Exploring the physics of ultra-dense nuclear matter with high-frequency gravitational waves

Yoichi Aso, Gravitational Wave Science Project, NAOJ

Abstract Detections of gravitational waves have become routine events these days. These detections are mostly made by capturing signals in the inspiral phase of compact binary mergers. Post-merger GW signals have not yet been detected clearly because the current detectors are not sensitive enough to those high-frequency signals. We are now exploring a possibility of converting TAMA into a high-frequency optimized detector, paving a way for a larger HF-GW detector: NEMO.

Current GW Detectors

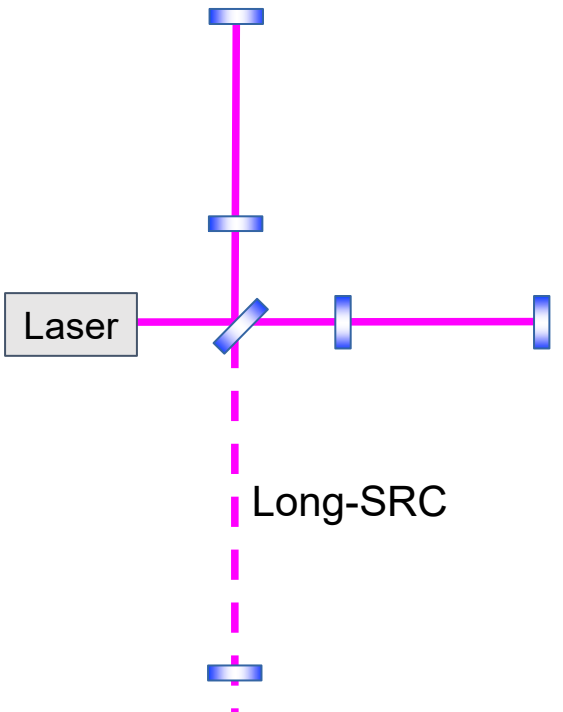
- Optimized for the detection of inspiral waves.
- Most sensitive around 100Hz.
- Poorer sensitivity in kHz and above.

Post-Merger GW of Neutron Star Binaries

Oscillations of a massive neutron star formed after the merger of two neutron stars generate high-frequency GW. The detection of this post-merger GW allows us to probe the physics of ultra-dense nuclear matter exceeding the nuclear saturation density. Such high-density region cannot be explored with any other means. Precise determination of neutron star equation of state may also allow us to break the degeneracy between the mass and redshift in the inspiral waveform, leading to the determination of Hubble constant without any optical counterpart.

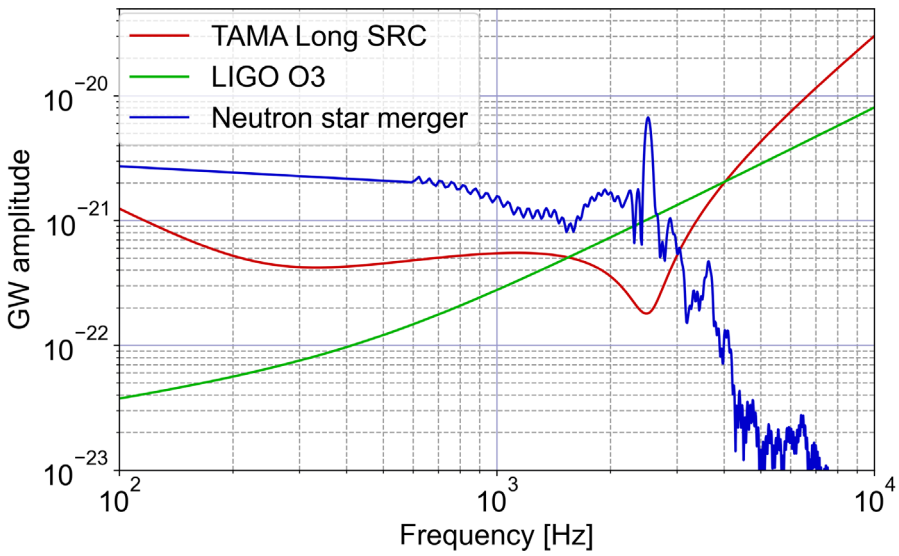
Long-SRC

By adding a long signal recycling cavity comparable in length to the arm cavities at the anti-symmetric port of an interferometer, we can create a peak in the sensitivity curve of a GW detector. Combined with high power laser and squeezing, we can strongly enhance the high-frequency sensitivity of a detector.



TAMA Long-SRC

We are exploring the possibility of retrofitting a Long-SRC to TAMA. It should give us a better sensitivity than aLIGO in 2-3kHz region. If successful, TAMA can contribute to the frontline of GW astronomy.



NEMO: Neutron star Extreme Matter Observatory

NEMO is a high-frequency GW detector concept proposed by Australian GW community. It is a 4km cryogenic interferometer with Long-SRC. Technologies and experience from KAGRA can be used for the cryogenic part. TAMA Long-SRC can serve as a prototype for the full-scale NEMO.