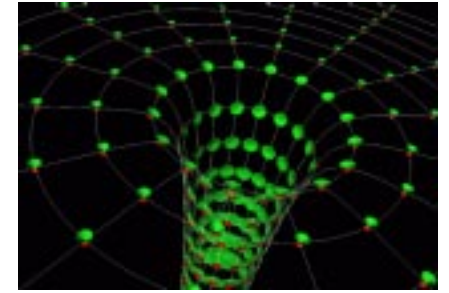




**Gravitational Waves:  
A Challenge to Theoretical Astrophysics  
Trieste, 5-9 June 2000**



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# **LIGO Status and Plans**

**Barry Barish  
5 June 2000**



# Seismic Isolation Systems

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## Progress

- » production and delivery of components almost complete
- » early quality problems have mostly disappeared
- » the coarse actuation system for the BSC seismic isolation systems has been installed and tested successfully in the LVEA at both Observatories
- » Hanford 2km & Livingston seismic isolation system installation has been completed, with the exception of the tidal compensation (fine actuation) system
- » Hanford 4km seismic isolation installation is complete



**HAM Door Removal  
(Hanford 4km)**



# 2km Fabry-Perot cavity

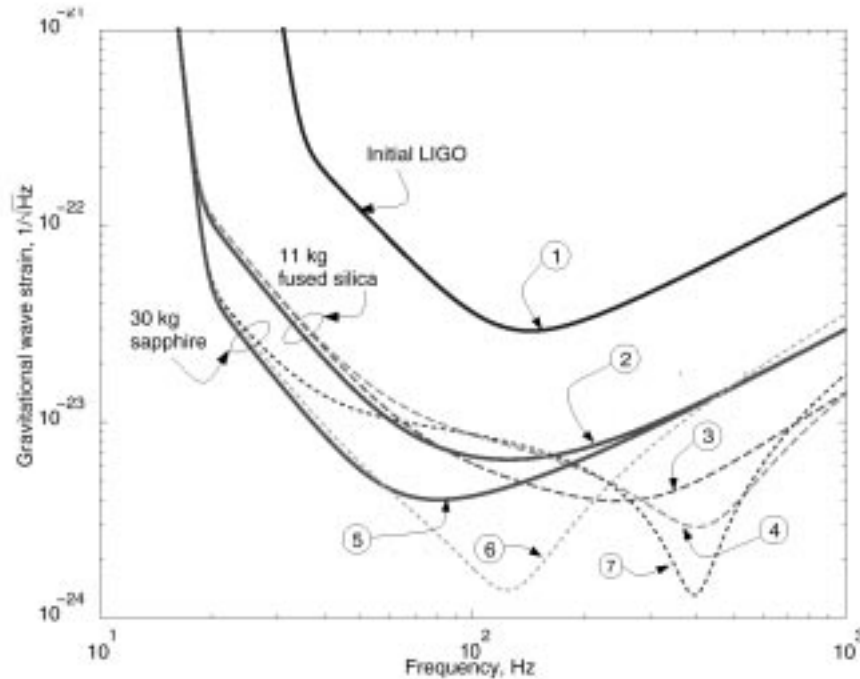
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- **Includes all interferometer subsystems**
  - » many in definitive form; analog servo on cavity length for test configuration
- **confirmation of initial alignment**
  - » ~100 microrad errors; beams easily found in both arms
- **ability to lock cavity improves with understanding**
  - » 0 sec 12/1 flashes of light
  - » 0.2 sec 12/9
  - » 2 min 1/14
  - » 60 sec 1/19
  - » 5 min 1/21 (and on a different arm)
  - » 18 min 2/12
  - » 1.5 hrs 3/4 (temperature stabilize pre modecleaner)



