ULTRAVIOLET ASTRONOMY IN THE XXI CENTURY

e-Workshop 2020 – October 27-29

JcUVa

First Co-spatial Comparison of Stellar, Neutral-, and Ionized-gas Metallicities in a metal-rich galaxy: M83

Svea Hernandez

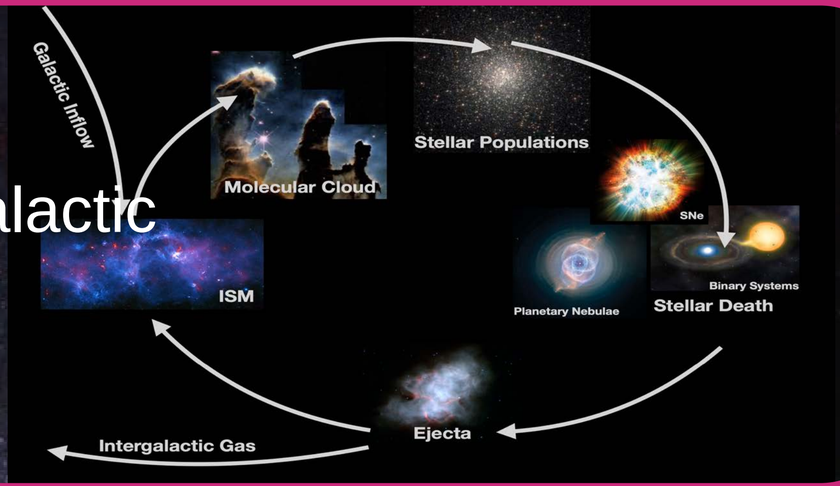
Alessandra Aloisi, Bethan James, Nimisha Kumari, et al.

STScI

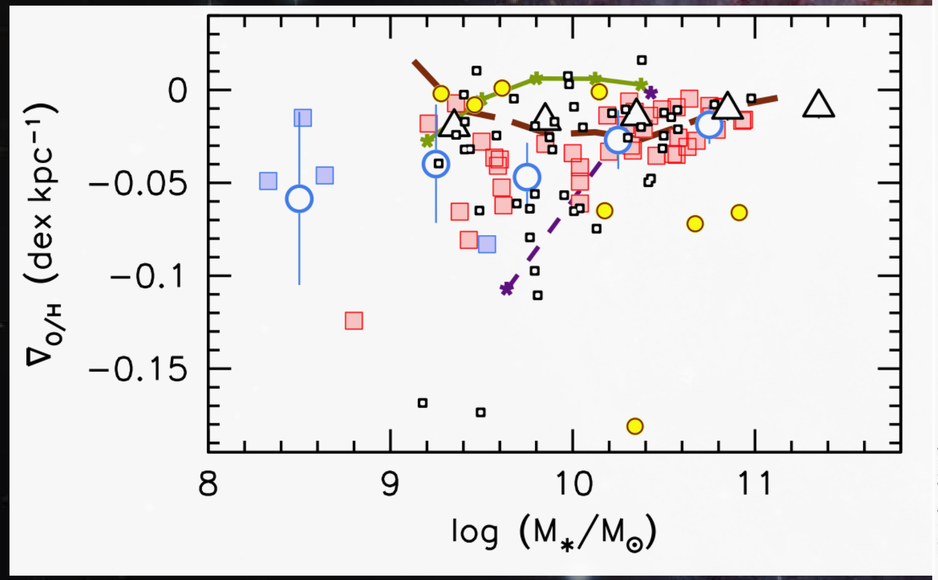
Chemical Composition:

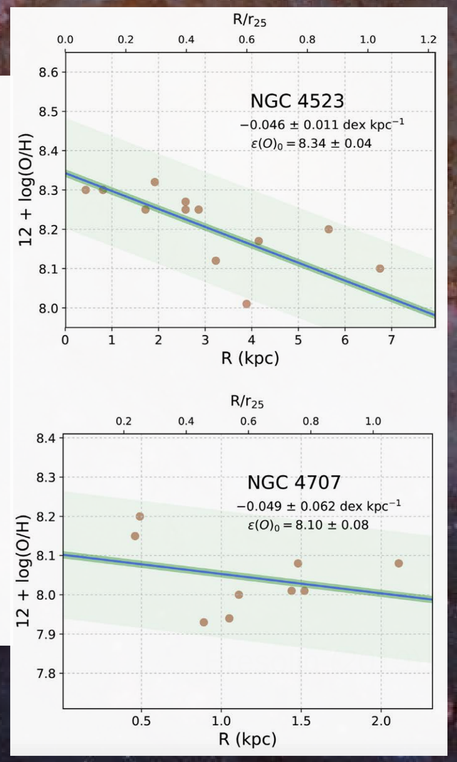
Why is it important?

