Daniel Lenz

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

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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)

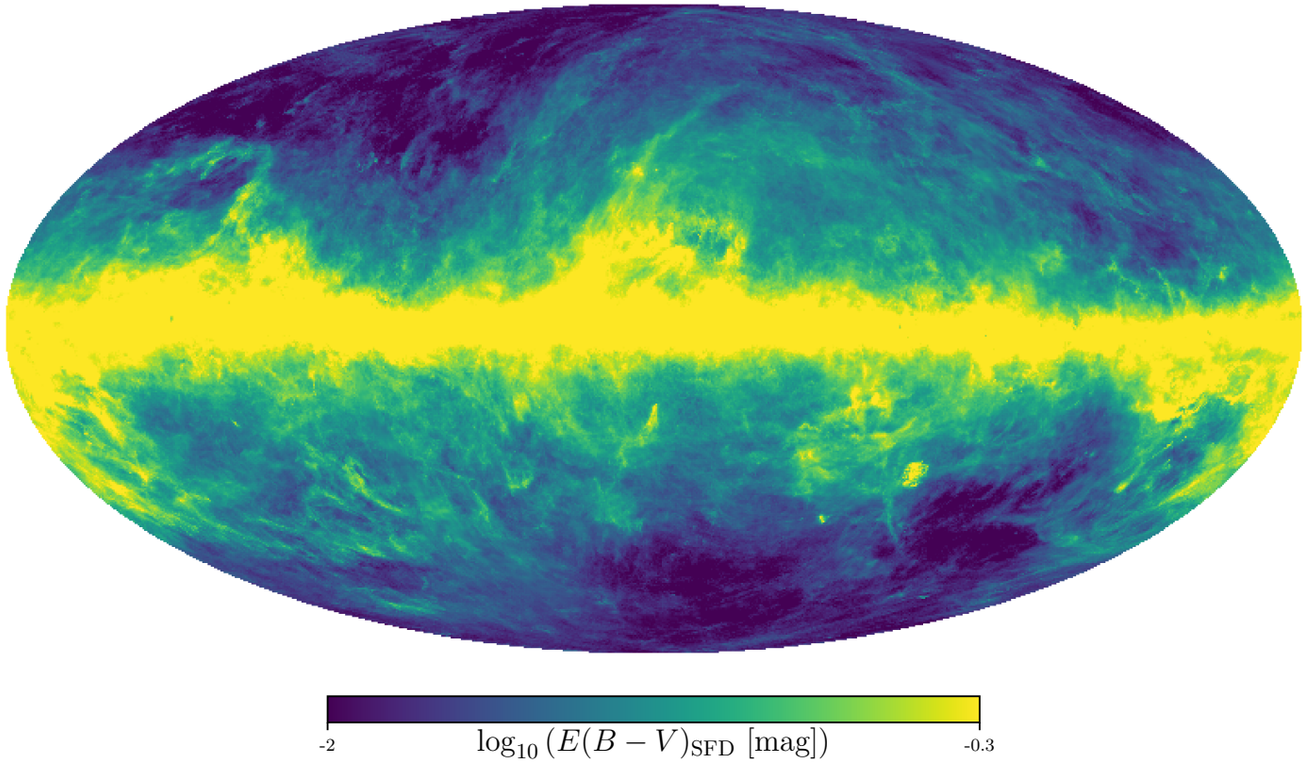
- E(B-V) = Extinction in B band - Extinction in V band
- More dust => larger E(B-V)
- E(B-V) maps **essential for correcting observations for Galactic reddening**

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)

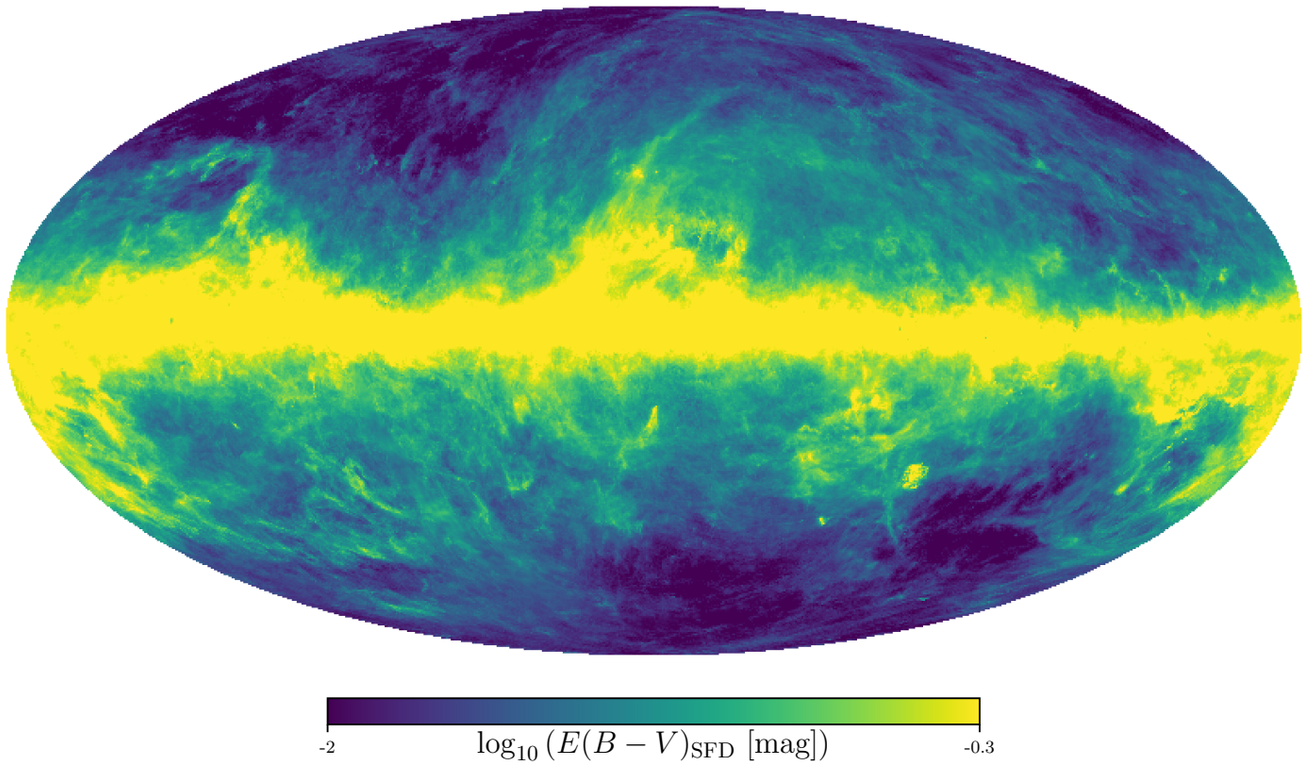
- E(B-V) is proportional to the dust column, so can convert dust column tracer to E(B-V)
- SFD used dust emission from IRAS to derive a calibration factor from FIR emission to E(B-V)
- Full-sky, high sensitivity measurements



