Gravitational Wave Astronomy: Source Populations

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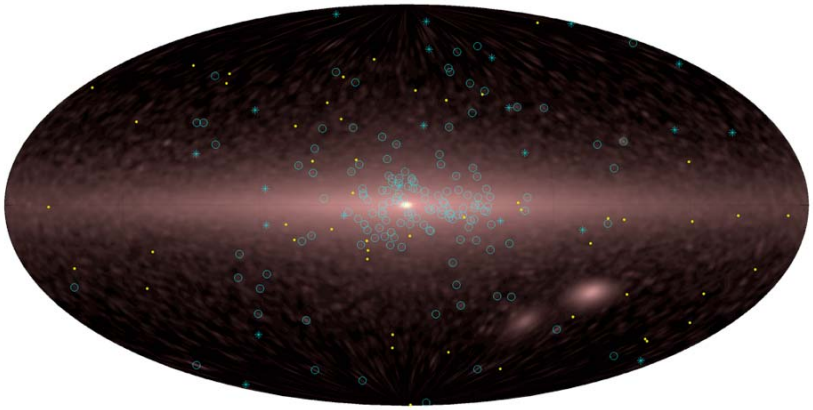
Looking in: the galactic neighborhood, our galaxy and its nucleus

Gravitational waves from close white dwarf binaries allow measurement of galactic structure constants

Galaxy is transparent in gravitational waves, allowing detailed projected imagery of bulge, disk, halo...



LISA *resolvable* compact binaries

Type	Resolved	With *df/dt*
(wd, wd)	$>10^4$	~600
AM CVn	$>10^4$	~50
(ns,wd)	21	3
Other	2	0

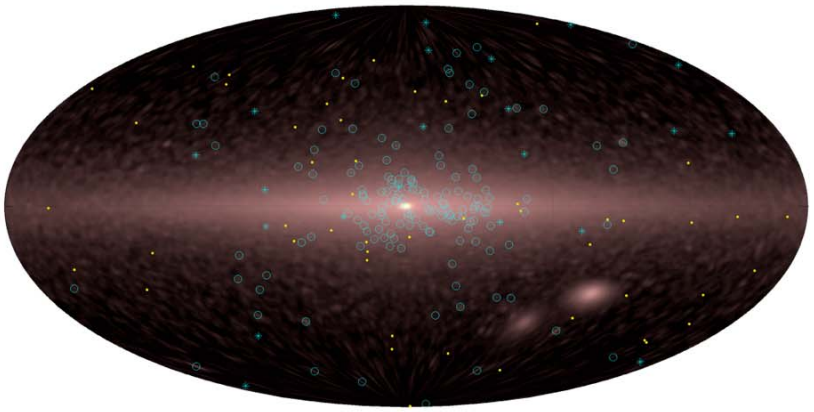
Nelemans 2003

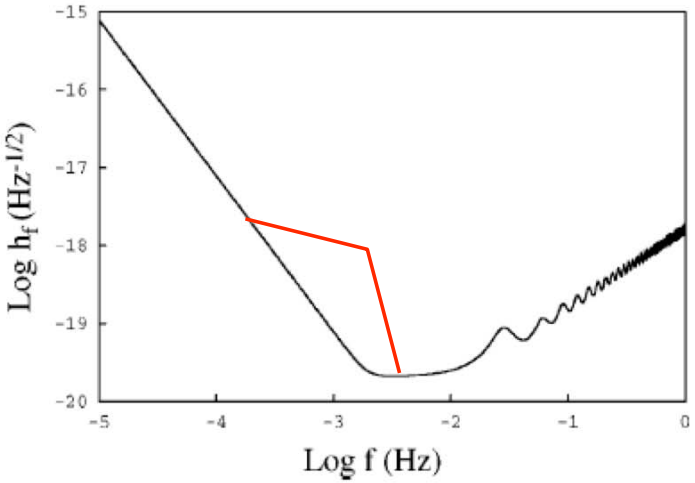
Bar dimensions, orientation, disk & halo scales, spiral arms, etc.

"Zone of avoidance" dwarf/satellite galaxies, globular clusters...

Binary mass function from consistency with galactic model...

Millions of unresolvable binaries will lead to a stochastic gravitational wave background





LISA sky below a few mHz a gravitational wave "fog"

Specific intensity proportional to binary column density along line-of-sight

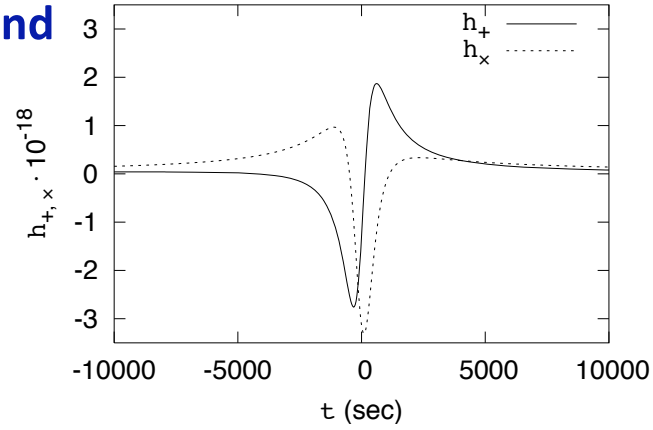
Frequency dependence and deviations from gravitational radiation "continuity" reveals sources, sinks of binaries

