Follow Ups

- SN1987A ~ few days
- GRB070201 ~ 2 years (Edge of Andromeda)
- LIGO Follow-up (ground based GW detector):
  - 3MPc Around GRB 070201: No Detection of Gravity Waves
    - Maybe not Compact Binary Merger (like used in calc.)
    - Maybe not at assumed location
    - Maybe GW's arrived 2 years ago (uncertainty in old LIGO data)

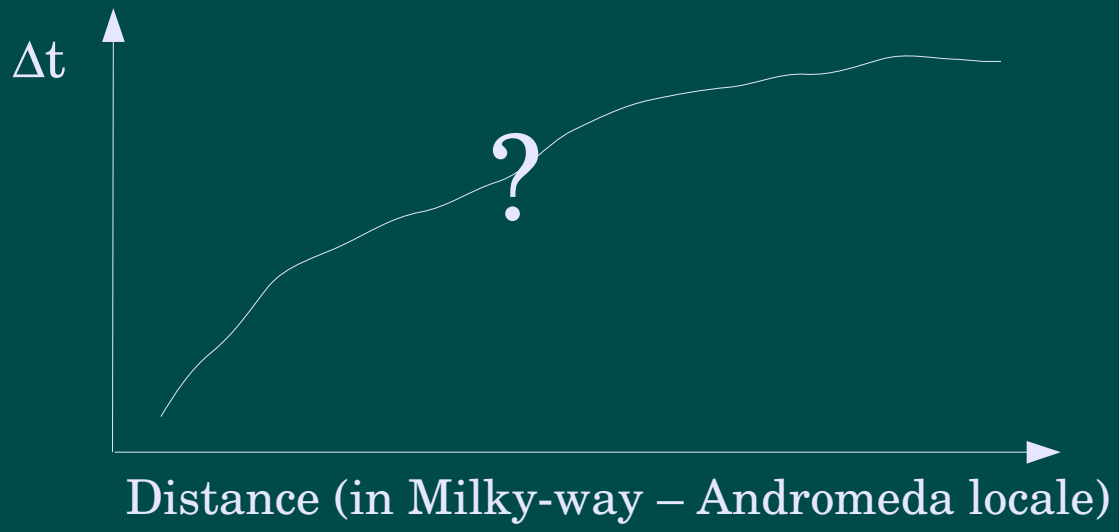
GW Detectors Status



- LIGO (ground)
  - Operating Since 2001
  - Instrument Reached Design Sensitivity last year
  - NO reported wave detection yet (recently completed S5)
  - LIGO II and Advanced LIGO under way} will deliver better performance
- LISA (space)
  - A mission to test (LISA Pathfinder) the instrumentation/setup during launch and in space will deploy by end of 2009
  - Expected to launch operating in 2018

NSF Green Lights Advanced LIGO

Future Work



- Determine Time Delay as a function of Distance (position) in Milky-way – Andromeda Locale