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



Reddening map of Schlegel, Finkbeiner, and Davis (1998)

The SFD reddening map

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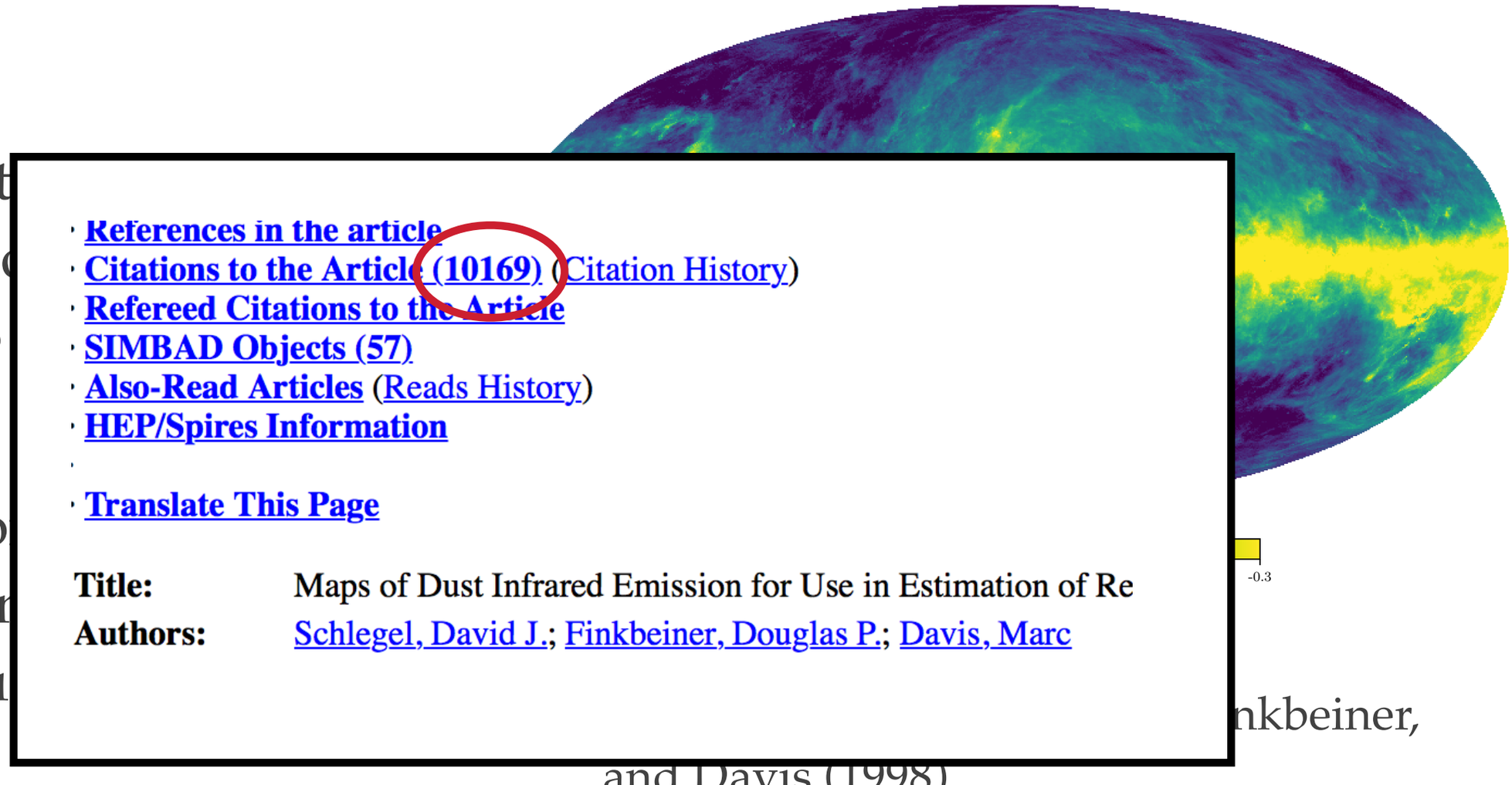
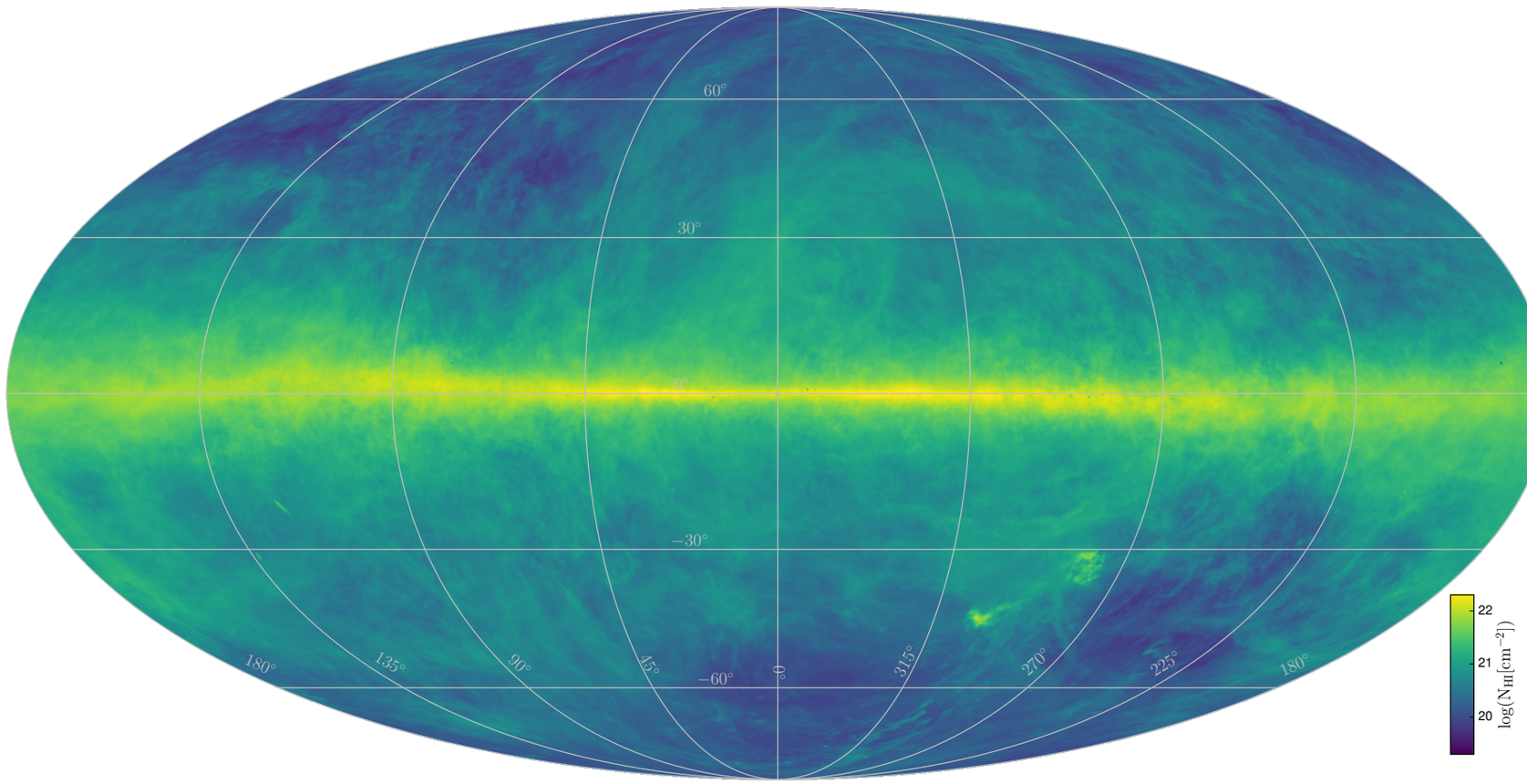


