Astro 250: Extragalactic Stellar Population

High-Mass IMF variations from Integrated Light:

Observation:

Hα tends to under predict the total SFR relative to the FUV in dwarf galaxies。

- **Lee et al. 2009:**

Stellar IMF is deficient in high-mass stars in dwarf galaxies.

- **Fumagalli et al. 2011:**

Joint probability of the SFR, CMF(cluster mass function) and universal IMF.

Varying IMF is inconsistent with the observation

Presented by Siyao Jia (Lucy)
9/26/2016

Measure SFR down to ultra-low activities

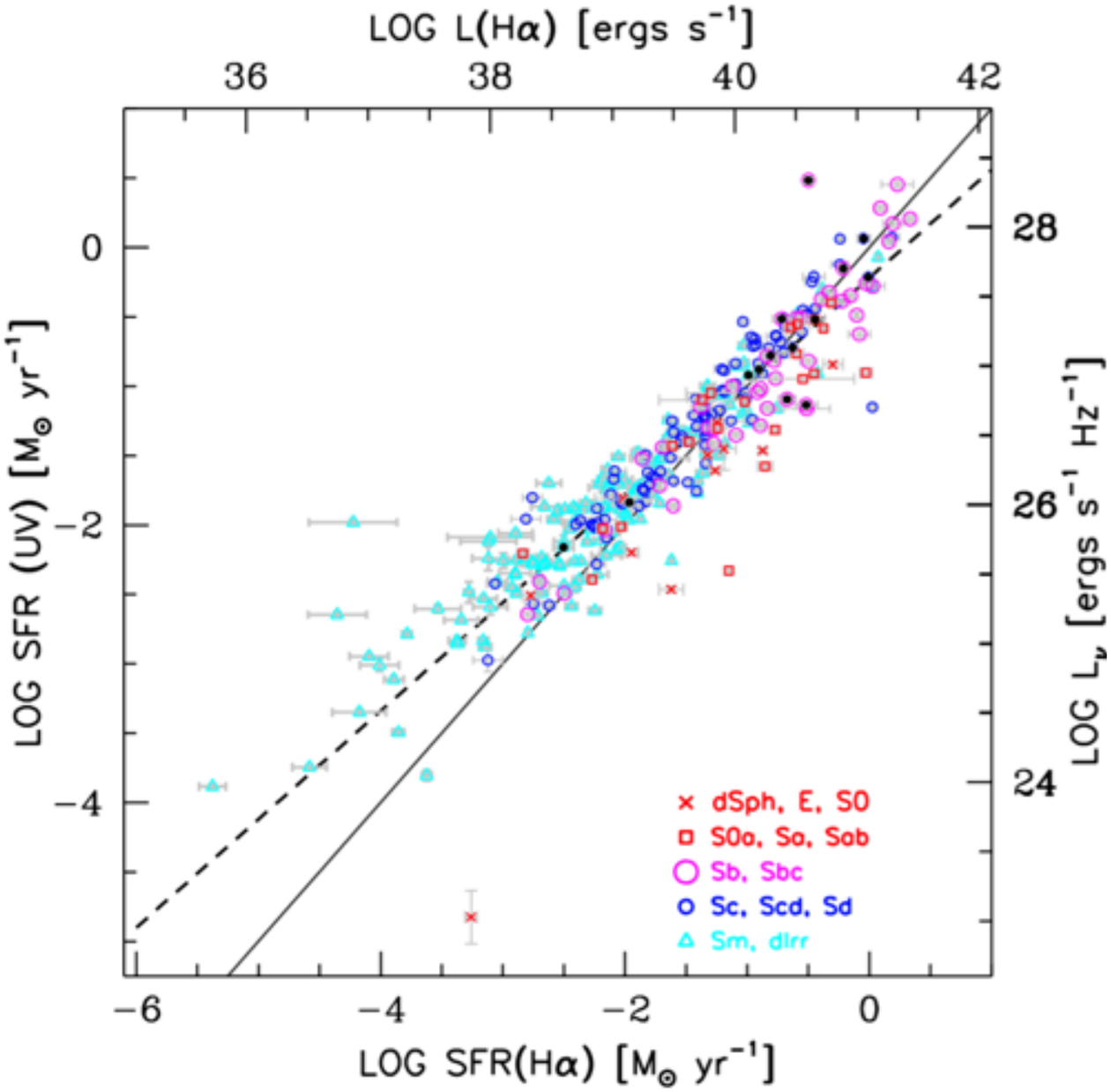
- Sample:
  ~ 300 star-forming galaxies within 11Mpc of the Milky Way

