A New Method to Probing the Dust Extinction law in M31

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Introduction

• Andromeda Galaxy: At a distance of ~780 kpc
• Review on research progress:
  - Top right: Bianchi et al. (1996) found that the extinction law in M31 shows a MW-type curve but with a weaker 2175 Å bump.
  - Top middle: Extinction curves in central region of M31 derived by Dong et al. (2014) are steeper than the average Galactic one.
  - Top left: The result of Clayton et al. (2015) shows similarity to those in the MW and the LMC. The figure is one result of his four samples.

Motivation

1. The extinction law of M31 is still unclear. Extinction curves with more bands and sightlines are needed;
2. Instead of adopting the FM parameterized extinction curves, we use theoretical extinction curves derived from dust model;
3. We aim to construct grids of model extinction curves to simplify the spectral comparison process.

Method

\[ f_\lambda = F_\lambda \theta_\lambda^2 10^{-0.4A_\lambda} \]

We construct a grid of 1080 model extinction curves of silicate–graphite grain model with KIM distribution:

- dn/da = n_v B(α) e^{-α/a_c} da
  - a: 0.005–5 μm
  - α: 0.5–4.0 with 0.1 steps
  - a_c: 0.01–0.3 with 0.01 steps
- Protosolar abundance (Asplund 09)
  - \( m_{\text{sil}} = 6258 \), \( m_{\text{gra}} = 2360 \) (50%)

Least square fitting method

\[ \chi^2 = \sum (\log(f_{\text{model}}) - \log(f_{\text{observed}}))^2 \]

Find the best model

Observed flux \( f_\lambda \)

Sample Results

J004412.17+413324
\( T_{\text{eff}} = 17400 \text{K} \)

\[ f_\lambda = F_\lambda \theta_\lambda^2 10^{-0.4A_\lambda} \]

F\_\lambda model  |  Tlusty  |  ATLAS9  
----------------|---------|---------|
Stellar Parameter  |  log \( g \) = 2.1 |  log \( g \) = 2.3  
Extinction Curve Parameter  |  \( \alpha = 1.2 \) |  \( \alpha = 1.0 \)  
|  \( a_c = 0.02 \) |  \( a_c = 0.02 \)  

Left: The extinction curves derived in this work look similar to Clayton’s result and to those in the MW and LMC.

Below left: Comparing our best-fitting model SED with Clayton’s.

Below right: Comparing our best-fitting model SED with observed SED.

Future works

1. Improve and enrich our grids of model extinction curves derived from dust model and extend them to other extinction works;
2. Perfect our spectral pair method;
3. Apply the method to more extinction tracers.

Reference