nkbeiner,
and Davis (1998)

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



HI4PI collaboration (2017)

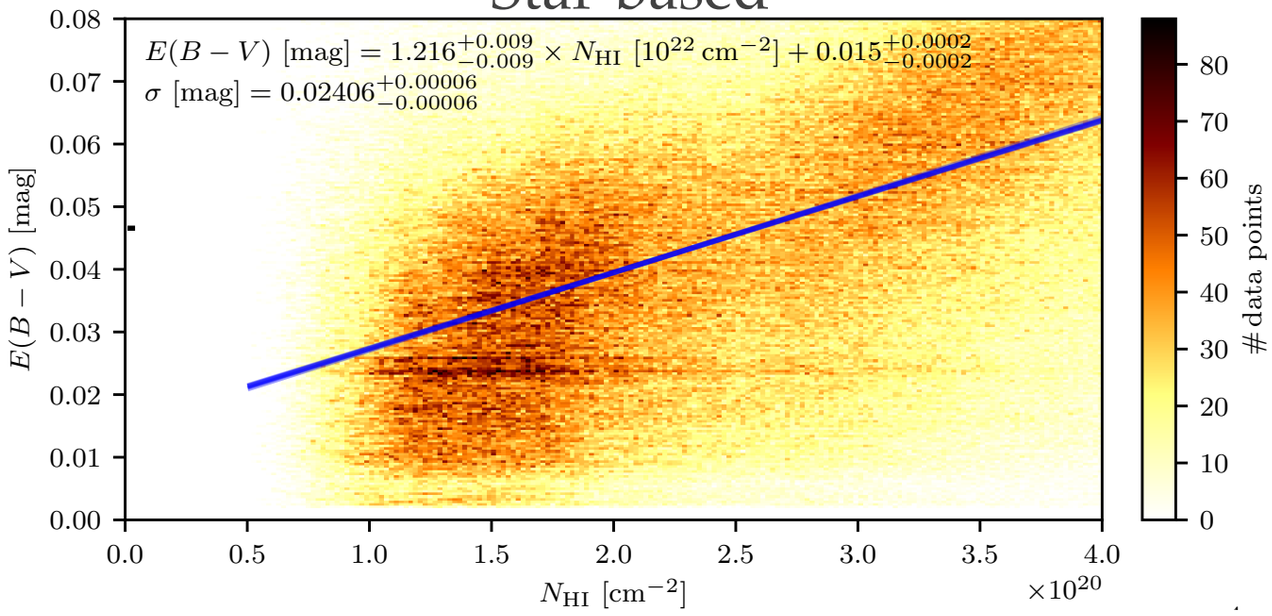
- Merges data from Effelsberg and Parkes
- Replaces LAB as state-of-the-art full-sky HI survey
- Higher sensitivity & resolution, fewer systematics, full sampling

