A Sample of Dust Attenuation Laws for DES Galaxies

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Type Ia supernovae (SNe Ia) are useful distance indicators in cosmology, provided their luminosity has been standardized by applying some corrections[1]. One of the factors motivating these corrections is dust extinction, accounted for in the β color-luminosity relation of the standardization. This relation is assumed to be universal, which can introduce systematics into the standardization. The "mass-step" observed for SN Hubble residuals has been suggested as one such systematic[2].

In this work we seek to ascertain whether the “mass-step” is linked to host galaxy dust properties. As such, we propose an alternative approach to infer dust attenuation laws towards the host galaxies of 162 SNe Ia, from both global and local (4 kpc) photometry. Simple Stellar Population models are fitted to optical photometry obtained from the Dark Energy Survey and used to recover the relevant dust parameters..

We show dust properties vary greatly across different galaxies, meaning a universal SN Ia correction cannot be assumed. We find a relation between the attenuation slope and the optical depth, both locally and globally, best explained by varying star/dust geometry with galaxy orientation[3]. This relation is shown to be very different from the extinction found directly for SNe. Analyzing the Hubble residuals for the usual Tripp standardization[1], we find evidence for a two dimensional "dust-step". Although comparable with the traditional "mass-step" in terms of significance and magnitude, we find that the two are not completely analogous. Additionally, we study an alternative SNe Ia standardization, separating the intrinsic and extinction contributions in the color-luminosity correction, the latter being approximated by the host attenuation data previously obtained. The proposed alternative standardization proves a worse fit of the data, ending up exacerbating the "mass-step", instead of eliminating.

We conclude that the "mass-step" cannot be fully accounted for using only host galaxy dust data, either using an alternative SN standardization or a "dust-step" approach.

References

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