EMU/GAMA: Understanding the link between dust geometry and star formation rate in galaxies

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Galaxy Star Formation Tracers

- Star formation rate: SFR
- Hα: 656nm
  - first and strongest of the spectral lines in the Balmer series of atomic Hydrogen
  - Traces ionized atomic hydrogen →star formation
  - Dust is optically thick to Hα
- Radio:
  - Insensitive to dust
  - Good starting point for SFR tracing



M51: S. Beckwith (STScI) Hubble Heritage Team , (STScI/ AURA), ESA , NASA

Balmer Decrement (BD)

- Measurement of HII dust attenuation:
  - wavelength-dependent effects of dust on incident light – absorption and scattering

- Doesn’t account for optically thick dust regions that block all Hα

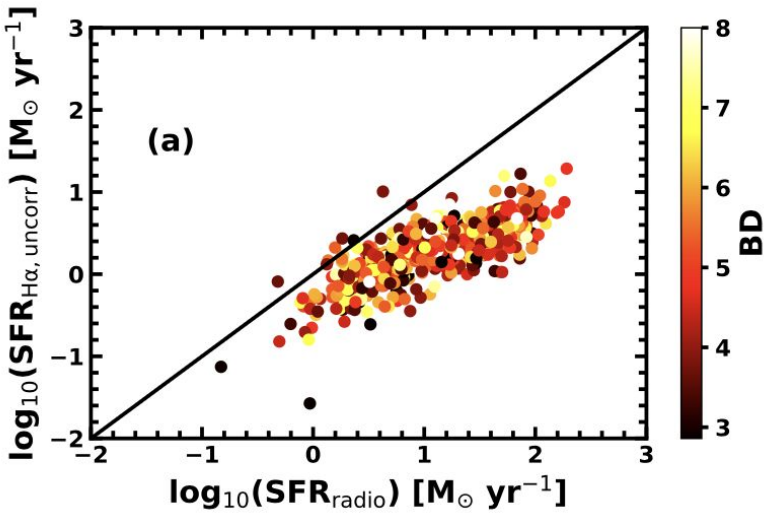
- How to make corrections that account for these thicker regions?

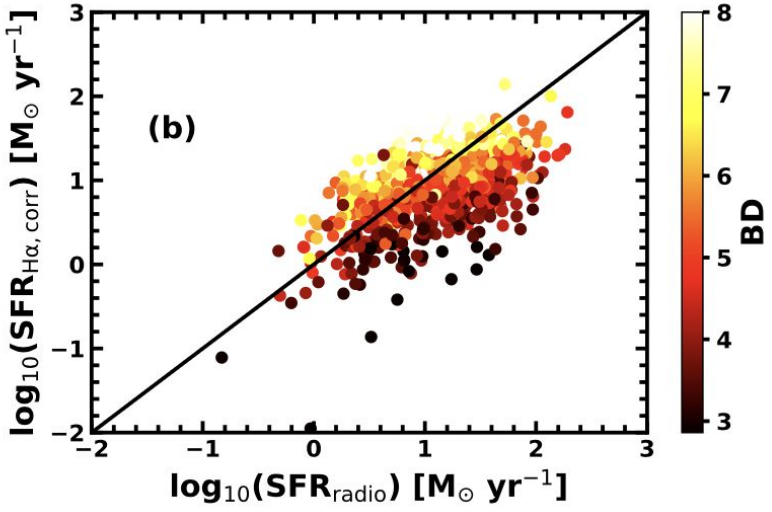
Sample: GAMA and EMU

- 3 main multi-wavelength surveys
  - Galaxy and Mass Assembly survey (GAMA)
  - Kilo-Degree survey (KiDS)
  - VISTA Kilo-degree INfrared Galaxy survey (VIKING)
- Evolutionary Map of the Universe (EMU)
  - Radio data
- SEDs were fit to the GAMA data (FUV-FIR)
  - Obtained stellar mass M*, dust mass M_d
- Limits applied:
  - $0<z<0.345$
  - Several quality flags (redshift, SNR, emission line detection, etc),
  - Star-forming galaxies with no AGN
  - Lower M* limit

$SFR_{H\alpha}$ vs. SFR_{radio}

- Top plot: no BD correction
  - $SFR_{H\alpha}$ is consistently too low – caused by dust
- Bottom plot: w/ BD correction
  - High BD → $SFR_{H\alpha}$ raised more
  - Still not quite 1-to-1
  - BD corrections aren't sufficient, especially for higher SFR
- Obvious need for a better SFR-correction method

