Dust attenuation in external galaxies

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Dust geometry in SFing galaxies

Star-forming regions + Birth clouds

- OB stars produce nebular emission lines
- dust opacity dominated by birth clouds
- predominantly (spherical) screen-like extinction
- T ~ TBirth Cloud

Intermediate-age stars

- mixed star-dust geometry
- attenuation primarily from diffuse ISM dust

- Old stars (also in bulge, not pictured) - predominantly responsible for NIR light
 - higher fraction in bulge and/or thick disk

Inclination

increases

Diffuse dust

- Birth-cloud dust

remains constant

- screen-like extinction (far-side)
- no attenuation (near-side)
- observe extinction law in NIR (τ ~ τ_{ext})
- Diffuse ISM dust (with radial gradient)

 - τ ~ τ_{ISM}

When do we need to measure dust attenuation?

- To measure many key physical properties from a galaxy spectrum/SED.
 - Star formation rates
 - From emission lines
 - From optical-UV continuum
 - Star formation histories
 - Stellar masses (stellar population models better in optical than NIR)
 - Mass functions
- To make mock observations from galaxy evolution models
 - •e.g. luminosity functions

Usual procedure

Choose a dust curve (i.e. attenuation as fn. wavelength)

- Calzetti
 - derived from 40 local starburst galaxies
 - tells us about attenuation of light from OB stars
- MW/LMC/SMC
 - Extinction laws, i.e. a dust "screen"
- Something else
 - **-** e.g. λ^{-0.7}
- Estimate an amplitude
 - Balmer decrement (correct for τ_{line}/τ_{continuum})
 - Model fitting to multiwavelength SEDs

Measuring dust laws

+ MW/SMC/LMC

- Colour difference technique
- 2 stars of same type, different intervening dust columns
- Divide SEDs

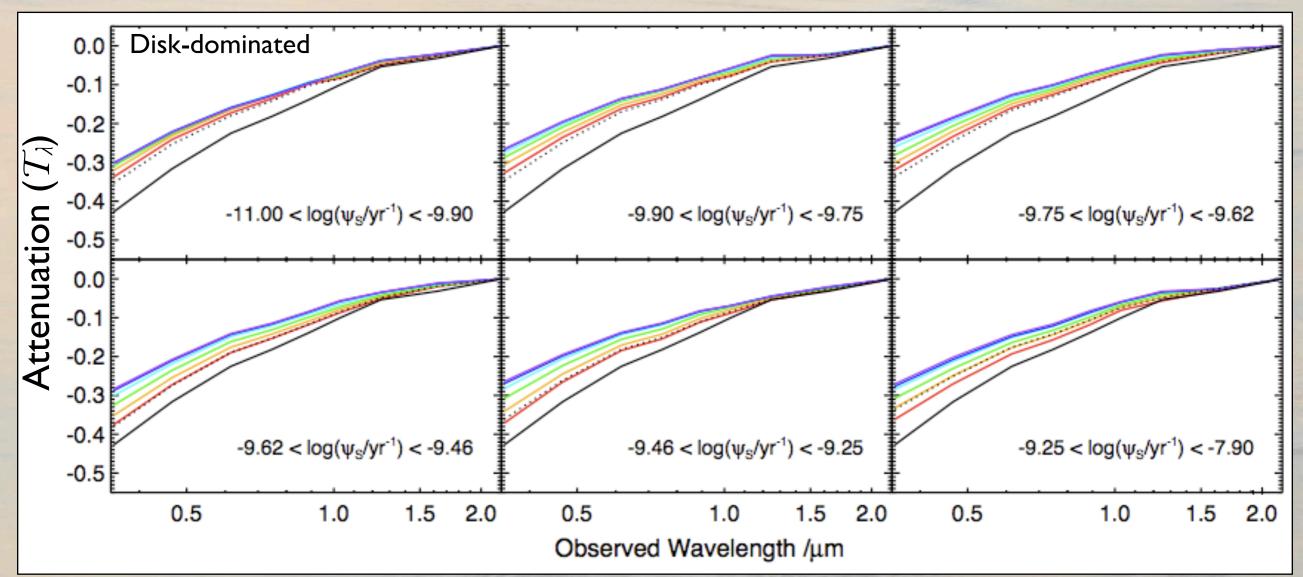
+ Calzetti

- Same idea, but using stacks of starburst spectra
- Starburst galaxies easiest type (homogeneous SEDs)

