

Z301r Planck's Transformative Contributions to Astrophysics

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The ESA Planck space mission has dramatically advanced astrophysics through its exceptional sensitivity and broad frequency coverage. Using sophisticated component-separation techniques, the collaboration transformed multi-frequency maps into key data products that illuminate the Cosmic Microwave Background (CMB), reveal large-scale structure through gravitational lensing, identify galaxy clusters via the thermal Sunyaev-Zeldovich effect, and map the cosmic-infrared background. Planck also produced comprehensive tracers of the Milky Way—dust, carbon monoxide, synchrotron, free-free, and anomalous microwave emission—along with catalogs of compact Galactic and extragalactic sources. These data have enabled new statistical methodologies supported by precise photometric calibration and extensive simulations. My presentation will highlight Planck's broad contributions, with emphasis on Galactic dust in total intensity and polarization. The mission's striking dust images, merging emission- and polarization-derived textures, have become iconic and now serve as reference maps for interstellar studies, much as CMB maps do for cosmology. They have opened the door to statistical characterization of the Galactic magnetic field and its interplay with interstellar matter and turbulence. Planck's multi-frequency dust observations have also reshaped theoretical models and connected interstellar astrophysics with key cosmological goals, including the search for primordial B-mode polarization—potential evidence of inflationary gravitational waves and a major frontier in understanding the early Universe.