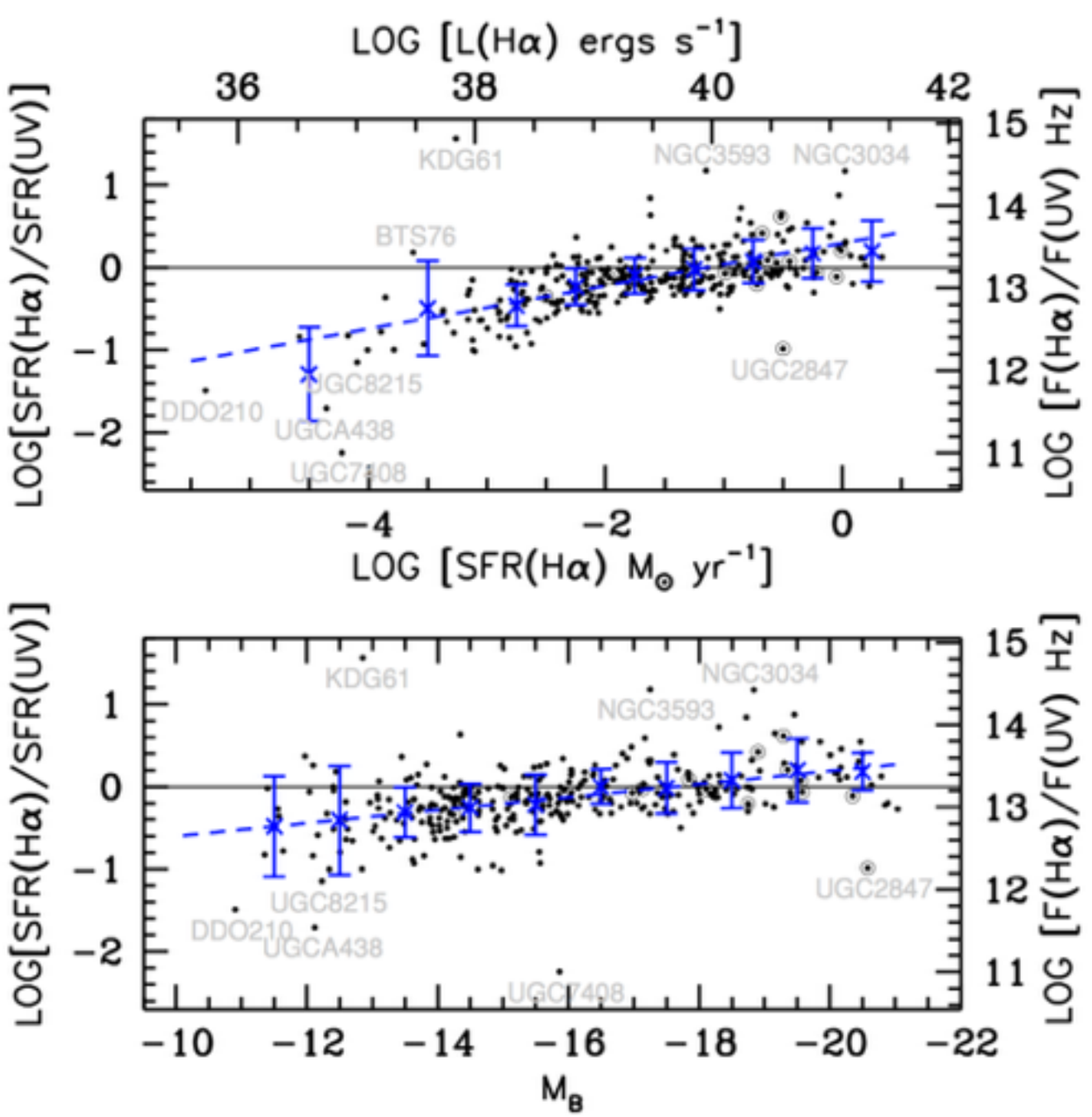
- Measure SFR (star formation rate) from:
  - Hα nebular line emission:
    recombination of gas ionized by the most massive stars
    (M> 17 solar mass) (a few million years)
  - UV flux:
    photospheres of a fuller mass spectrum of the less massive stars
    (M> 3 solar mass) (over 100 million years)
    assume SFR/L = const