➞ Allow us to uncover a variety of physical and evolutionary processes: star-formation episodes, galactic winds, and accretion of pristine matter

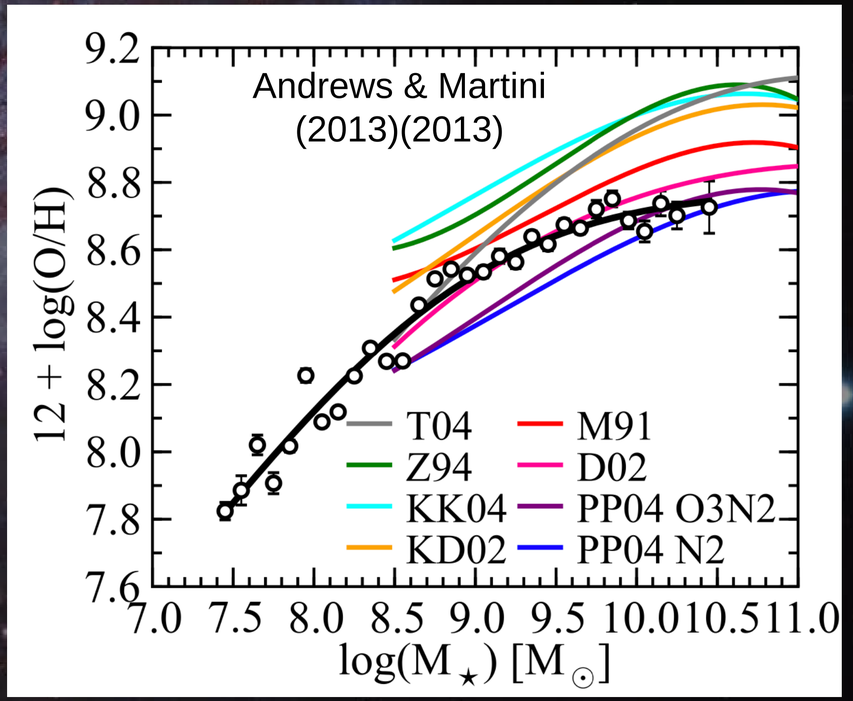


Metallicity Gradients





Mass-Metallicity Relation (MZR)



Metallicity Diagnostics

H II regions (emission lines)

Neutral Gas (absorption lines)

Stellar Populations (absorption lines)

Steidel et al. (2016): 30 SFGs at z~2, found a factor of ~4-5 difference between their inferred stellar and nebular metallicities

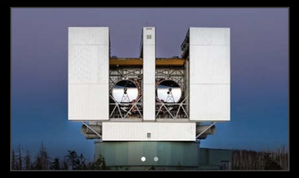
Chisholm et al. (2019): 61 SFGs at z <0.2, and 19 galaxies at z~ 2, find that the stellar and nebular metallicities are similar to each other when assuming mixed-age stellar populations

H I

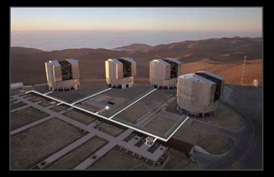
Metallicity of the multi-phase ISM and Stellar populations in M83

