Starburst-Like Dust Extinction in the Small Magellanic Cloud

Gordon and Clayton 1998

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Stellar Populations

Why study UV extinction in SMC?

- UV dust extinction in Small Magellanic Cloud (SMC) similar to starburst galaxies.
- Starburst galaxies are the only galaxy type that have been detected from low to high z ($z > 2.5$)
  - Therefore, they probe galaxy formation through the study of their star formation and enrichment rates at different redshifts.
  - These rates are sensitive to adopted UV dust extinction
- Thus, the SMC can help us the physical processes responsible for starburst-like dust.

In this paper:

- This paper investigates 4 pairs of well matched reddened and un-reddened stars.
- They are trying to investigate how star formation activity affects dust properties.

Method: Star Matching

- Find two stars of the same temperature and luminosity, where one of them is reddened and the other is not.

- This study improves on previous work by having higher S/N spectra and better spectral matching in the pairs.

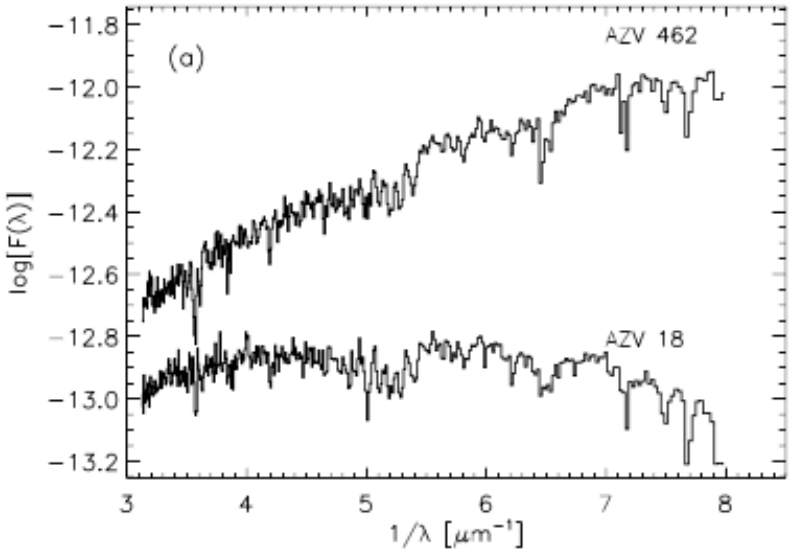
Fitzpatrick Criteria

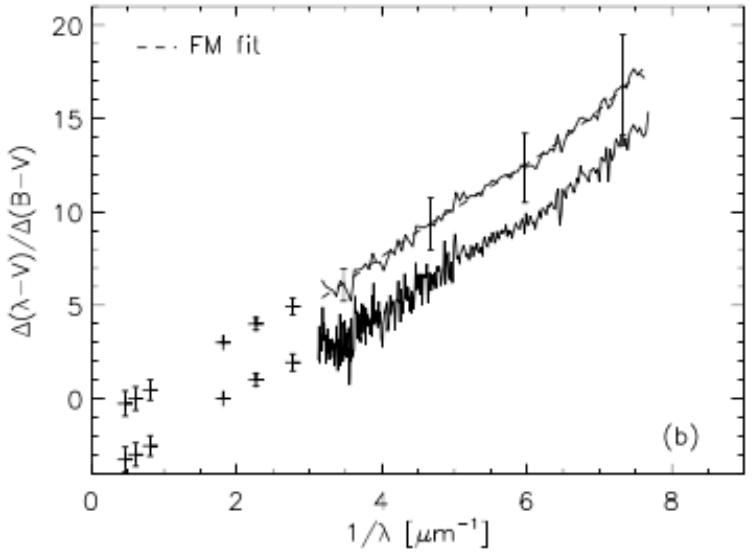
- Star pairs were searched for based on Fitzpatrick Criteria. (Fitzpatrick 1985)
- 1. Δ(U-B)/Δ(B-V) must have a value appropriate for reddening due to dust.
- 2. $\Delta V_0 < 0.8$ mag (difference between dereddened V magnitude of reddened star and V mag of comparison star)
- 3. Good luminosity and temperature match between detailed spectra of the two stars.
- Found 4 star pairs: 3 in SMC bar (high SF) and one in the SMC wing (less SF).