# LIGO II

## incremental improvements



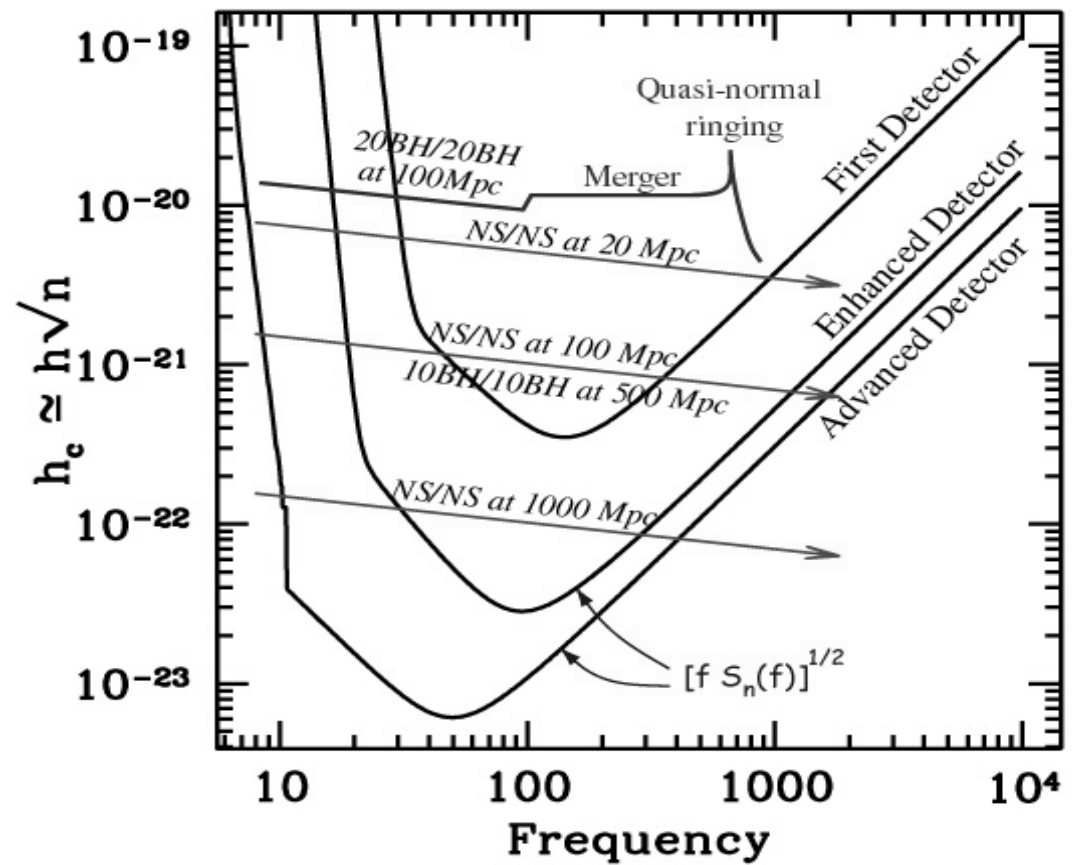
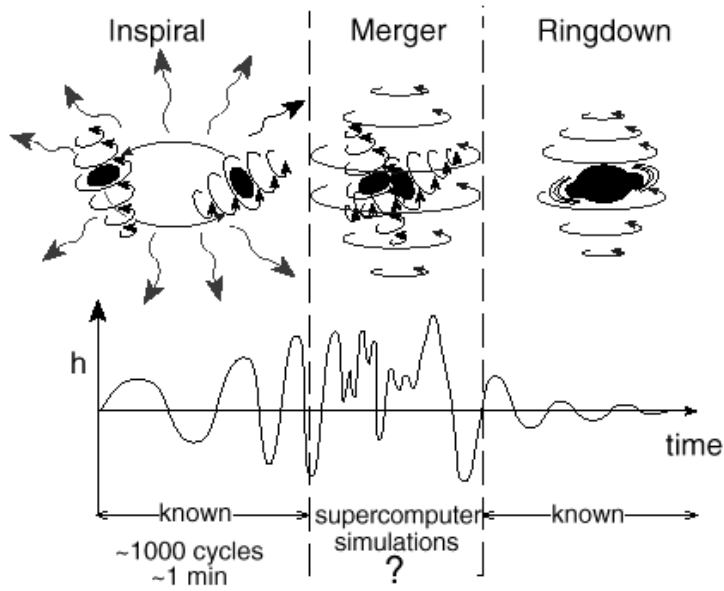
Parameter	Curve 1	Curve 2	Curve 3, 4	Curve 5, 6, 7
Parameter	Initial LIGO I value	Double suspension, 100 W laser, thermal de-lensing	Signal tuned configuration	Alternative test mass material
Input power to recycling mirror	6w	62w	140w	
Mirror loss (transmission+scatter)	50 ppm	20 ppm		
Effective power recycling	30	93		
Substrate absorption	5ppm/cm	0.4 ppm/cm		17 ppm/cm
Thermal lensing correction	(none)	factor 10		
Suspension fiber	steel wire, $Q = 1.6 \times 10^5$	fused silica $Q = 3 \times 10^7$		
Test mass	fused silica, 10.8 kg, $Q = 1 \times 10^8$	fused silica, 10.8 kg, $Q = 3 \times 10^7$	sapphire, 30 kg, $Q = 2 \times 10^8$	
Signal recycling mirror transmission	(none)		T=0.6 (curve 3) T=0.15 (curve 4)	Curve 5: none T=0.3 (curve 6) T=0.09 (curve 7)
Tuning phase			0.7 rad (curve 3) 0.45 rad (curve 4)	1.3 rad (curve 6) 0.45 rad (curve 7)



