Highlights of Astronomy, Volume 14
IAU XXVI General Assembly, 14-25 August 2006
Karel A. van der Hucht, ed.

doi:10.1017/S1743921307011945

Large surveys and determination of interstellar extinction

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The study of the spatial distribution of interstellar extinction, A_V, is important for many investigations of galactic and extragalactic objects. Three-dimensional (3D) extinction models have been produced using spectral and photometric stellar data, open cluster data, star counts, the Galactic dust distribution model.

The standard approach to construct a 3D extinction model has been to parcel out the sky in angular cells, each defined by boundaries in Galactic coordinates (l, b). From the stars in each cell, the visual extinction $A_V(l, b)$ can then be obtained as a function of distance $A_V(l, b, r)$. The angular size of the cells has varied from study to study, although each cell was generally chosen to be large enough to contain a statistically significant number of calibration stars at different distances. Published 3D models, using spectral and photometric data, are based on $104-105$ stars. Modern large surveys contain photometric (3 to 5 bands) data for $107-109$ stars. But to make that data useful for a 3D extinction model construction one needs to run a correct cross-identification of objects between surveys. Another problem is a lack of spectral data in photometric surveys.

Identification of objects requires the federation of multiple surveys obtained at different wavelengths and with different observational techniques. Such cross-matching of catalogs is currently laborious and time consuming. But using VO data access and cross-correlation technologies a search for counterparts in a subset of different catalogues can be carried out in a few minutes. Particularly, information on interstellar extinction may be obtained from modern large photometric surveys data.

The goal of our paper is to design a procedure for construction of 3D interstellar extinction model, based on data from large surveys. To test the procedure we have selected a two-arc-minute area on the sky with $l = 323$, $b = +6$. For further analysis the following multicolor surveys were chosen (photometric bands are given in brackets): DENIS (J, K'), 2MASS (J, H, Ks), USNO-B (SERC-J). Our two-arc-minute test area contains 134 objects cross-identified in all three surveys. For 36 of them all required photometry is available. We approximate our result by the relation: $A_V = 0.01|cosec6^o|[1 - exp(-0.008r|sin6^o|)]$. The uncertainty of A_V is about $0.^{\rm m}1$ depending primarily on the uncertainties of intrinsic colors. The relative error of the distance is about 25 %, depending primarily on the uncertainties of absolute magnitudes.

The proposed method has a number of advantages. One does not need for spectral type data and trigonometric parallaxes for calibration stars. One uses 104 - 106 times more stars than in 'traditional' models (it allows to choose angular cells on the sky small enough so that individual interstellar clouds can be resolved). 'On-line' model can be constructed to calculate $A_V(l, b, r)$ based on available data for a user defined area on the sky. When available, other multi-wavelength surveys like DPOSS, SDSS, UKIDSS can be incorporated using VO techniques.