- 11Mpc Hα and UV Galaxy Survey (11HUGS)

Comparison of observed FUV and Hα SFRs

Lee et al.





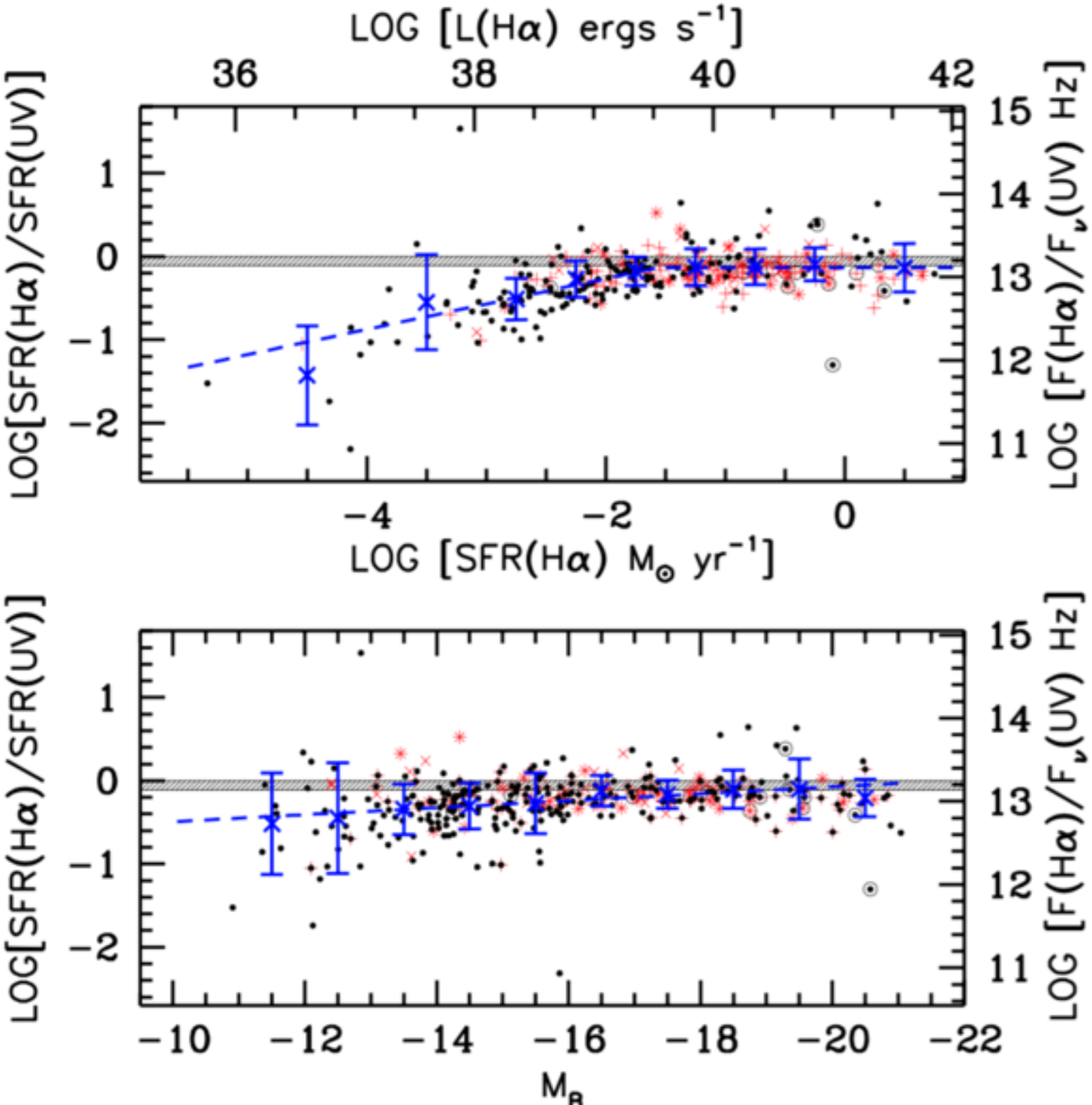
Comparison of observed FUV and Hα SRFs

Lee et al.

