Abstract Submitted
for the APR21 Meeting of
The American Physical Society

Identifying Type-II Strongly-Lensed Gravitational-Wave Images in Third-Generation Gravitational-Wave Detectors YIJUN WANG, RICO K.L. LO, ALVIN K.Y. LI, YANBEI CHEN, Caltech — Strong gravitational lensing is a gravitational wave (GW) propagation effect that influences the inferred GW source parameters and the cosmological environment. Identifying strongly-lensed GW images is challenging as waveform amplitude magnification is degenerate with a shift in the source intrinsic mass and redshift. However, even in the geometric-optics limit, Type-II strongly-lensed images cannot be fully matched by Type-I (or unlensed) waveform templates, especially with large binary mass ratios and orbital inclination angles. We propose to use this mismatch to distinguish individual Type-II images. Using planned noise spectra of Cosmic Explorer, Einstein Telescope and LIGO Voyager, we show that a significant fraction of Type-II images can be distinguished from unlensed images, given sufficient SNR (~ 30). We predict the detection rate of lensed GW sources with detectable Type-II images to be 172.2, 118.2 and 27.4 per year for CE, ET and LIGO Voyager, respectively. Among these detectable events, 33.1, 7.3 and 0.22 percent will be distinguishable via their Type-II images with a log Bayes factor larger than 10. We conclude that such distinguishable events are likely to appear in the third-generation detector catalog and supplement existing strong lensing search strategies.

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Date submitted: 06 Jan 2021 Electronic form version 1.4