HST/COS

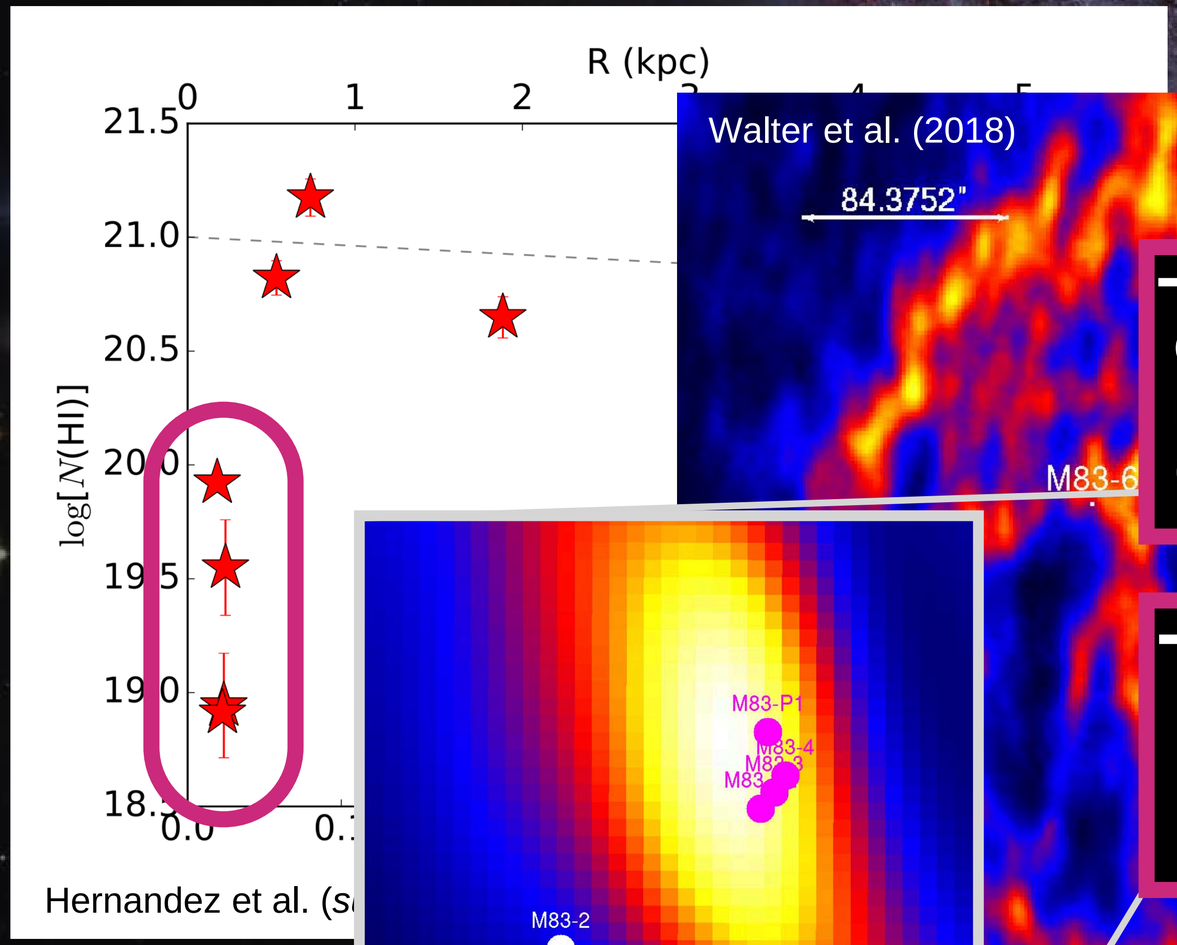
LBT/MODS

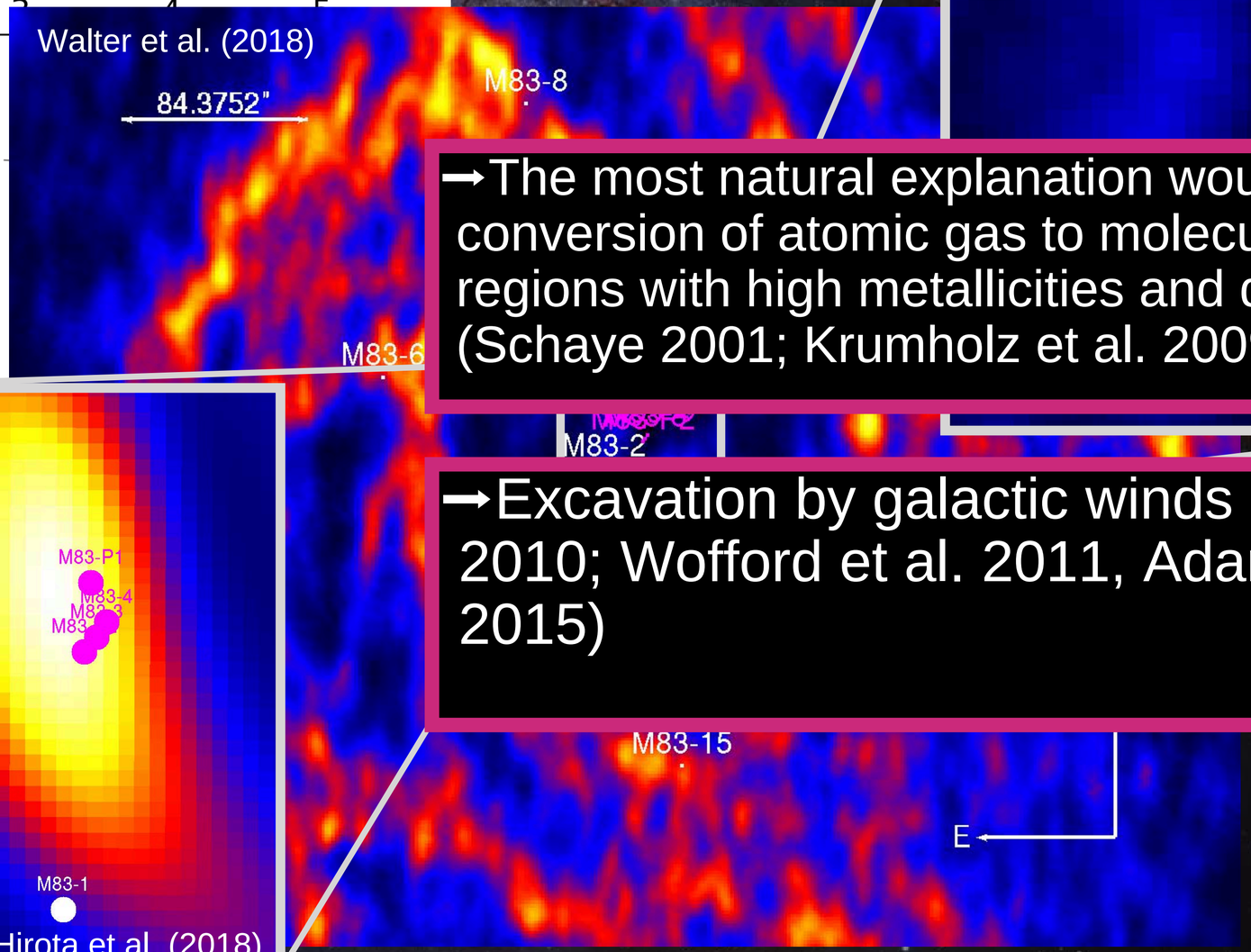


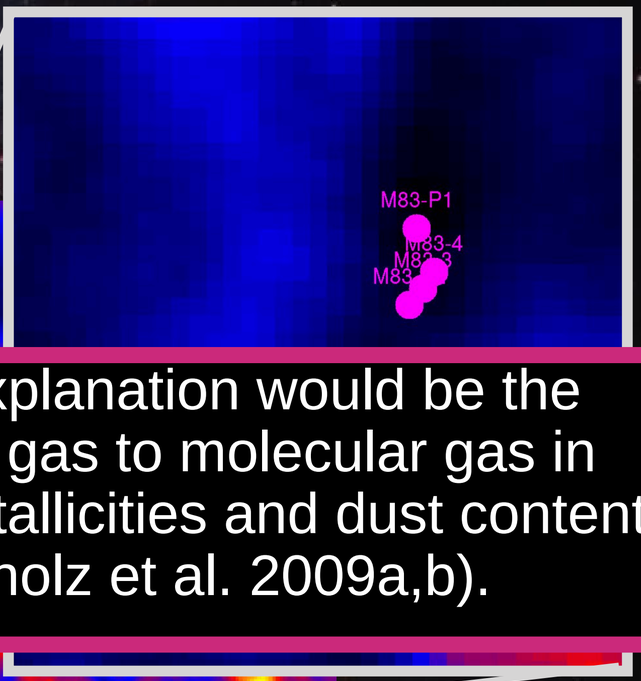
VLT/MUSE



M83: H I distribution