Calculating Extinction

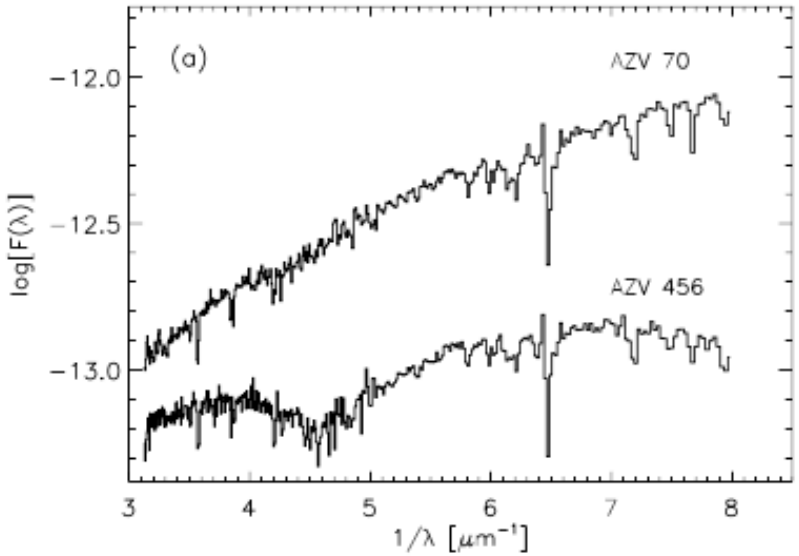
$$E(\lambda) = \frac{\Delta(\lambda - V)}{\Delta(B-V)} = \frac{m(\lambda - V)_r - m(\lambda - V)_c}{(B-V)_r - (B-V)_c}$$

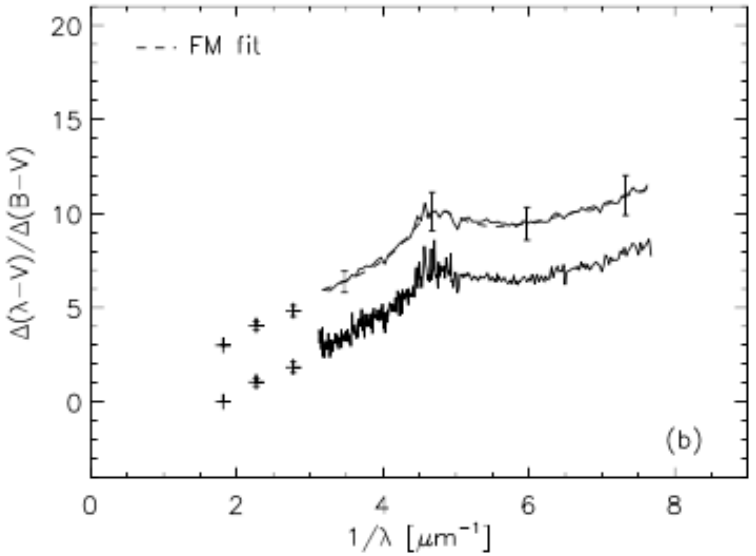
- Spectra extended from 1300-3200Å
- Extinction curves were fit with:
  - Linear term (slope, y-intercept)
  - A Lorentzian-like 'Drude' profile for the 2175 Å bump
  - Curvature term for far UV