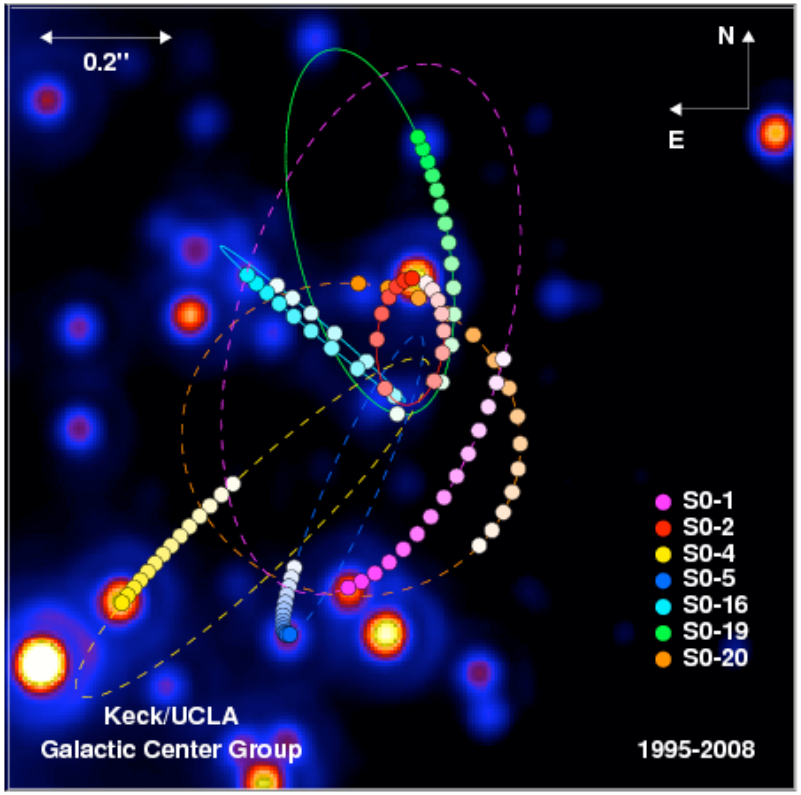
Over-densities may reveal globular clusters, satellite and other nearby galaxies in zone of avoidance

Gravitational waves from close orbits about our galaxy's central black hole reveal character of nuclear cluster

Ghez et al. observations include stars with peri-passage at 90 au.

Stars on closer orbits will have peri-passage periods in LISA band





Burst rate, character signal nuclear cluster phase space characteristics near cluster center

Looking out: extra-galacti sources, coevolution and cosmology

Extreme mass ratio inspirals (EMRIs) map spacetime metric in vicinity of black holes

Extreme mass ratio? $1:10^6$

Star is test-body compared to black hole

Orbit follows spacetime geodesic

Determined exclusively by metric connection

Orbit adiabatically moves along family of geodesics

Radiation reaction drives inspiral

Evolving orbit traces structure of black hole spacetime

Gravitational wave observations of nuclear black hole mergers provide evidence for coevolution

Gravitational wave signal visible to redshift z > 15

Galactic mergers, formation of pre-galactic structures

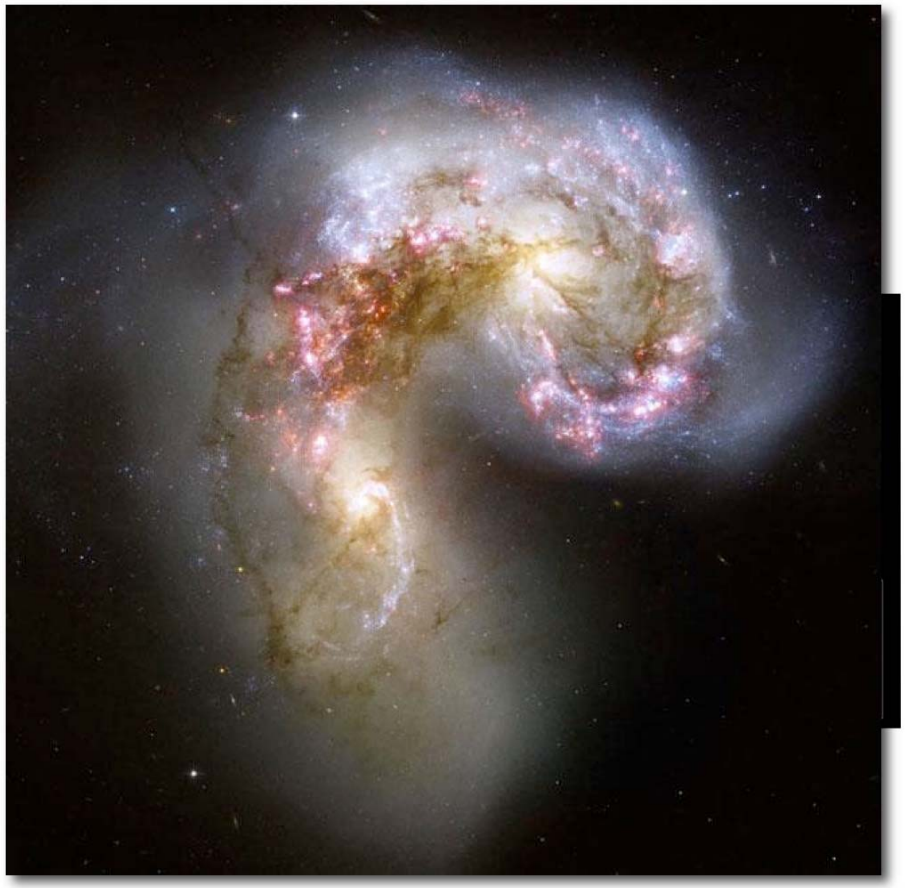
Hierarchical formation

Masses, spins of merging component nuclear black holes

Mass, spin of merged black hole

Galactic cores appear to coevolve with their nuclear black hole

Merger to merger, black hole to black hole, probes evolution of galactic structure at high z



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