The Multi-wavelength Extinction Law and its Variation in the Coalsack Molecular Cloud Based on the Gaia, APASS, SMSS, 2MASS, GLIMPSE, and WISE Surveys

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Accurate interpretation of observations relies on the interstellar dust extinction law, which also serves as a powerful diagnostic for probing dust properties.
In this study, we investigate the multi-wavelength extinction law of the quiescent, starless molecular cloud Coalsack and explore its potential variation across different interstellar environments: the surrounding region, the nearby high Galactic latitude region, the inner dense region, and the inner diffuse region.
Using a sample of 368,524 dwarf stars selected from Gaia DR3 as tracers, we establish the effective temperature Teff-intrinsic color relations to derive the intrinsic color indices and optical-mid-infrared (MIR) color excess (CE) for 20 bands.
Linear fits to the CE–CE diagrams provide color excess ratios (CERs), which are subsequently converted into relative extinction.
The resulting extinction curves for different environments exhibit steep slopes in the near-infrared (NIR) and flat profiles in the MIR. In the optical-NIR range, the Coalsack extinction law is consistent with R_V = 3.1, while in the MIR it follows R_V = 5.5 similar to the results of active star-forming clouds. At an angular resolution of 1.3', our extinction map reveals fine cloud structures. No correlation is found between R_V and E(B-V) for E(B-V) > 0.3 mag, implying a uniform optical extinction law in the Coalsack cloud. The derived average R_V value is 3.24 ± 0.32.