Optical and Mid-IR Interstellar Dust Extinction Observations Karl D. Gordon STScI, Baltimore, MD USA Dusting the Universe Tucson, AZ 4 Mar 2019

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### Near-IR for Near Future



"Have Dust – Will Study"

## Summary

- Spectroscopic diffuse ISM extinction measurements
  - Mid-IR and optical (joining UV)
- Silicate features 10 & 18 micron
  - Do not correlate w/ 2175 A or R(V)
- New optical features (4370, 4870, & 6300 A)
  - Two blue correlate w/ 2175 A
- NIR spectroscopic next
  - IRTF SpeX data in hand

## Why Extinction?

• Pillar in constraining dust grain properties



Weingartner & Draine (2003)

### Why Extinction?



Jones et al. (2013)





λ [µm]

#### **Mid-Infrared Extinction**

#### Past MIR measurements

- Selection (but representative)
- Usually high A(V) sightlines



# Spitzer program

- Two programs (PIs: Gordon & Misselt)
  - IRS spectra (5-40 um)
  - IRAC/IRS Blue/MIPS photometry (pesky slit losses)
- Classical pair method
- Stars with measured UV extinction curves
  - Compare with UV properties
- Spectral reduction challenging
  - Multiple techniques used  $\rightarrow$  convergence!

Gordon, Misselt et al. 2019, goal submission

### IR Spectra (standards)



# IR Spectra



### $E(\lambda - V)$ Curves



# $E(lambda-V) \rightarrow A(lambda)/A(V)$

- Usually done via ~1.1 E(K-V)
- More accuracy needed
- Fit Pei (1992) functional form











#### No Correlations(!)



## **Optical Extinction**

## Optical Extinction

- Spectroscopic!
- Hubble/STIS

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k(A-55)

- R(V) dependence
- Very Broad Structure



Fitzpatrick, Massa, Gordon, et al. 2019, almost submitted

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Inverse Wavelength  $(\mu m^{-1})$ 

#### Comparison to Previous (all from photometry)



#### 3 Drudes + polynomial



Massa, Fitzpatrick, Gordon, et al. 2019, almost submitted

#### **Near-Infrared Extinction**

## **NIR Extinction**

- Spectroscopic!
- NASA IRTF SpeX instrument
- Spectra taken, analysis soon
  - Publish before JWST launch



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#### Thanks

# Extinction (not Attenuation)

- Extinction
  - Absorption and scattering **out** of the line-of-sight
  - Specific to a point source behind a screen of dust
    - (not too near the point source)
- Attenuation includes information not present in extinction
  - scattering into the line-of-sight
  - Star/dust geometry
  - Applies to galaxies, regions of galaxies, stars with circumstellar dust

#### Simple Attenuation Example