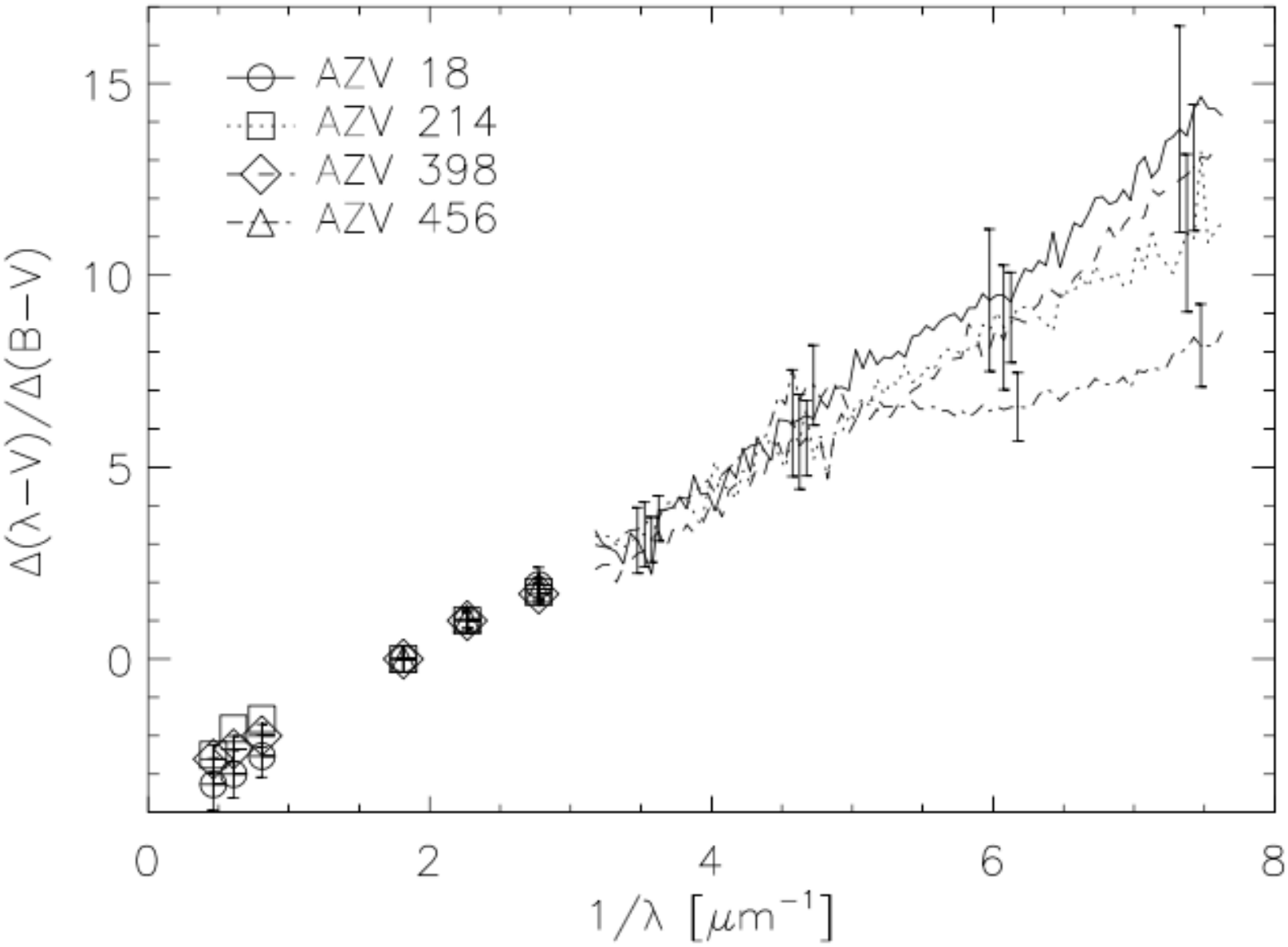


¾ stars: Roughly linear extinction curve (λ^{-1}), amplified extinction at far-UV. In high star forming region, looks like starburst galaxy extinction