# LIGO

## *astrophysical sources*

Sensitivity of LIGO to coalescing binaries

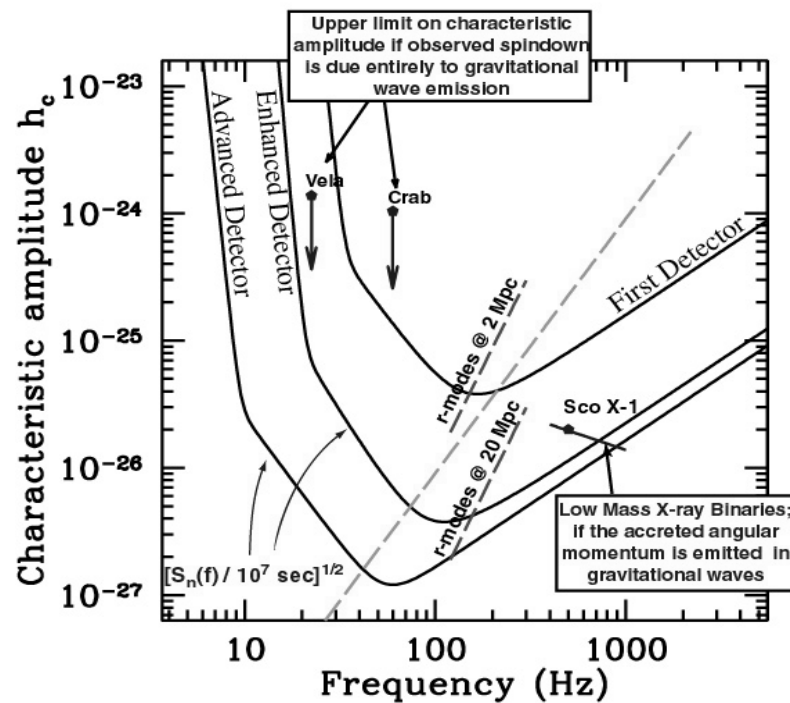




# LIGO

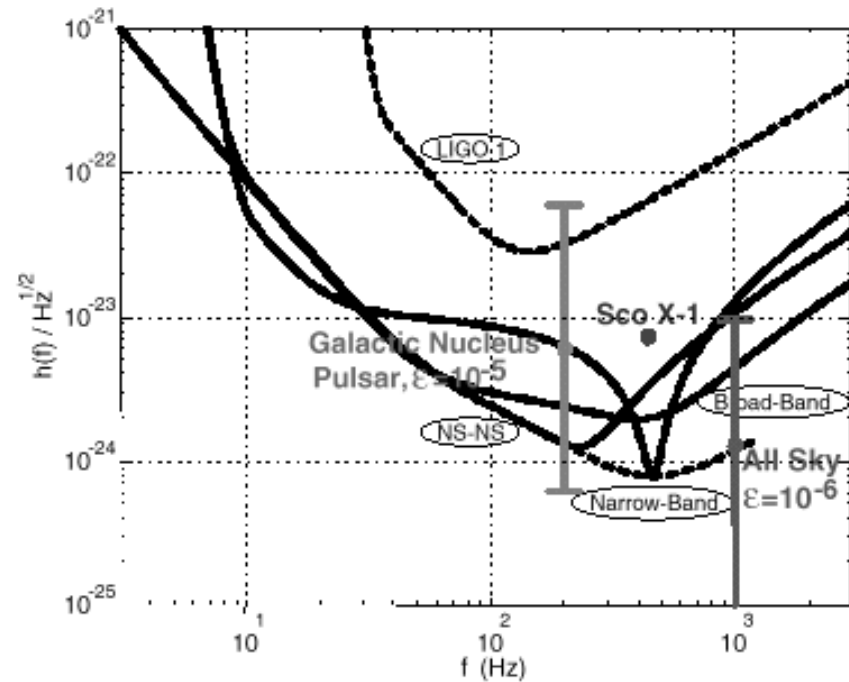
## *astrophysical sources*

Sensitivity of LIGO to continuous wave sources

