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Future Missions for MeV Gamma-Ray Astrophysics

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The Universe in the MeV gamma-ray range is characterized by the most violent explosions, such as mergers, and supernovae, as well as the most powerful and dynamic sources such as pulsars, and black holes. The next generation of gamma-ray telescopes will be tasked with unraveling the life cycle of the elements by observing the de-excitation of newly generated nuclei from supernovae and mergers, gaining insight into the evolution and acceleration mechanisms in jets of, e.g., blazars, contributing to multi-messenger astrophysics by studying astrophysical events that produce gravitational waves and neutrinos, better understanding the physics in the most extreme environments such as neutron stars and near black holes, searching for signatures of dark matter in the MeV band, solving mysteries such as the Fermi bubbles and the origin of the Galactic positrons, and many more. These discoveries will be enabled by the groundbreaking new capabilities of the next generation of MeV gamma-ray telescopes. COSI, the Compton Spectrometer and Imager, is a 0.2-5 MeV Compton telescope capable of imaging, spectroscopy, and polarimetry of astrophysical sources. Such capabilities are made possible by COSI's germanium cross-strip detectors, which provide high efficiency, high resolution spectroscopy and precise 3D positioning of photon interactions. COSI is currently in a competitive Phase A concept study to consider COSI as a Small Explorer (SMEX) satellite mission. As a proof-of-concept of this new generation of telescopes, COSI had a successful 42-day stratospheric balloon flight in 2016, and was able to observe the 511-keV emission near the Galactic center region as well as several other astrophysical sources such as Crab, Cen-A, and Cyg X-1.

The All-sky Medium-Energy Gamma-ray Observatory Explorer (AMEGO-X) is an envisioned combined Compton-scattering and pair-creation telescope operating in the 200 keV to 20 GeV energy range. It will consist of an electron tracker made of Silicon detectors and a CsI calorimeter. In the Compton regime it will enable Compton recoil-electron tracking and thus enable unprecedented background reductions.

GECCO, the Galactic Explorer with Coded aperture mask Compton telescope, is a mission concept which will operate in the 100 keV to 10 MeV range, and will combine the background reduction and sensitivity of a Compton telescope with the angular resolution of a coded mask.

In the presentation, we will discuss and compare the science goals, designs, and current status of these and a few more future MeV gamma-ray telescope projects, and present the latest results of the analysis of the 2016 COSI balloon flight.

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