Explanations for systematic decline in L(Hα)/L(FUV):

1.Internal Dust Attenuation:

correct for attenuation



UV stellar continuum is more affected by attenuation than the Hα emission.

For all galaxies, the correction decrease the SFR(Hα)/SFR(UV).

But higher luminosity galaxies tend to suffer more from attenuation, the Hα-to-SFR ratio is depressed by a greater factor, so the slope is flattened on average.

So this effect mitigates the relative discrepancy at lower luminosity y 0.1 dex, but the offsets still remain.

Lee et al.

Explanations for systematic decline in L(Hα)/L(FUV):

2. Stellar Model uncertainties:

3. Metallicity:

   generally assume solar metallicity populations

4. Ionizing photon loss:

   Dwarf galaxies are often embedded in large envelop of HI which makes it unlikely that the Lyman continuum photons find their way completely out of a galaxy an into the Intergalactic medium.

5. Starbursts in Dwarf Galaxies:

   Assume SFR has been constant over a time period that is long enough for the birth of stars responsible for the FUV and Hα emission to balance their deaths. Variations in the SFR over timescales ~100Myr would disrupt this equilibrium.

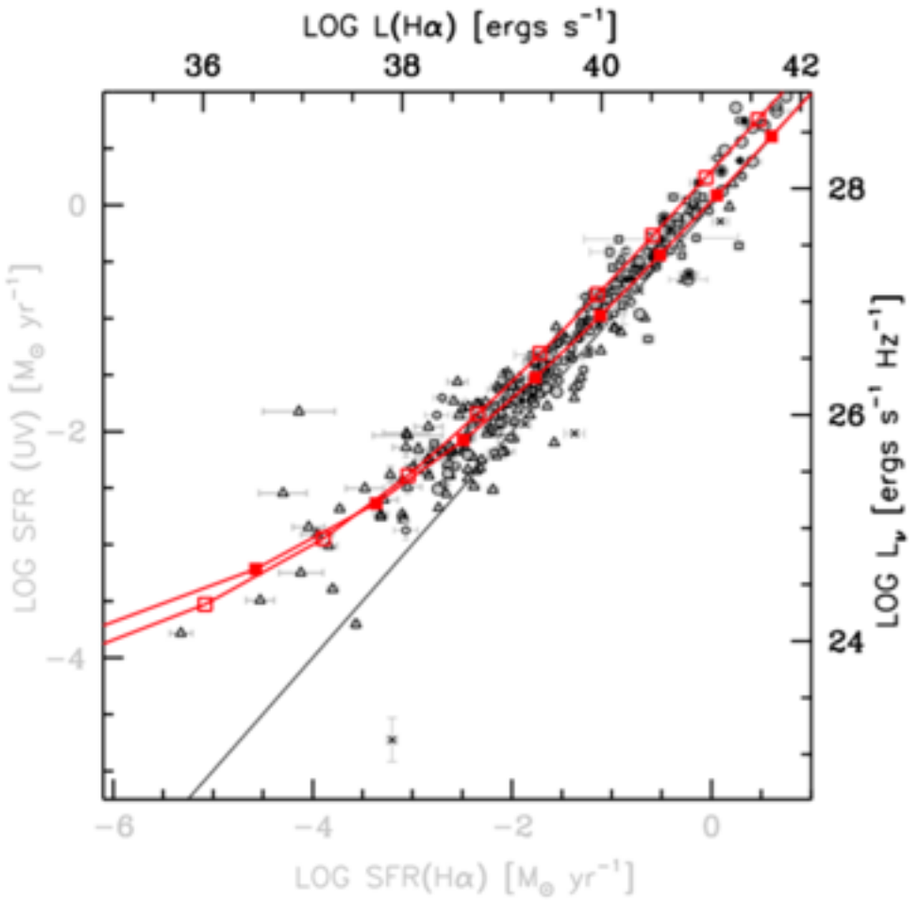
6. Stochasticity in high mass star formation at low SFRs!