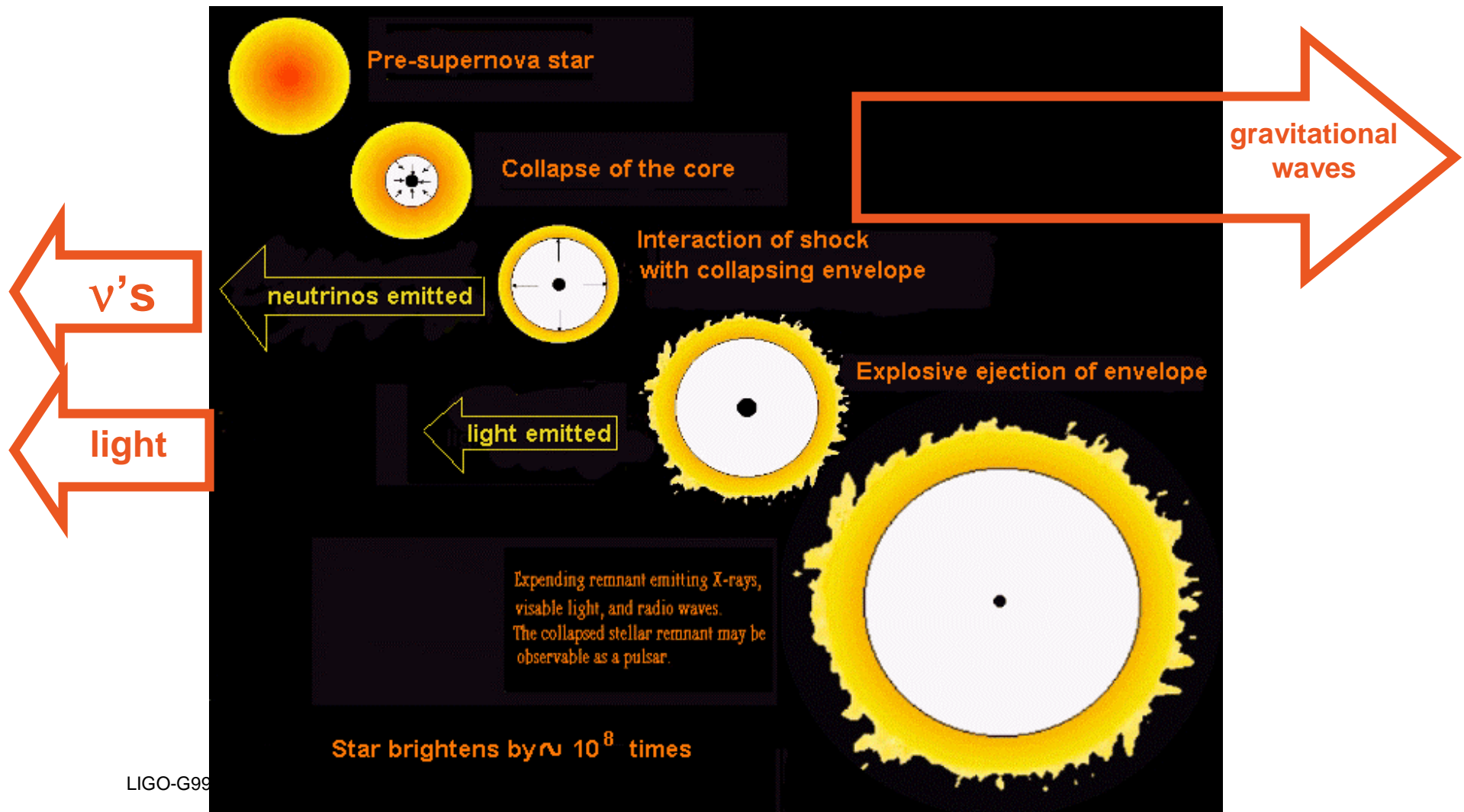


### ■ Pulsars in our galaxy

- » non axisymmetric:  $10^{-4} < \epsilon < 10^{-6}$
- » science: neutron star precession; interiors
- » narrow band searches best



