

Interstellar Extinction from Gaia XP Spectra: Probing the Dusty Interstellar Medium Towards Next-Generation 3D Maps

We present a methodology to estimate interstellar extinction from Gaia low-resolution XP spectra, designed to exploit current data products and scale to the upcoming Gaia DR4. Our approach extends the empirical intrinsic color–color relations of Lallement et al. (2019), which relied on broadband Gaia EDR3 and 2MASS photometry, by generating synthetic narrow-band photometry from XP spectra over the 400–1050 nm range. This extraction improves the treatment of magnitude trends and flux-uncertainty underestimation, enabling the construction of 44 intrinsic color–color relations, complemented by relations involving GRVS and 2MASS photometry when available.

The relations are modeled with B-splines and incorporate metallicity information from the GSP-Spec module, reducing systematic biases particularly for metal-poor stellar populations and improving precision and robustness compared to previous photometric approaches. Extinction is inferred assuming the mean Milky Way extinction law of Fitzpatrick et al. (2019), after recalibration of the NIR regime.

By relying primarily on XP spectra, the method enables extinction estimates for a large fraction of Gaia sources, making it well suited for statistical studies of stellar populations across a wide range of Galactic environments. Already applicable to current XP datasets, the method naturally scales to the significantly larger samples expected from Gaia DR4, paving the way for next-generation 3D maps of the Galactic dust distribution and contributing to our understanding of the dusty interstellar medium. Furthermore, the potential to derive reliable extinction estimates for individual open sources, makes it a valuable tool for various scientific applications, such as studies of open clusters.