♦ Wild et al. 2011b

- Same idea, but use 23,000 SEDs to find close SED matches
- Ordinary SFing galaxies, and as function galaxy properties
- With spectra to measure absolute dust content

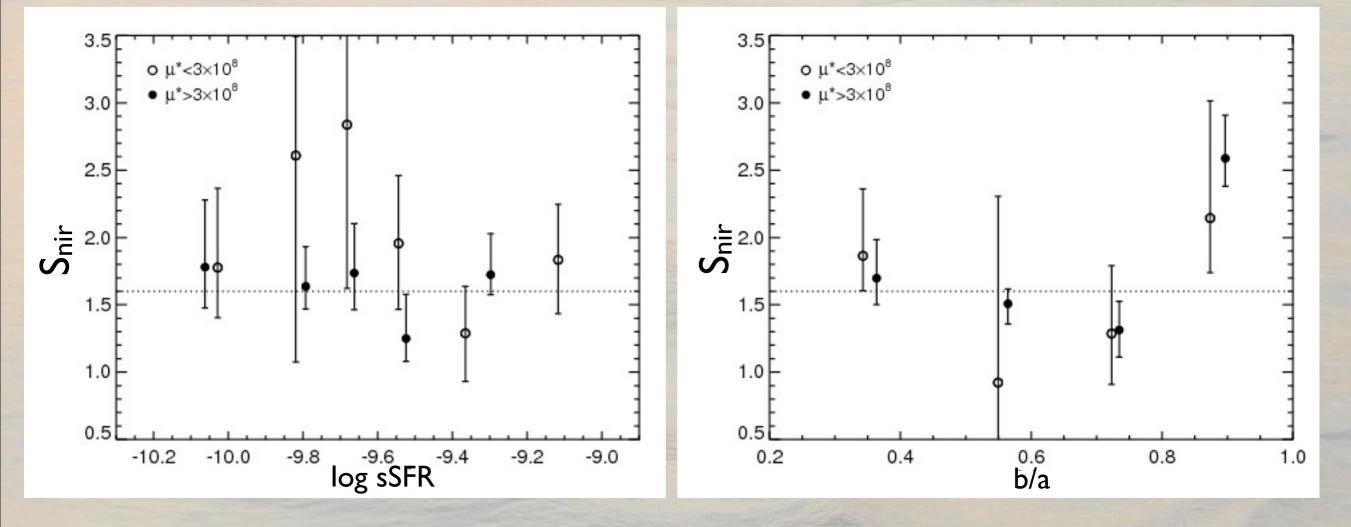
Results: Attenuation curves



25% R_{pet} 35% R_{pet} 50% R_{pet} 70% R_{pet} 90% R_{pet}

Matched (physical) apertures, relative to each galaxy's Petrosian radius in r-band

The importance of the NIR



A universal NIR slope

- Also invariant along different lines-of-sight in the MW
- Large dust grain properties are invariant with environment and galaxy properties
- Global geometric effects unimportant in the NIR

Dust attenuation curves for SFing galaxies

- Provide dust attenuation curves for use with "normal" galaxies
- Measure how dust attenuation curve shape changes with galaxy properties
 - Measure slopes over key wavelength regions
- Radial gradients as function of galaxy properties
 - Compare amplitudes of curves
- Variation of 2175A dust bump strength with galaxy properties
 - Using GALEX bands
- Line vs. continuum dust as a function of galaxy properties
 - For 3" apertures, compare with Balmer decrement

See Wild et al. 2011b, MNRAS, 417, 1760