# Supernovae



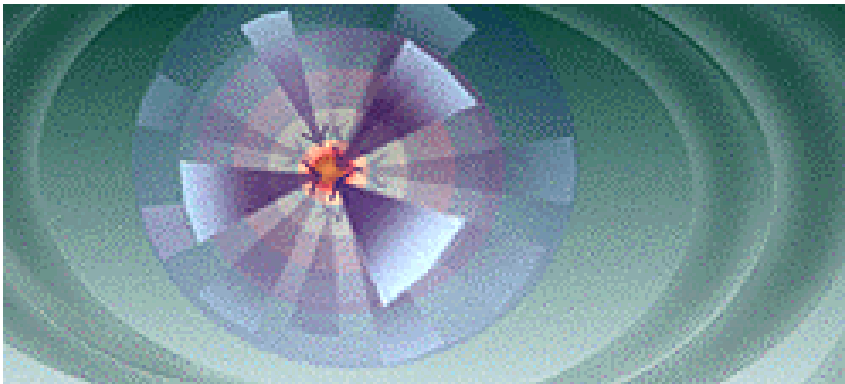


# Supernovae

## *Gravitational Waves*

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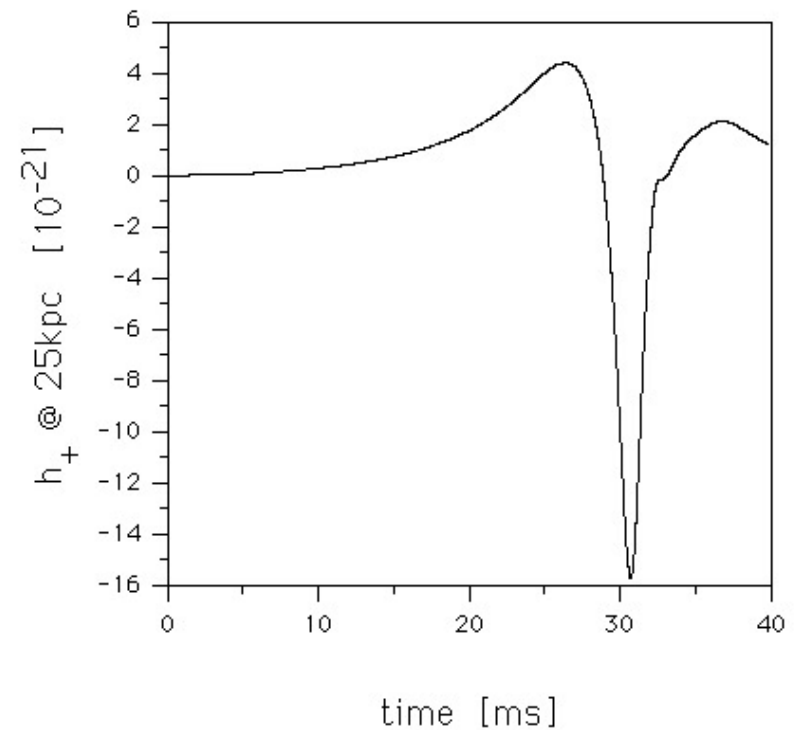
### Non axisymmetric collapse