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

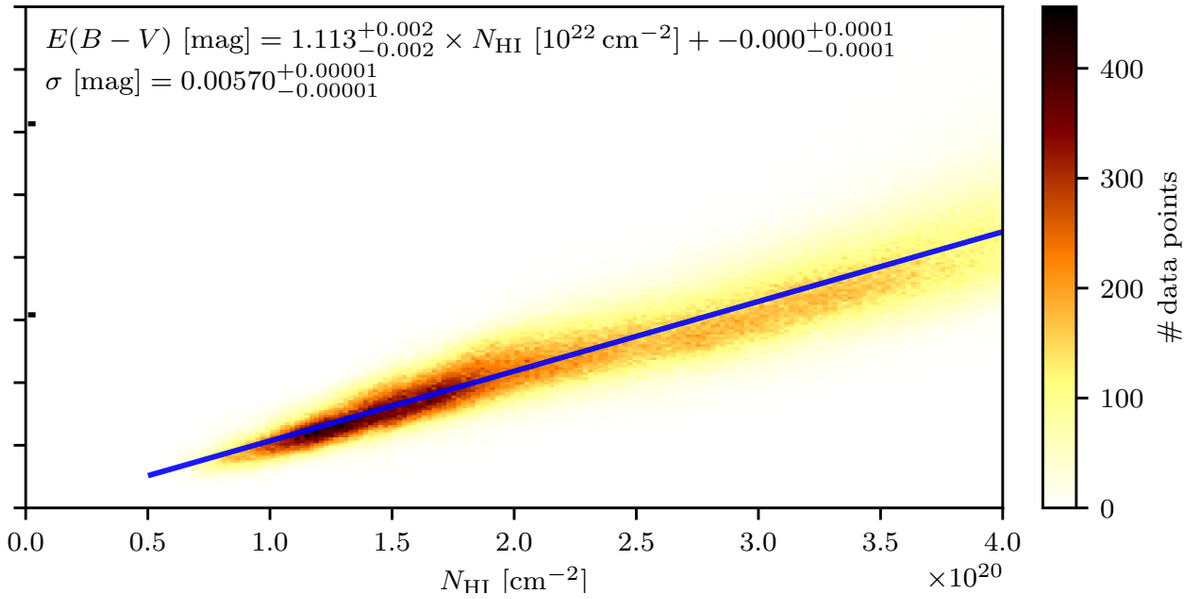
Pan-STARRS E(B-V), Schlafly+ (2014)

SFD E(B-V)

Star-based



Dust-based



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

SFD E(B-V)

