Abstract Submitted
for the DAMOP19 Meeting of
The American Physical Society

Table Top Ultrasensitive Gravitational Wave Detector Using Superluminal Ring Lasers[1] SELIM SHAHRIAR, MINCHUAN ZHOU, ZIFAN ZHOU, Northwestern University, JACOB SCHEUER, Tel Aviv University, Israel
— We propose a new scheme of a gravitational wave (GW) detector, composed of a pair of orthogonally oriented superluminal ring lasers (SRLs). Each laser contains a gain medium that is tailored to provide a negative dispersion for producing the superluminal effect in order to enhance the sensitivity of the detector. We evaluate the quantum noise limited sensitivity of the detector, considering shot noise and radiation pressure noise. A gravitational wave modulates the length of the two laser cavities, out of phase with respect to each other, and creates a frequency modulation in the beat signal. In the limit where the response time of the laser cavity to a change in the cavity length is shorter than the period of the GW signal, the beat frequency tracks the evolution of the GW. Using a 10 meter long cavity for each SRL with effective group index of 10^{-4}, and intra-cavity power of 1 kilo-watt, we can achieve a quantum noise limited sensitivity a factor of ten better than the current Advanced LIGO with 4km long arms over the same band: from 50 Hz to 500 Hz. If a 1 meter long cavity is used for each SRL, the optimal sensitivity is nearly a factor of 100 better than that of Advanced LIGO, but for a band from 500 Hz to 10 kHz.

[1]AFOSR Grants No. FA9550-18-01-0401 and FA9550-18-P-0003

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Date submitted: 08 Feb 2019 Electronic form version 1.4