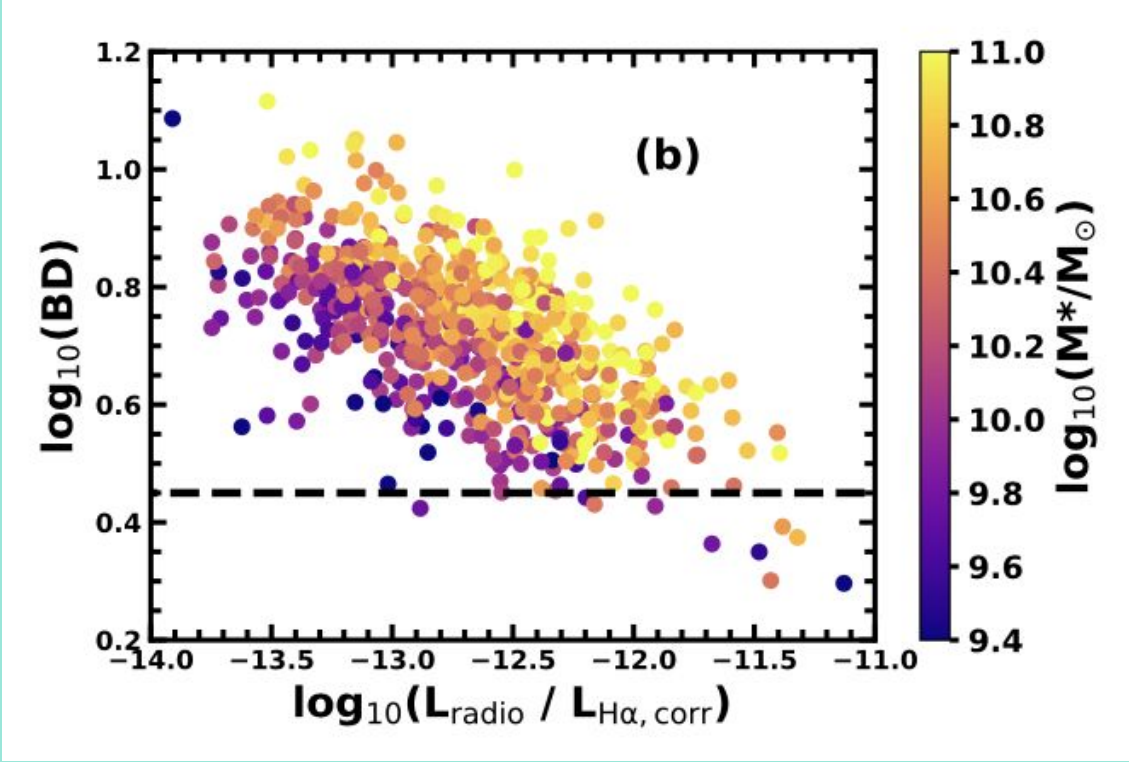




BD, Hα Deficit, and M*

- Hα deficit = $\log(L_{radio}/L_{H\alpha,\,corr})$
- high BD values significantly increasing the Hα, which shifts the Hα deficit to the left
- High BD increases $L_{H\alpha,\,corr}$

  → smaller Hα deficit
- M* dependence → there is a parameter relying on BD and M* correlating with Hα deficit



The New Dust Parameter: H_{dust}

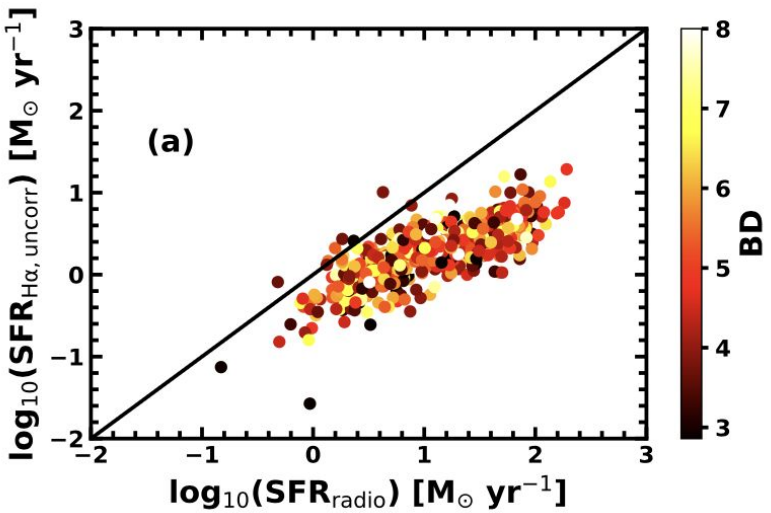
- Neither BD or M_d entirely account for effects of dust
  - BD doesn't account for thick dust regions blocking all Hα
  - M_d doesn't account for extent of dust attenuation

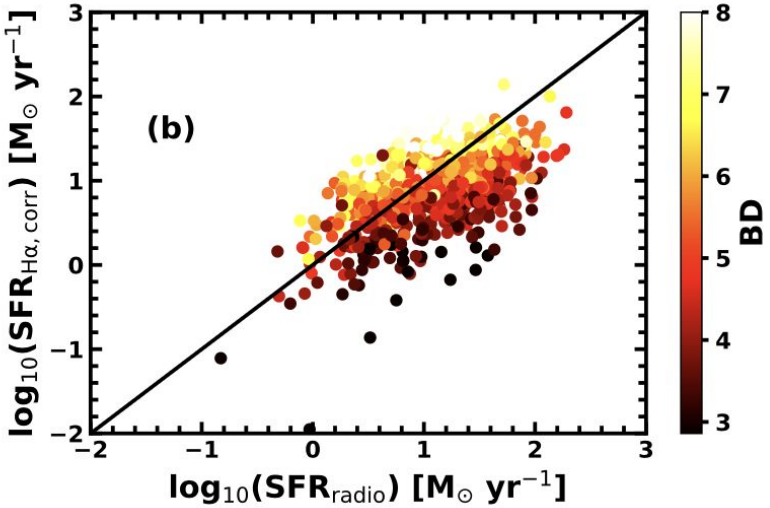
- H_{dust} combines the two previous dust parameters: BD and M_d

- Incorporates optical depth of dust regions

- Linearly related to Hα deficit, and only needs Hα, BD, and M_d → easier to make $L_{H\alpha}$ corrections, even on a large scale

$$H_{\text{dust}} = \frac{M_d}{10^{\tau_B^l}} = 10^{1.0578} \frac{M_d}{\text{BD}^{2.303}}$$





Proven to be a simple and effective method of correction!