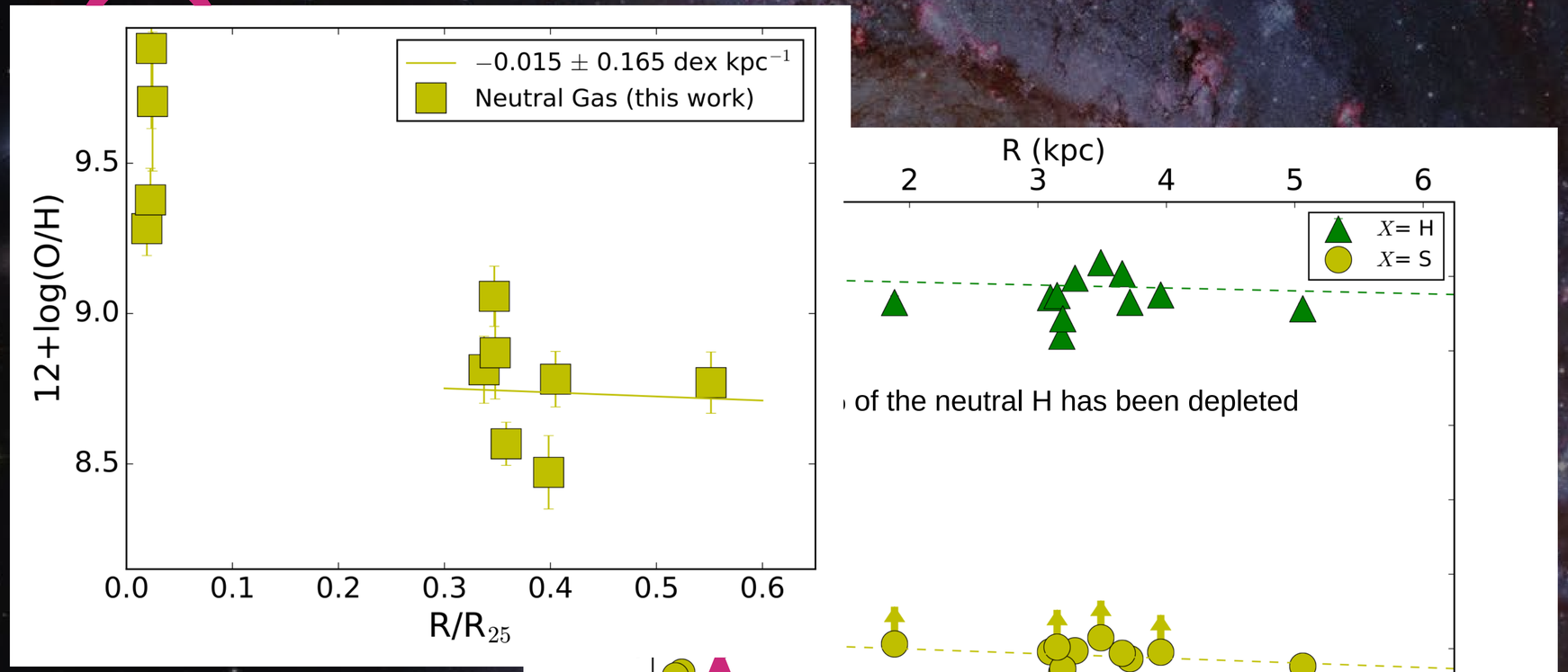




➞The most natural explanation would be the conversion of atomic gas to molecular gas in regions with high metallicities and dust