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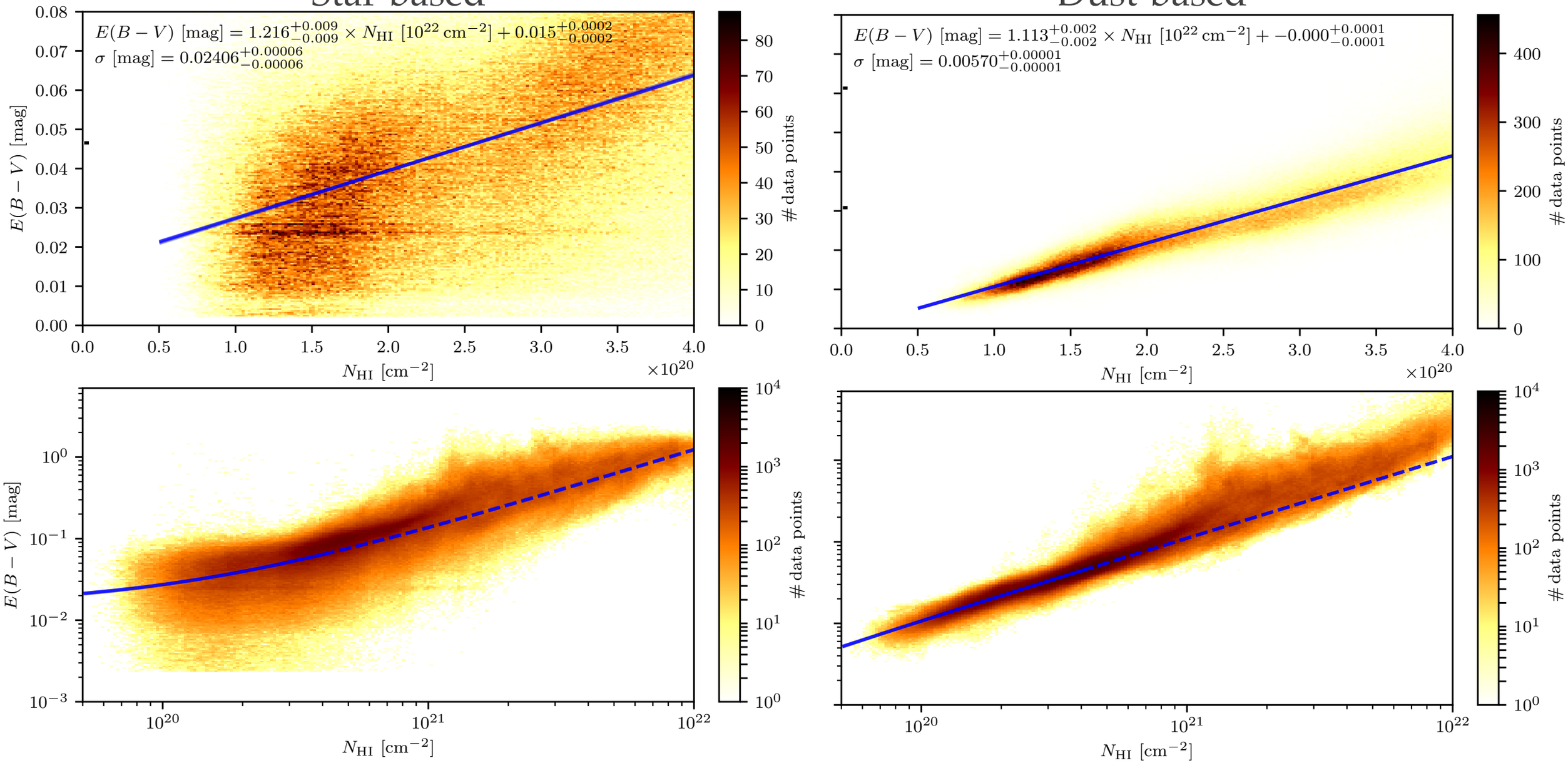
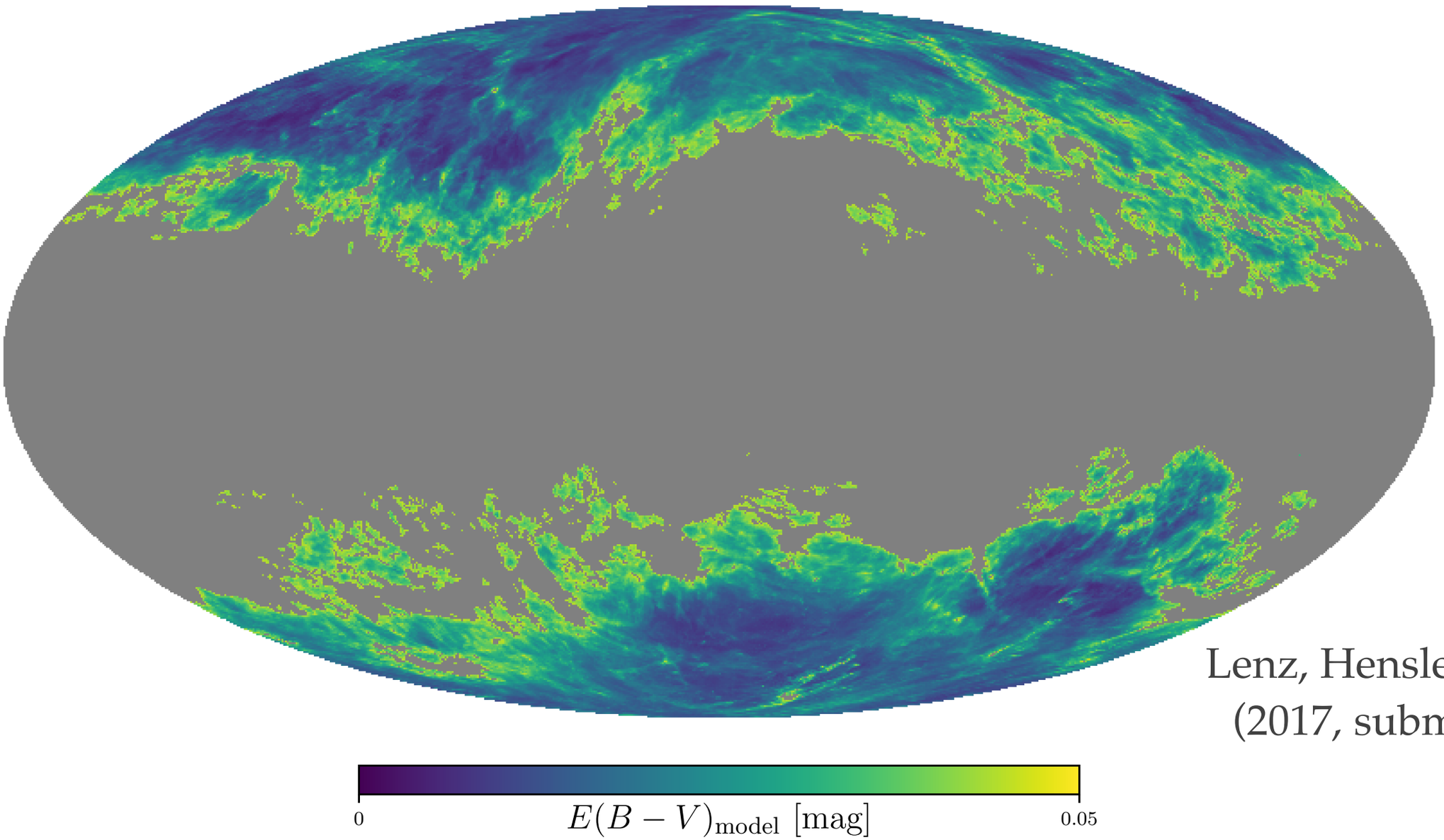


