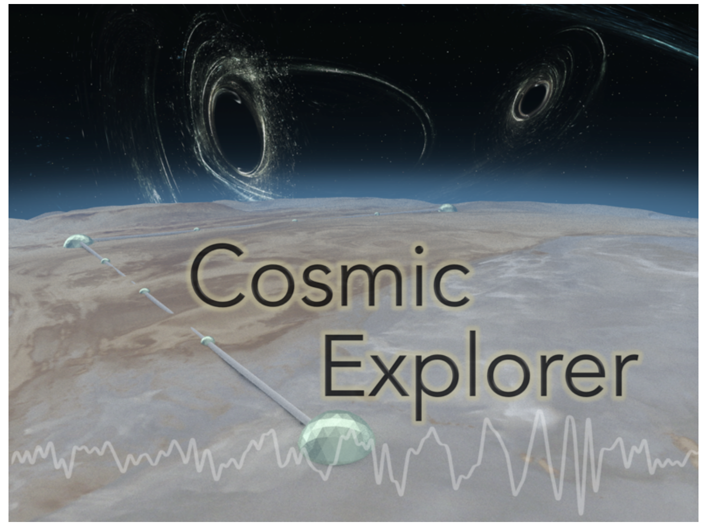
Cosmic Explorer

Matthew Evans
Massachusetts Institute of Technology



The age of gravitational-wave astronomy began in 2015 when the National Science Foundation's (NSF) Advanced Laser Interferometer Gravitational-wave Observatory (LIGO) observed a pair of black holes colliding a billion light-years away [1]. The neutron star binary coalescence observed in 2017 by Advanced LIGO and by Advanced Virgo was accompanied by emission seen across the electromagnetic spectrum by telescopes around the world [2, 3]. Building on the Initial LIGO technologies [4], the second-generation (2G) Advanced LIGO detectors [5] have: the direct detection of gravitational waves [1]; the most direct verification that black holes exist and can form binaries [1, 6, 7]; the first tests of general relativity in the domain of strong gravity and highly curved spacetimes [7, 8, 9]; information about the physics and properties of coalescing binary neutron stars [2]; and "standard candles" to measure the Hubble expansion rate [10]. These discoveries all came from instruments capable of surveying only a small fraction of the Universe. Today it appears possible to build third-generation (3G) detectors capable of surveying the entire Universe; detectors an order of magnitude more sensitive than the current generation.

A global network of 3G observatories will probe physics beyond the reach of existing observatories, detect black holes colliding at the edge of the Universe, and yield high-fidelity measurements of binary neutron stars [11]. Precision measurements of black holes mergers will challenge the analytical relativity, numerical relativity, and quantum gravity communities. Observing the hierarchical growth of black holes will shed light on fundamental questions in large-scale structure formation and cosmology. The demographics of compact objects will help astrophysicists understand stellar evolution over cosmic history, and regular joint electromagnetic and gravitational-wave observations will allow us to explore the matter inside neutron stars, the formation of r-process elements in kilonovae, and the engines that power short gamma ray bursts.

In this talk, I will focus on one of the 3G instrument concepts known as Cosmic Explorer (CE) [12]. A team of 5 US institutions (led by MIT, funded by the NSF, and collaborating with the international community via GWIC [13]), is currently working to develop the foundations for a CE design study, including a cost estimate and a detailed science case. I will give an update on the progress of this work, and talk about a potential timeline for the future.

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