contents (Schaye 2001; Krumholz et al. 2009a,b).

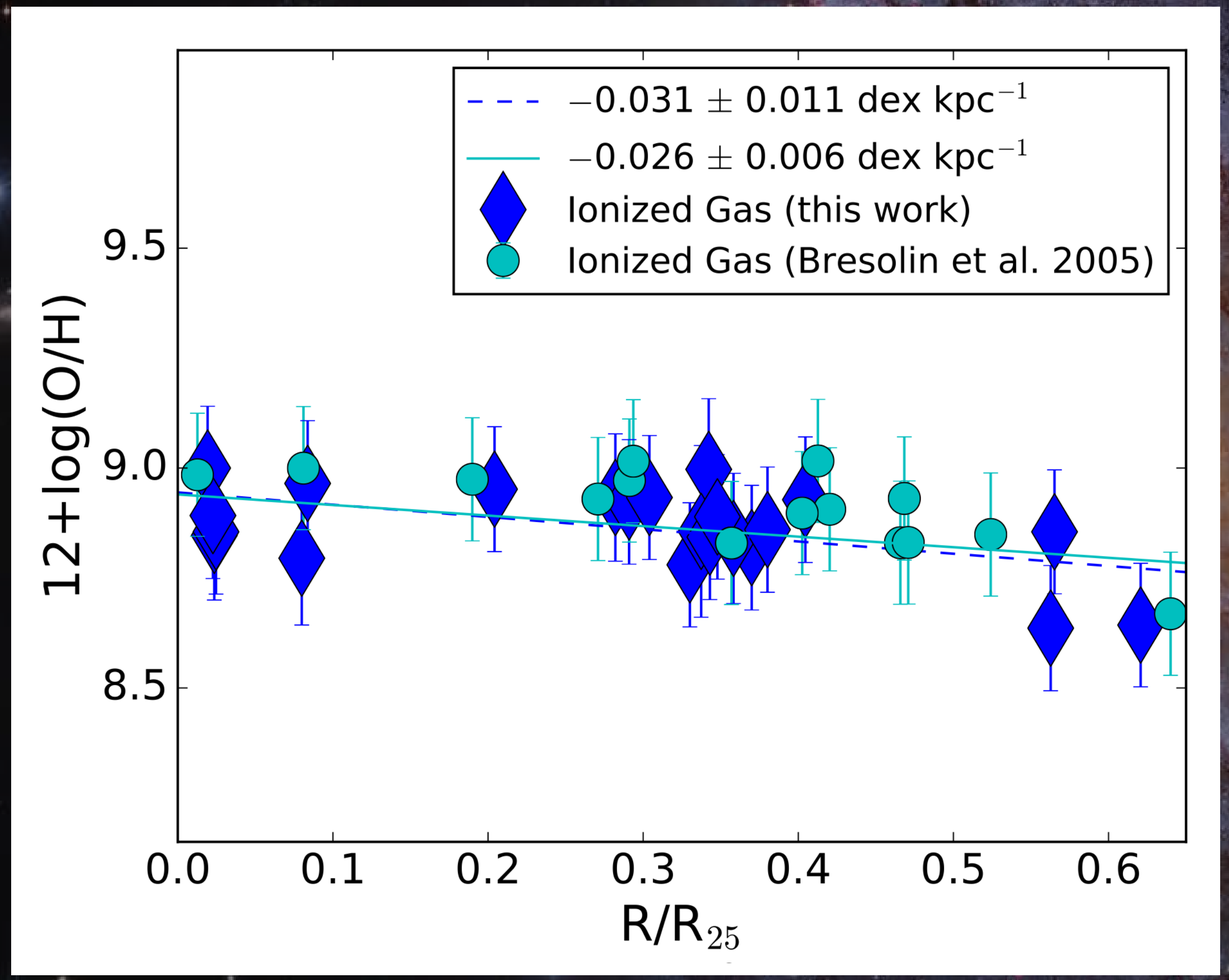
➞Excavation by galactic winds (Dopita et al. 2010; Wofford et al. 2011, Adamo et al. 2015)