The E(B-V) map

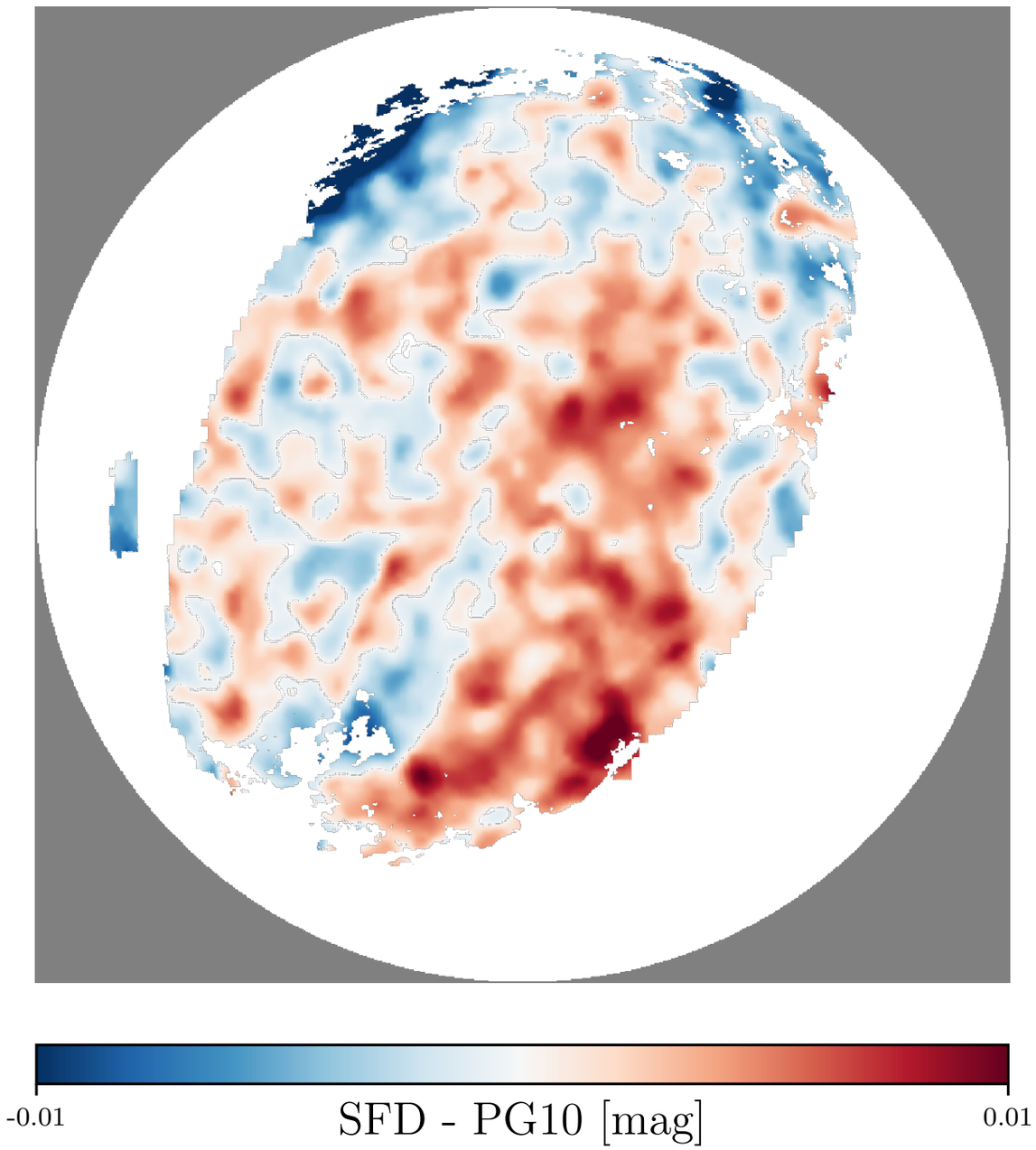


Lenz, Hensley, Doré
(2017, submitted)

