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Advances in Theoretical Cosmology in Light of Data
July 19

HI emission as a tracer of interstellar reddening

in collaboration with B. Hensley & O. Doré

arXiv:1706.00011
Which foregrounds do we care about?

"(...) the name of the game is component separation, not noise reduction"

H.K. Eriksen

- Dust and synchrotron foregrounds in CMB data
- De-lensing of CMB data for primordial gravitational waves
- CIB measurements
- Extinction for cosmological galaxy surveys
Reddening
E(B-V)

- $E(B-V) = \text{Extinction in B band} - \text{Extinction in V band}$
- More dust $\Rightarrow$ larger $E(B-V)$
- $E(B-V)$ maps **essential for correcting observations for Galactic reddening**
Mapping E(B-V): Direct approach

- Find many sources with known spectrum (e.g. stars, passive galaxies)
- Measure spectra, attribute differences to dust
- E.g. Schlafly+ 2014 used 500 million stars from Pan-STARRS to measure reddening to 4.5 kpc

- Direct measurements are hard!
- Photometric/spectroscopic errors
- Ensuring sources lie behind full dust column
- Ensuring adequate number of sources have been measured
Dust emission as measure of E(B-V)

- E(B-V) is proportional to the dust column, so can convert dust column tracer to E(B-V)
- SFD used dust emission from IRAS to derive a calibration factor from FIR emission to E(B-V)
- Full-sky, high sensitivity measurements

Reddening map of Schlegel, Finkbeiner, and Davis (1998)
The SFD reddening map

- Requires a temperature correction to go from dust emission to a dust column density
- FIR emission may have contributions from Zodiacal Light and unresolved galaxies

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References in the article
Citations to the Article (10169) (Citation History)
Refereed Citations to the Article
SIMBAD Objects (57)
Also-Read Articles (Reads History)
HEP/Spires Information

Translate This Page

Title: Maps of Dust Infrared Emission for Use in Estimation of Reddening
Authors: Schlegel, David J.; Finkbeiner, Douglas P.; Davis, Marc

Reddening map of Schlegel, Finkbeiner, and Davis (1998)
HI emission as basis for E(B-V)

- Gas and dust are well-coupled in the ISM
- Perform an SFD-like analysis to convert HI emission to E(B-V)
- Resulting maps free from errors due to dust temperature, Zodi, and extragalactic emission
- Limited by non-HI gas along the line of sight
HI4PI Survey

- Merges data from Effelsberg and Parkes
- Replaces LAB as state-of-the-art full-sky HI survey
- Higher sensitivity & resolution, fewer systematics, full sampling

HI4PI collaboration (2017)
The E(B-V)/N_{HI} ratio

Pan-STARRS E(B-V), Schlafly+ (2014)

Star-based

\[ E(B-V) \text{ [mag]} = 1.216^{+0.009}_{-0.009} \times N_{HI} \text{ [10}^{22} \text{ cm}^{-2}] + 0.015^{+0.0009}_{-0.0002} \]
\[ \sigma \text{ [mag]} = 0.02406^{+0.00006}_{-0.00006} \]

Dust-based

\[ E(B-V) \text{ [mag]} = 1.113^{+0.002}_{-0.002} \times N_{HI} \text{ [10}^{22} \text{ cm}^{-2}] + 0.0006^{+0.0001}_{-0.0001} \]
\[ \sigma \text{ [mag]} = 0.00570^{+0.00001}_{-0.00001} \]
The \( \frac{E(B-V)}{N_{HI}} \) ratio

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Dust-based

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\sigma \text{ [mag]} = 0.00570 \pm 0.00001
\]

Pan-STARRS E(B-V), Schlafly+ (2014)

SFD E(B-V)
The E(B-V) map

40% sky coverage, 16.1' resolution

Lenz, Hensley, Doré (2017, submitted)
Dust systematics

- Peek & Graves (2010) used SDSS passively evolving galaxies as "standard crayons"
- Correction to the SFD map at 4.5 deg
Dust systematics

Based on extragalactic sources

Based on galactic HI
HI systematics

Investigate systematics due to complex ISM physics
Model extensions

- Several large-scale data sets available, all of which do not significantly improve the model.
- A future work would need to combine multiphase gaseous data, FIR dust data, and Pan-STARRS/Gaia data.
When and why to use this extinction map

- New HI based extinction map
- In line with independent corrections, but much higher resolution and better sky coverage
- Yahata+ (2007) find correlation of SFD with large-scale structure
- For high latitudes, our map overcomes many of the SFD problems and is much more sensitive than stellar data-based E(B-V) maps