M83 Metallicity gradients: Neutral Gas



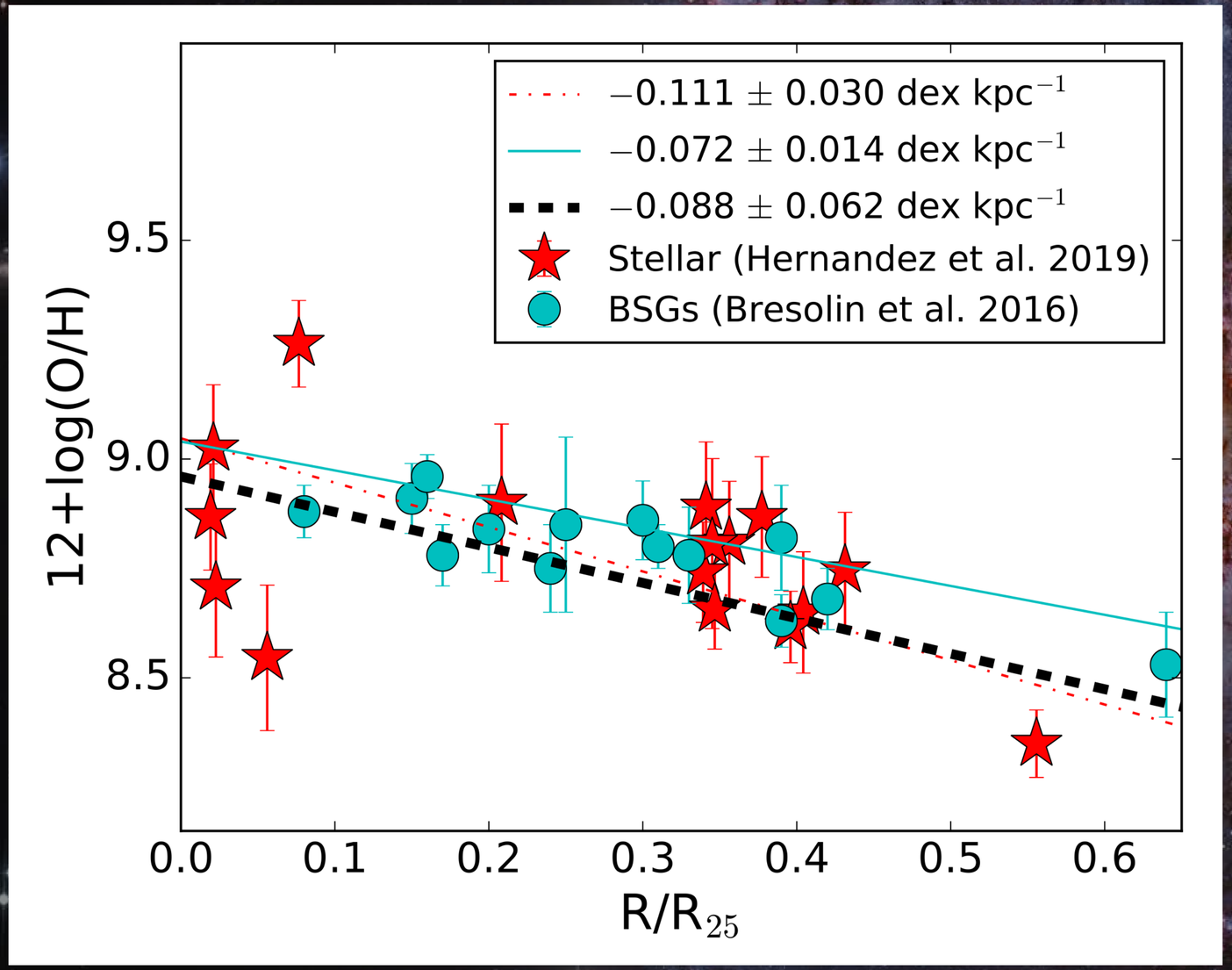
H I

M83 Metallicity gradients: Ionized Gas



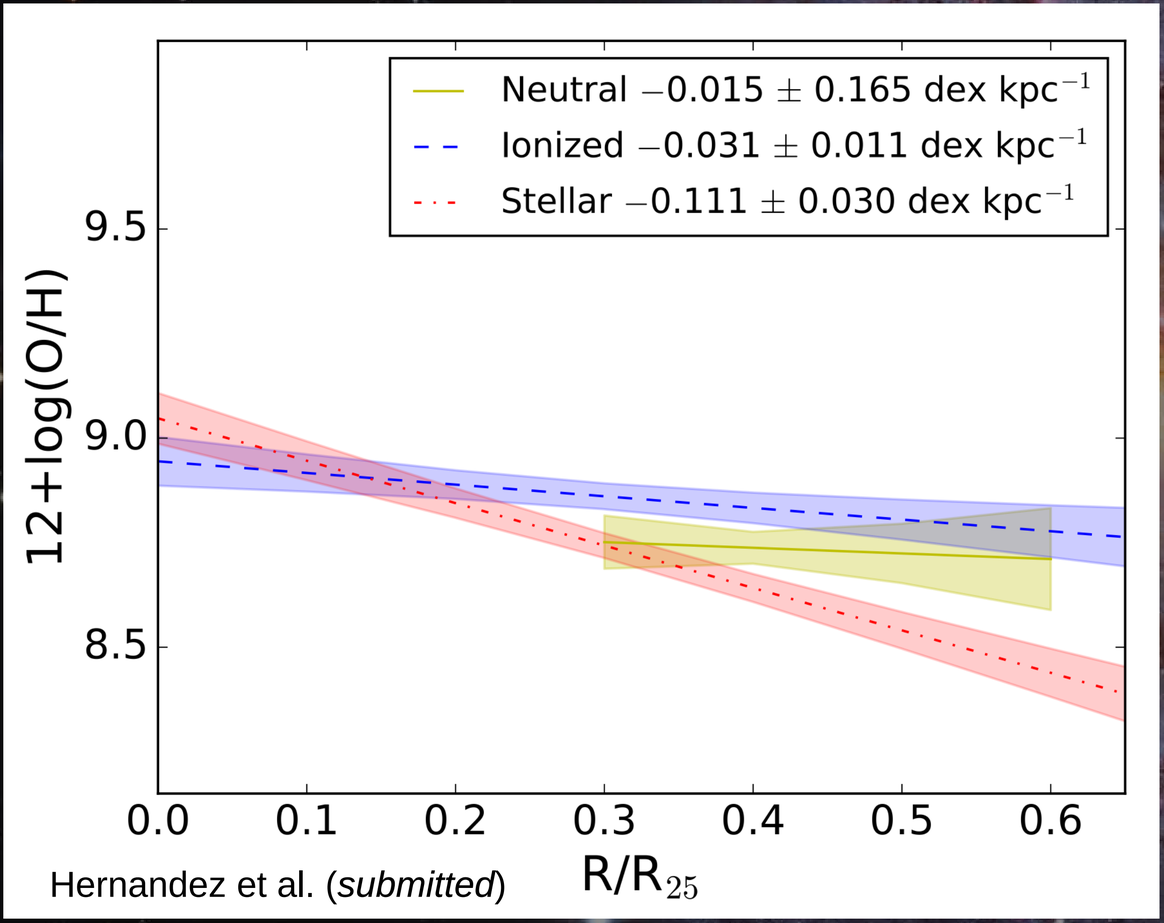
Comparable to the metallicity gradient of a local benchmark of 49 nearby star-forming galaxies of −0.026 ± 0.002 dex kpc^{-1} (Ho et al. 2015)

M83 Metallicity gradients: Stellar Populations



Similar to previous studies (Bresolin et al. 2016, Davies et al. 2017) we find that the metallicity gradient obtained using the *direct (T_e-based)* method is in excellent agreement with that from Young Massive Clusters (stellar populations).