40% sky coverage, 16.1’ resolution

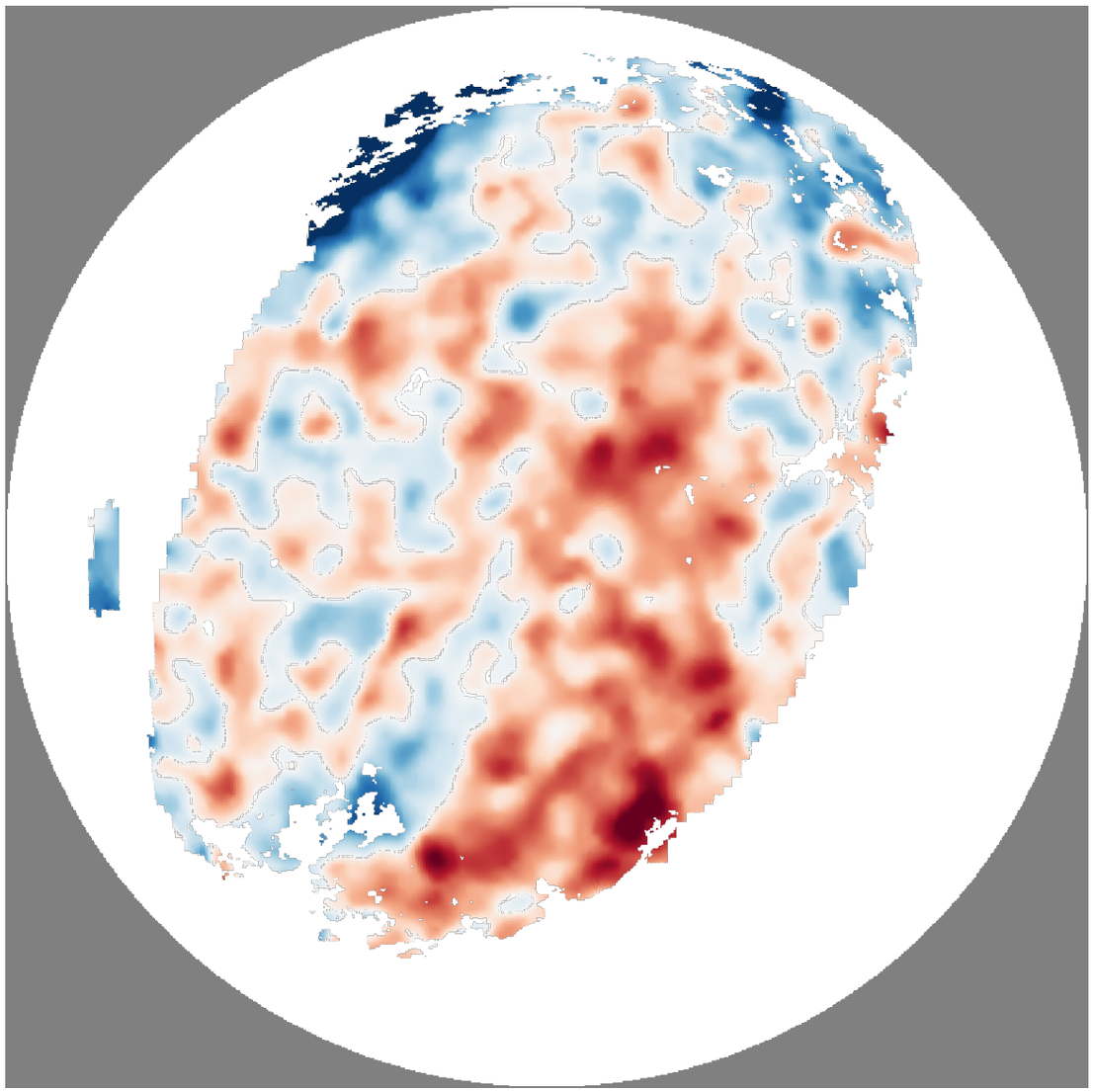
Dust systematics

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



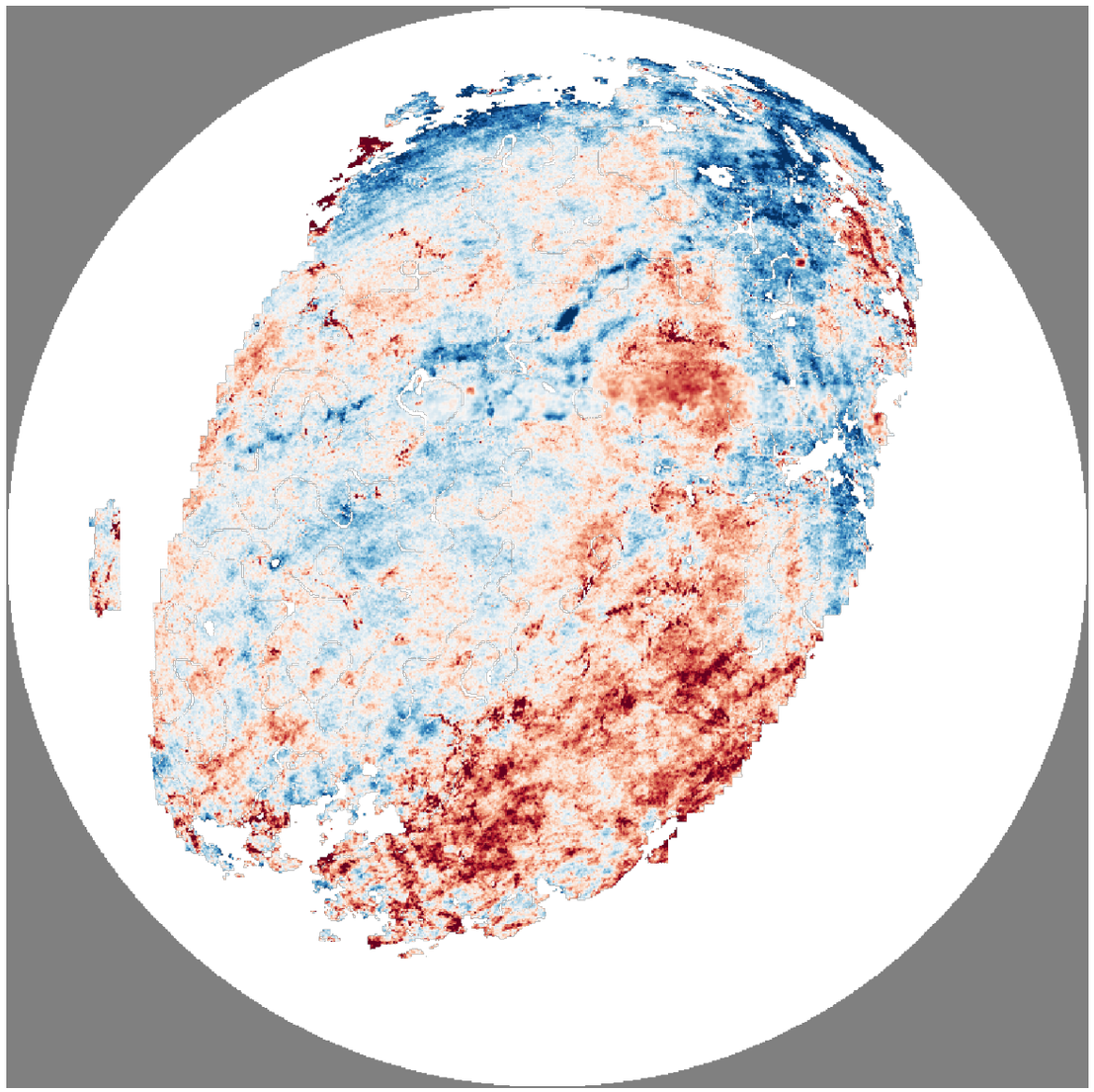
Dust systematics

Based on extragalactic sources



