Gravitational Wave Astronomy Prospects for Core-Collapse Supernovae Populations

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We present an updated estimate of the intrinsic core collapse supernovae (CCSNe) rate within 20 Mpc from Earth. This distance is of interest because the cumulative rate produces a few CCSNe per year and some extreme emission models are currently detectable up to more than 10 Mpc from previous detections. The CCSN rate estimate takes into account the spatial distribution and the morphology of the local galaxies, minimizing the major observational biases. It gives an accurate cumulative rate as a function of distance and provides the most probable host galaxies and regions of the sky where the GW signals of CCSNe can come from. We evaluate a CCSN rate of $470.95^{+307.55}_{-123.16}$ CCSNe per century within 20 Mpc. This rate estimate allows us to evaluate the benefits of having multiple CCSN candidate events during the laser interferometer science runs. Explicitly, we compare the performance of two collective detection methodologies (the Feldman-Cousins counting method and the local probability method currently used for GW searches from gamma-ray bursts) with the standard single SN detection methodology. Implications for the standard candle model exclusion probabilities for CCSNe are also discussed. Illustrative examples of the sensitivity improvement with respect to the single-event current approaches show that the detectable 50% efficiency range of the CCSN GW population is about five times larger than the one detectable for a single CCSN GW. This study is provided using phenomenological and *ad-hoc* astrophysical waveforms, multi-dimensional first principle CCSN simulations, and analytic and semi-analytic GW emission models of more extreme scenarios.