M83 Metallicity gradients

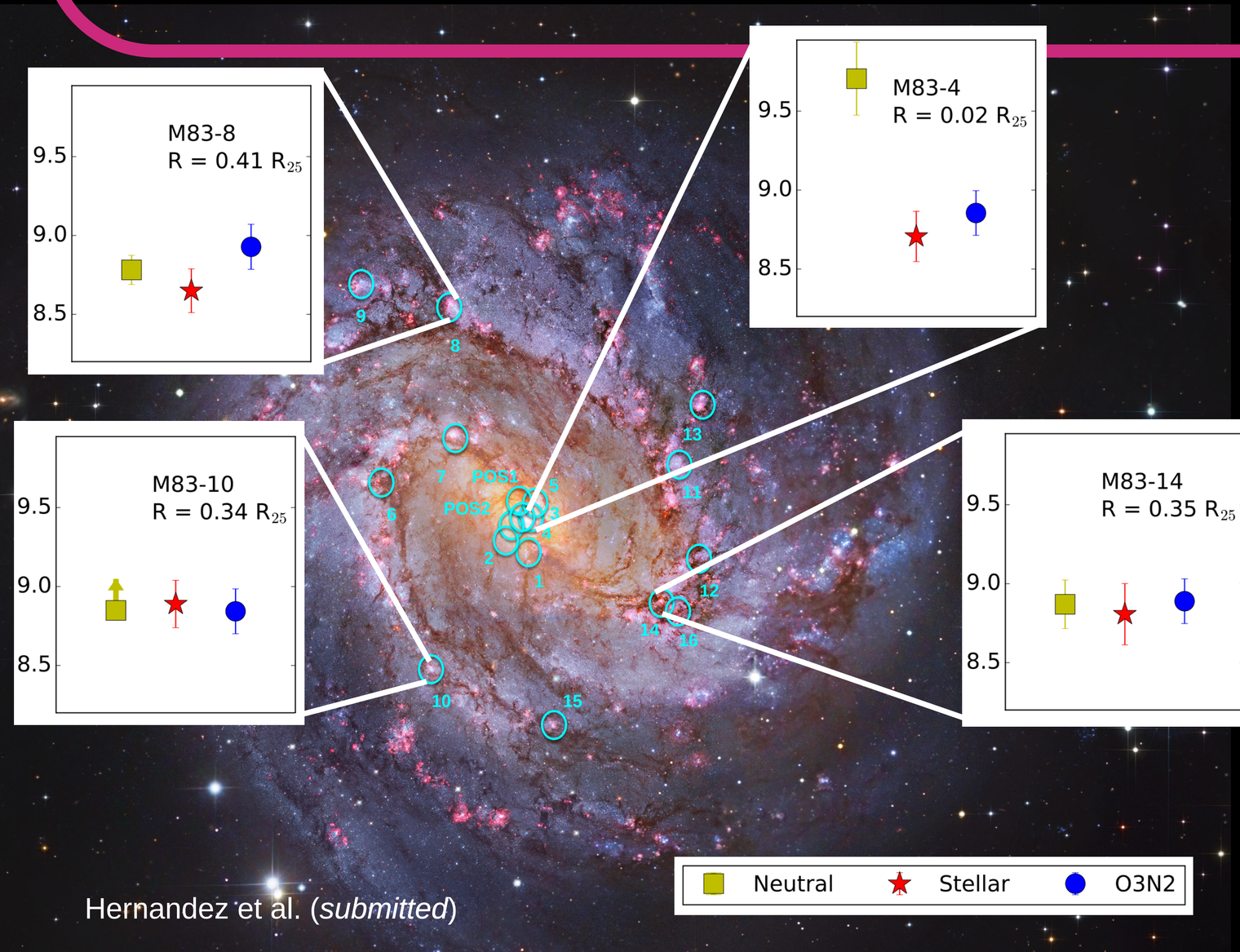


Hernandez et al. (*submitted*)

➞consistent with previous studies where metallicity gradients inferred from stellar populations are ***steeper*** than those measured in the ionized gas using strong-line calibrators

➞it is critical to examine in detail the effects and activity in the ***nuclear regions*** of star-forming galaxies when studying metallicity gradients imprinted in the ***neutral-gas component***

M83: Co-spatial comparison of multi-phase gas, and stellar populations



Hernandez et al. (*submitted*)

➞ Even when the inferred gradients for the different components appear to be dissimilar, outside of the central regions the abundances of the multiphase gas and stellar populations appear to be more homogenized

➞ This hints at a scenario where on small galactic scales (<100 pc) it takes longer than the lifetime of the most massive stars (~10 Myr) to fully mix the newly synthesized metals.

M83 Metallicity study:

➞ We find a clear depletion of H I gas as observed from the H I column densities in the core of M83.

➞Using the O3N2 calibration by Pettini & Pagel (2004) we measure a metallicity gradient of -0.031 ± 0.011 dex kpc^{-1} for the ionized gas, comparable to the local benchmark of metallicity gradients of nearby star-forming galaxies by Ho et al. (2015)

➞A co-spatial comparison of the metallicities of the multi-phase gas and the stellar populations show excellent agreement outside of the nucleus of the galaxy. This hints at a scenario where on small galactic scales (~100 pc) it takes longer than the lifetime of the most massive stars (~10 Myr) to fully mix the newly synthesized metals.

➞Similar co-spatial studies are essential for validating the observed trend in a variety of other environments in the Local Universe.