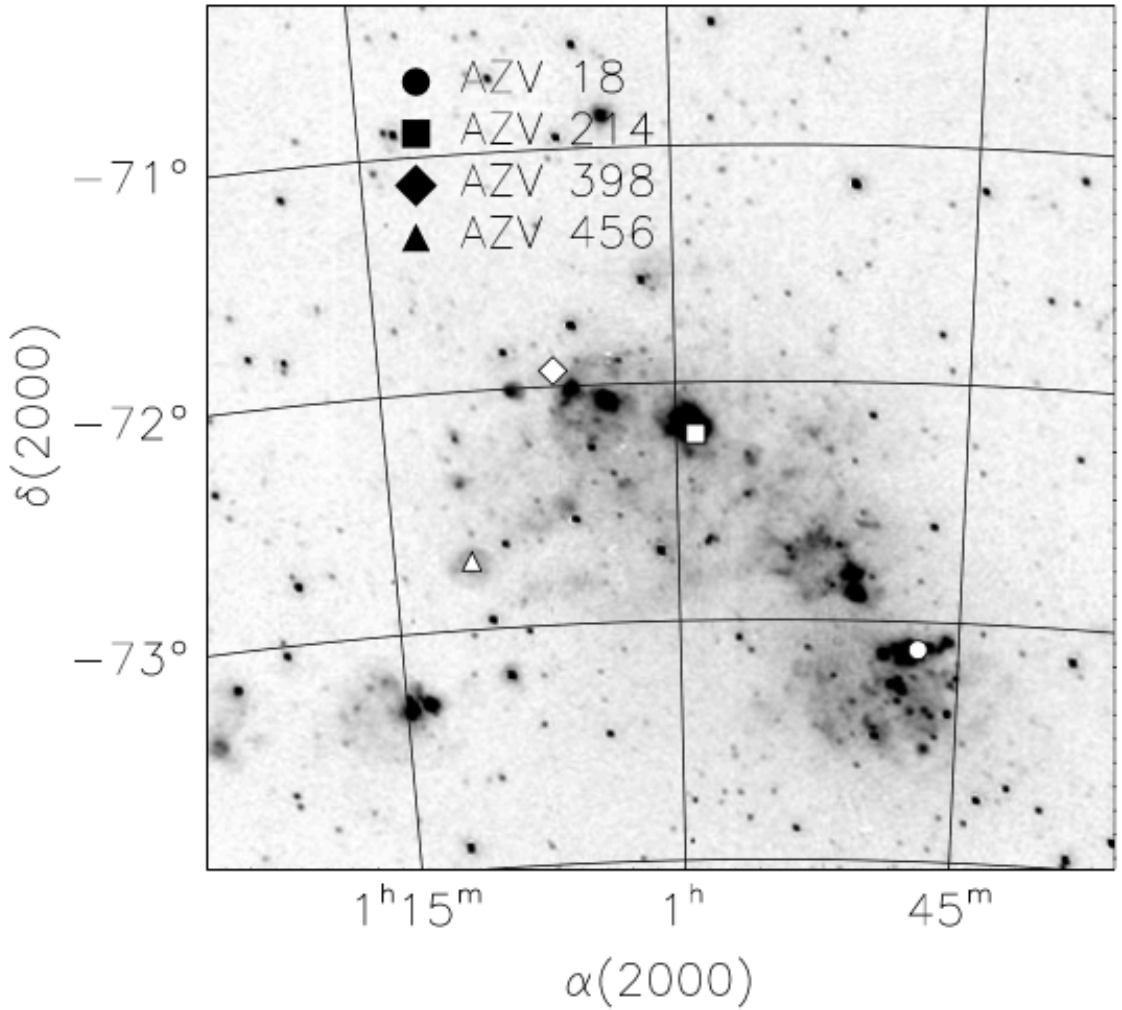




¼ stars: Extinction curve with 2175 Å bump and weaker far-UV rise. In a less intense star forming region, looks like MW extinction