   Only a handful of O-stars are formed in the regime of ultra-low SRFs.

Lee et al.

Explanations for systematic decline in L(Hα)/L(FUV):

7. IMF

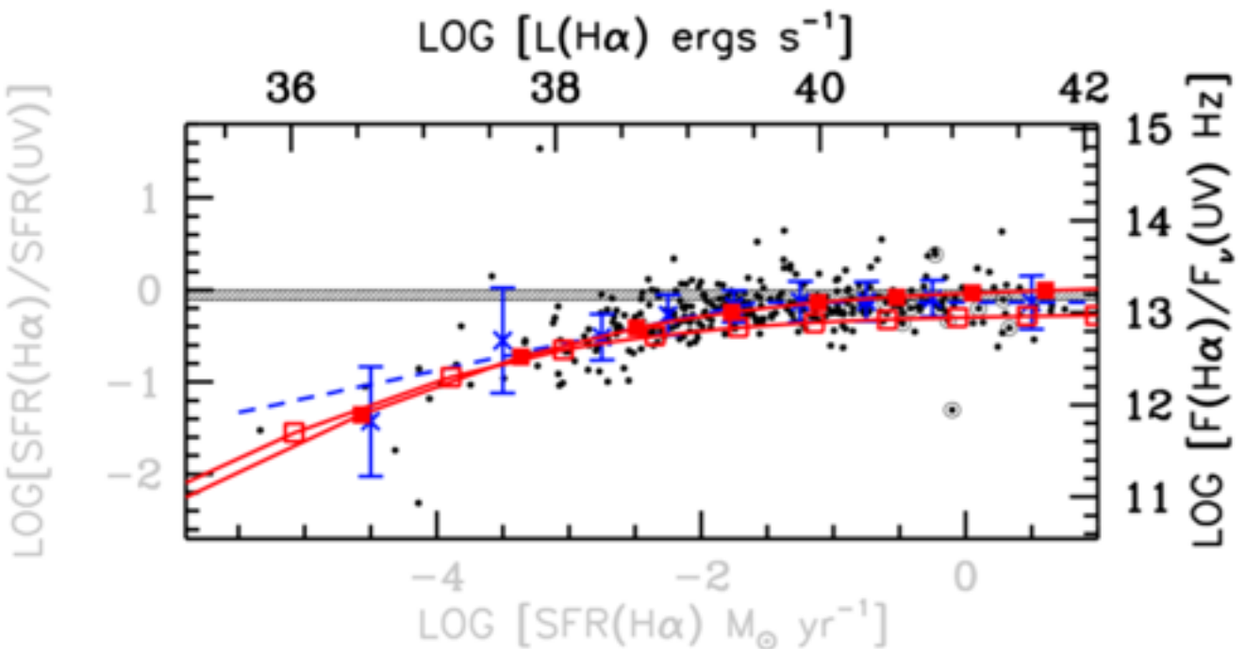


predicts based on IGIMF model

the maximum mass of a cluster formed in a given galaxy depends on its SFR.

the maximum mass of a star formed in a given cluster depends on the total cluster mass *M*.

-> IGIMF: Integrated Galaxial IMF



Conclusion: The underlying cause for the trans is not clear, but they cannot rule out the variations in the IMF.

Fumagalli et al.

Explanations for systematic decline in L(Hα)/L(FUV):

6. Stochasticity in high mass star formation at low SFRs!

- At high SFRs, the large number of stars guarantees a nearly complete sampling of the IMF.
- At low SFRs, due to the smaller number of stars that are formed, the probability of finding massive stars decreases.

  The IMF is not fully sampled, and (m_max) < (m_max in the IMF)

SLUG is used to create stochastic sampling.