-0.01 SFD - PG10 [mag] 0.01

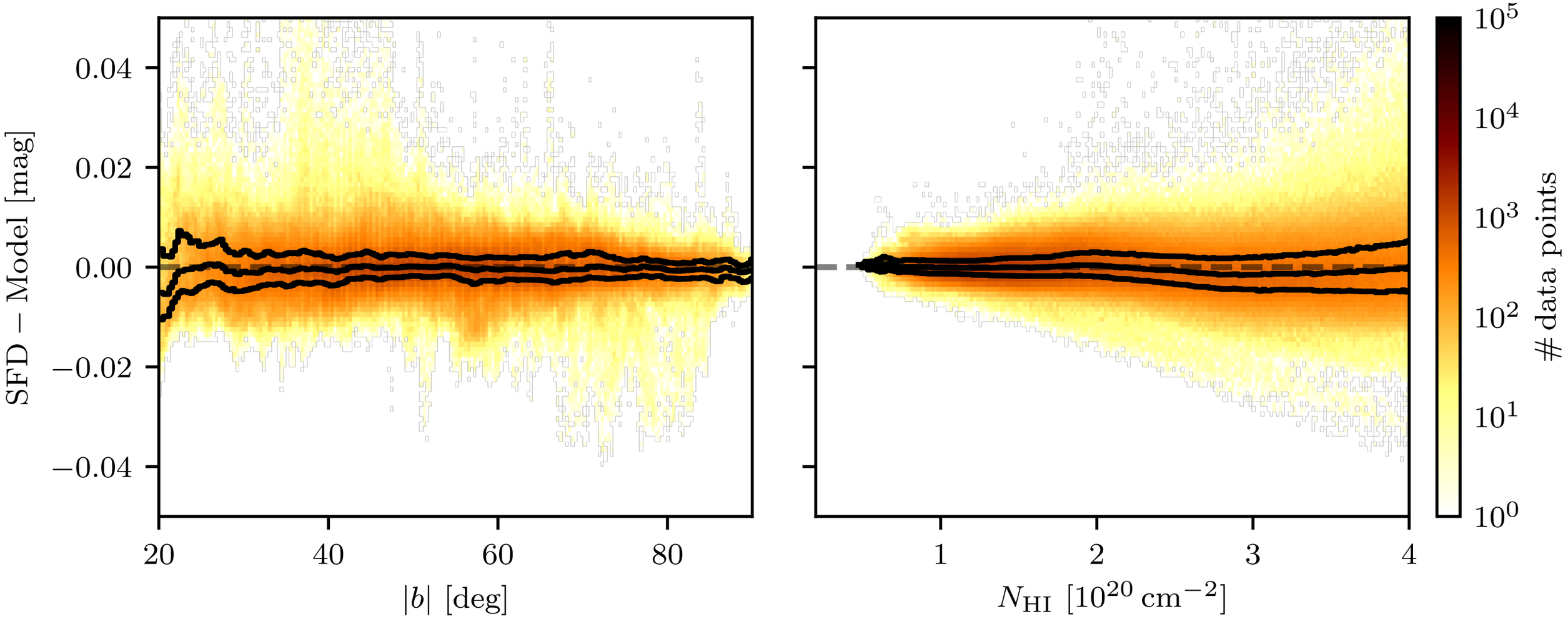
Based on galactic HI



-0.01 SFD - Model [mag] 0.01

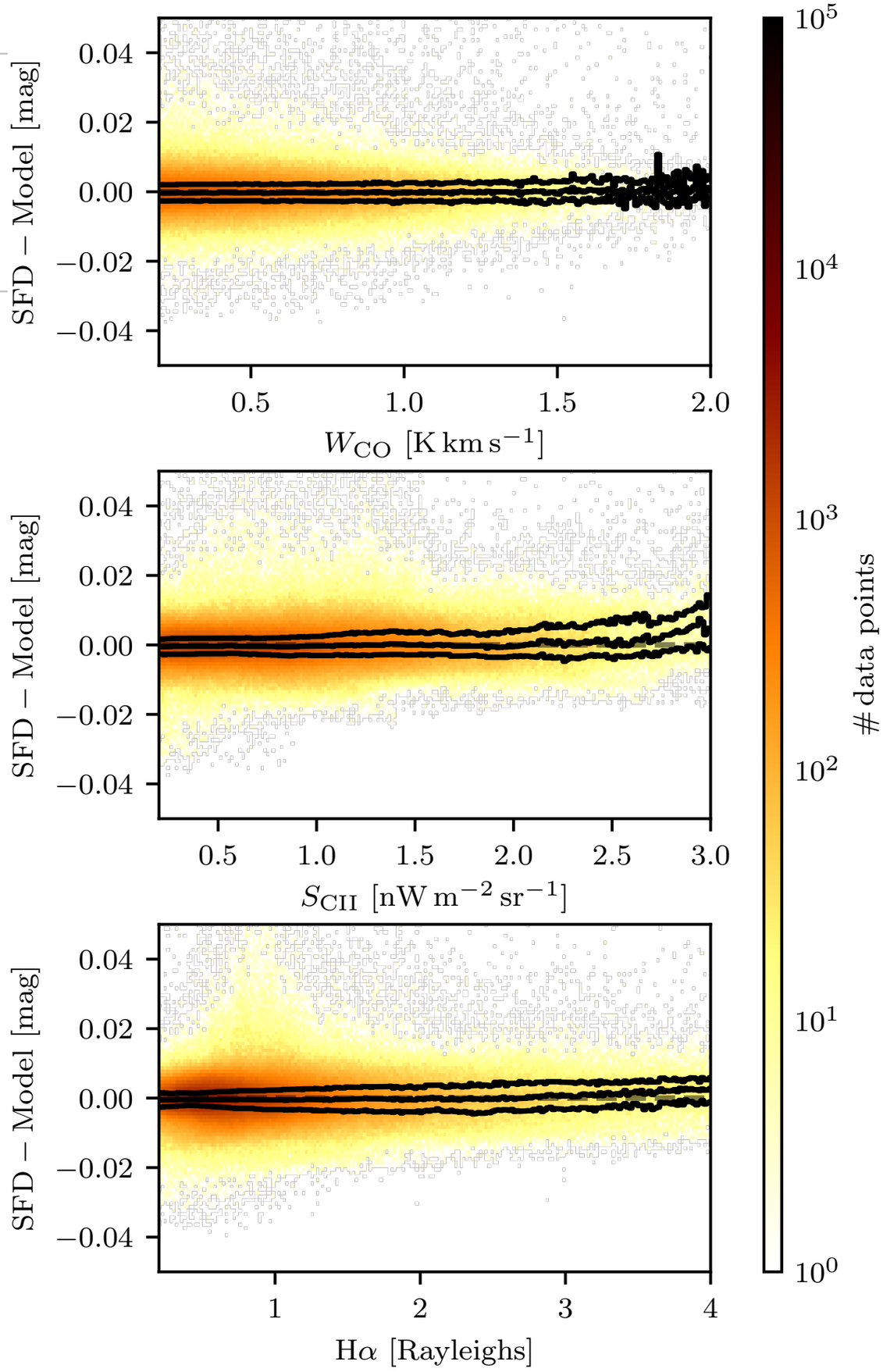
HI systematics

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