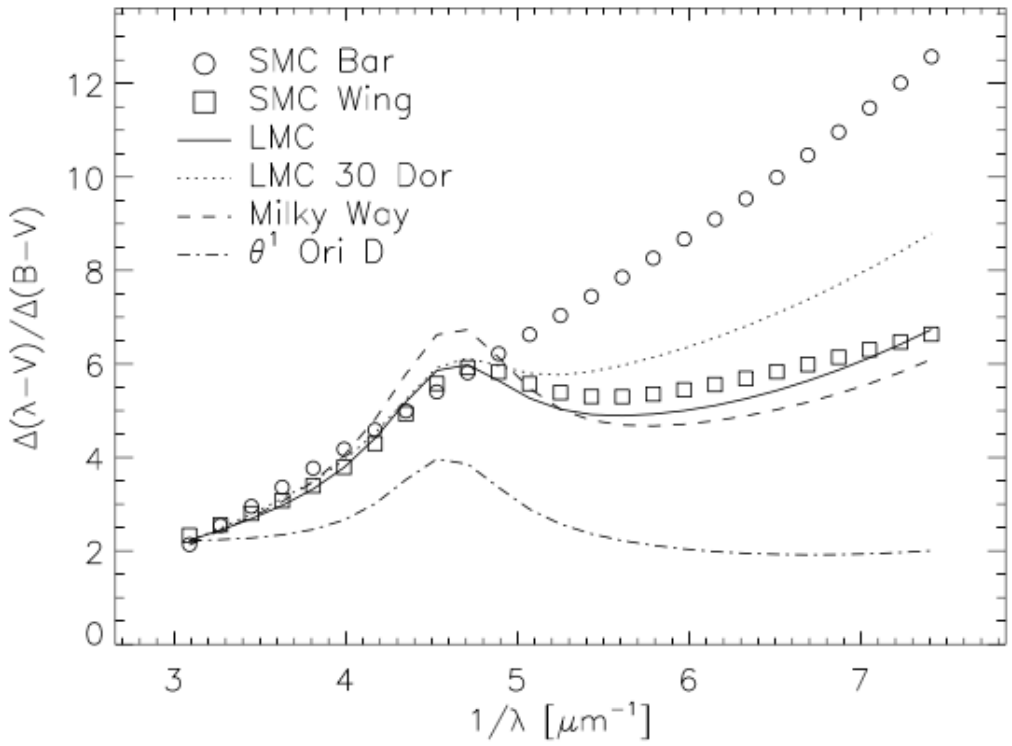

AZV 18
AZV 214
AZV 398
AZV 456
15
10
5
0
0
2
4
6
8
Δ(λ−V)/Δ(B−V)
1/λ [μm⁻¹]

What's causing the difference in extinction curves? Environment?



Stars on map of H α , which traces star formation activity.

Comparing Extinction Curves



- SMC Bar dust only observed elsewhere in starburst galaxies.
- Largest SF in SMC only 10% that of LMC 30 Dor- must be other factor affecting the extent to which SF can modify dust.

Metallicity?

- The metallicity of SMC is 0.6 dex lower than ISM (LMC is only 0.2 dex lower)
- Metallicity is correlated with dust-to-gas ratio: significantly less dust in SMC (compared to LMC)
  - This could affect the ability of dust grains in the SMC to shield themselves from radiation and shocks.

Summary

- Improved UV extinction curves for SMC
- Processing of dust near regions of star formation results in variations in UV extinction.
- No simple correlation between strength of variations and amount of star formation activity- other parameters like metallicity must play a role.
- Need more than only 4 reddened stars to learn more.

Any discussion of the behavior of the dust in the SMC based on only four extinction curves is obviously severely hampered by the small sample size. Yet, interesting trends