Two models are compared:

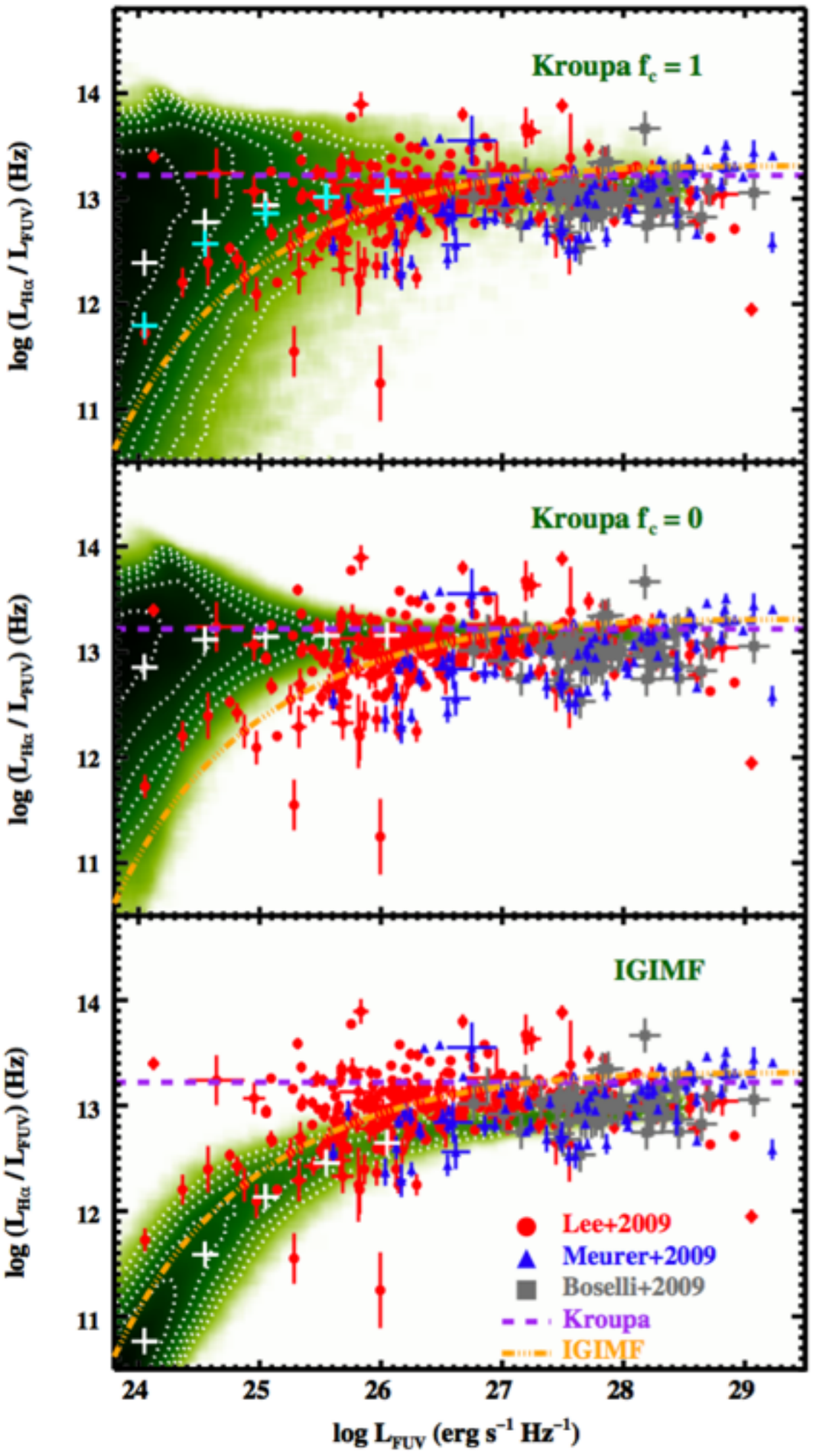
- a universal Kroupa 2001 IMF:

