What can the interstellar extinction curves tell us about?

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Extinction curve is a powerful tool to investigate the chemical composition and size distribution of interstellar dust, and its understanding is essential for extracting the intrinsic spectral energy distribution of the observed objects. Furthermore, since the current properties of interstellar dust are end-products of various formation and destruction processes of dust in interstellar space (ref [1]), the extinction curve holds important clues to the origin and evolution history of interstellar dust. Motivated by these pieces of importance, many studies have invested great effort to find the interstellar dust model that can best reproduce the average extinction curve in our Galaxy (e.g., ref [2], [3], [4], [5], [6], [7]). However, despite the fact that there is a large variety on extinction curves depending on the lines of sight, it has not been systematically explored to what extent the properties of interstellar dust can be varied by the diversity of extinction curves

In this study, we aim to present the fundamental understanding about the possible variation of the chemical composition and size distribution of interstellar dust in the Milky Way. We first analyze a comprehensive data set of extinction curves by Fitzpatrick & Massa (2007, ref [8]) and compare it to the extinction curves derived from the CCM formula ([9]). We show that there is a difference in near-infrared extinction between the data of Fitzpatrick & Massa and the CCM curves, and point out that the average interstellar dust model constructed from the CCM extinction curve is not necessary conclusive. Then, assuming that the size distribution of dust follows power-law distributions, we probe its upper cut-off radius (a_{max}) and power-law slope (q) that can satisfy the ranges of interstellar extinction derived by Fitzpatrick & Massa. We find that (1) even if the observed variation of extinction curves is considered, the values of a_{max} and q are confined to the narrow ranges (0.2 μm < a_{max} < 0.4 μm, and -3 < q < -4), and (2) there is no combination of a_{max} and q that fulfill the CCM extinction curve as long as the power-law size distribution is assumed. We also discuss the properties of interstellar dust in the Small Magellanic Cloud obtained by using the same procedure as above.

References

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