The Advanced Particle-astrophysics Telescope: Reconstruction of the MeV gamma-ray sky and estimation of point-source sensitivity in the presence of the background

Roger Chamberlain[1], Marion Sudvarg[2], Wenlei Chen[3], APT Collaboration[4]
[1]Washington Univ. in St. Louis, Saint Louis, MO, [2]Washington University in St. Louis, Saint Louis, MO, [3]University of Minnesota, Minneapolis, MN, [4]Washington University, St. Louis, MO

The Advanced Particle-astrophysics Telescope (APT) is a mission concept of a gamma-ray and cosmic-ray observatory aimed at multi-messenger astronomy and dark-matter searches, but it would provide significant new capabilities for mapping the MeV sky. With a multiple-layer tracker and an imaging calorimeter, APT is designed to observe gamma-rays at energies from hundreds of keV up to a few TeV. We present simulations of the gamma-ray background and the instrument performance of APT in the Compton regime (from hundreds of keV to a few tens of MeV) in an L2 (the second sun-Earth Lagrange point) orbit. We estimate and simulate the MeV gamma-ray background from the Milky-Way emission and the extragalactic sky. We develop an iteration algorithm to reconstruct the MeV gamma-ray sky from the all-sky Compton map. For a long-term exposure of more than 2 years, APT should be able to resolve the MeV Milky Way with a degree-level resolution. We also simulate solar particles and galactic cosmic rays at the L2 orbit for different solar-activity levels. We calculate the detection sensitivity for gamma-ray transients and find that the APT can achieve a degree-level to sub-degree-level localization accuracy for gamma-ray transients with fluence down to ~ 0.1 MeV·cm^{-2} in the presence of the gamma-ray and astro-particle background. In addition, we present a background simulation for the Antarctic Demonstrator for APT (ADAPT), a planned Antarctic balloon experiment that includes all of the key elements of the APT detector.