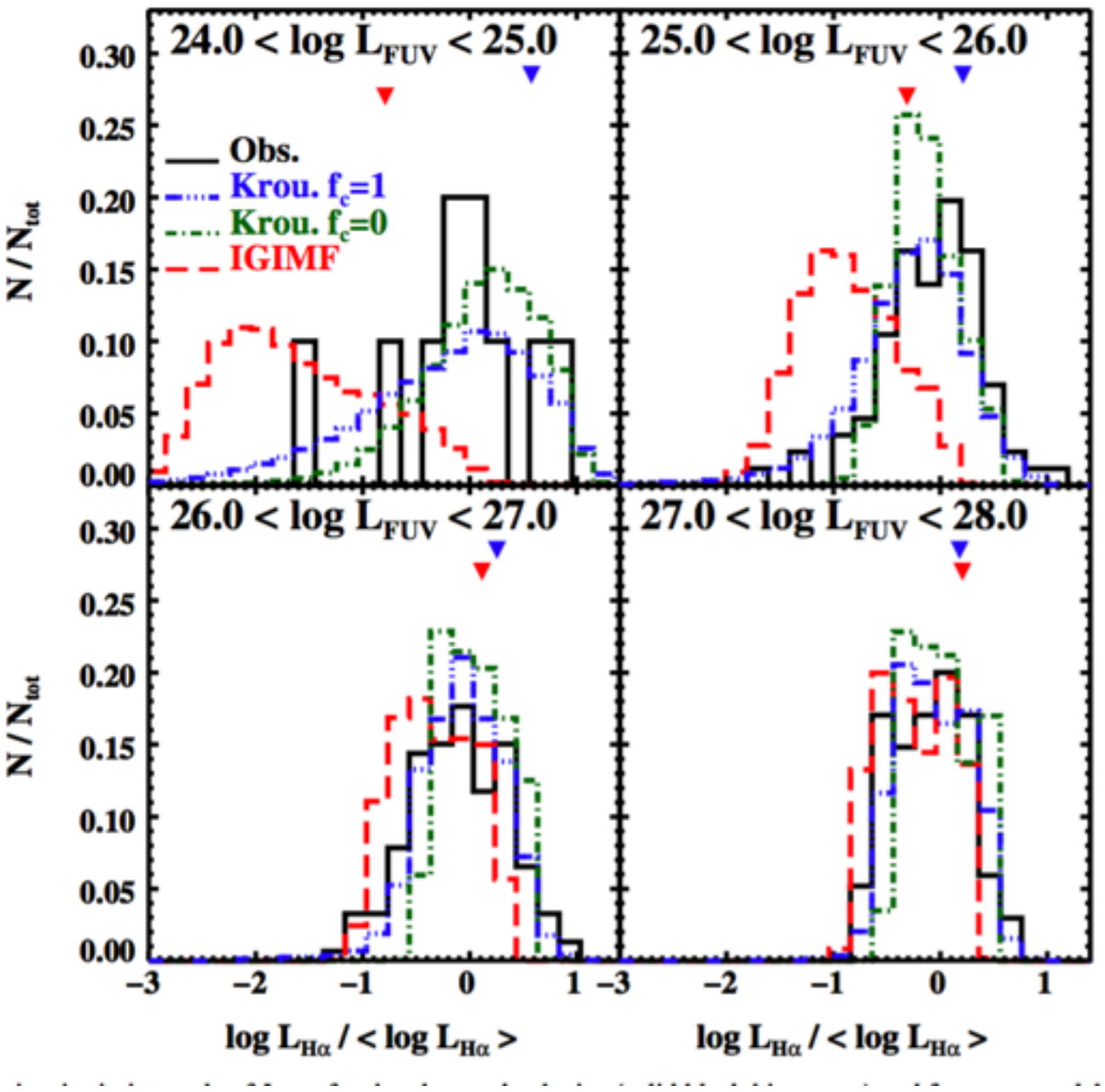
  fc: the fraction of stellar population that is formed in cluster.

  - fc = 1: total stellar population are formed in clusters
  - fc = 0: total stellar population are formed in field.
- IGIMF:

Fumagalli et al.

distribution of Hα luminosity





Observed Hα and FUV luminosities in a sample of nearby galaxies

Conclusion:

- Present observations of the integrated luminosity in nearby galaxies are consistent with a universal IMF.
- IGIMF model is not needed to account for the integrated luminosities in galaxies