### Rate

*1/50 yr - our galaxy*  
*3/yr - Virgo cluster*

### 'burst' signal

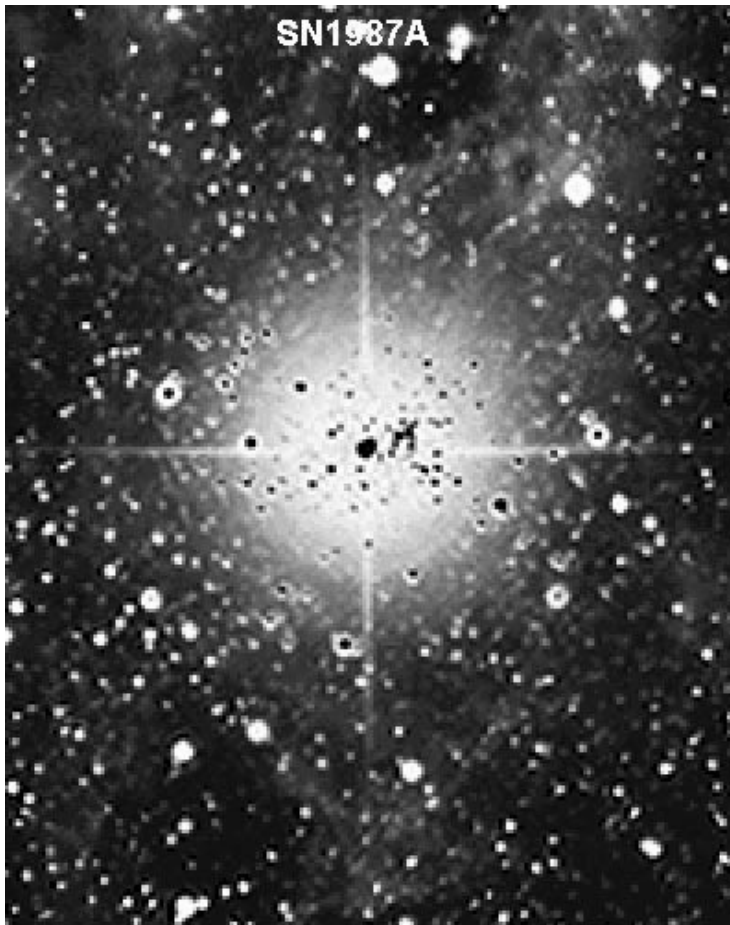




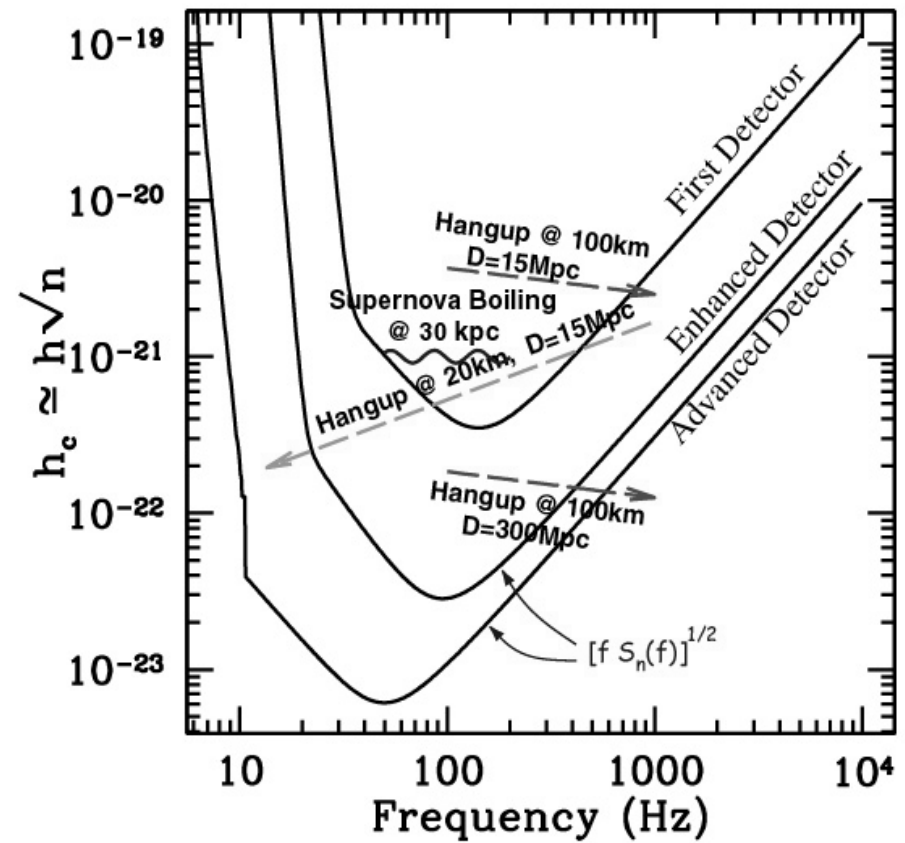
# LIGO

## *astrophysical sources*

### SN1987A



Sensitivity of LIGO to burst sources





# Conclusions

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- **LIGO I construction complete**
- **LIGO I commissioning and testing 'on track'**
- **Interferometer characterization underway**
- **Data analysis schemes are being developed, including tests with 40 m data**
- **First Science Run will begin in 2002**
- **Significant improvements in sensitivity anticipated to begin about 2006**