Ionization of the Diffuse Gas in Galaxies explained by HOLMES

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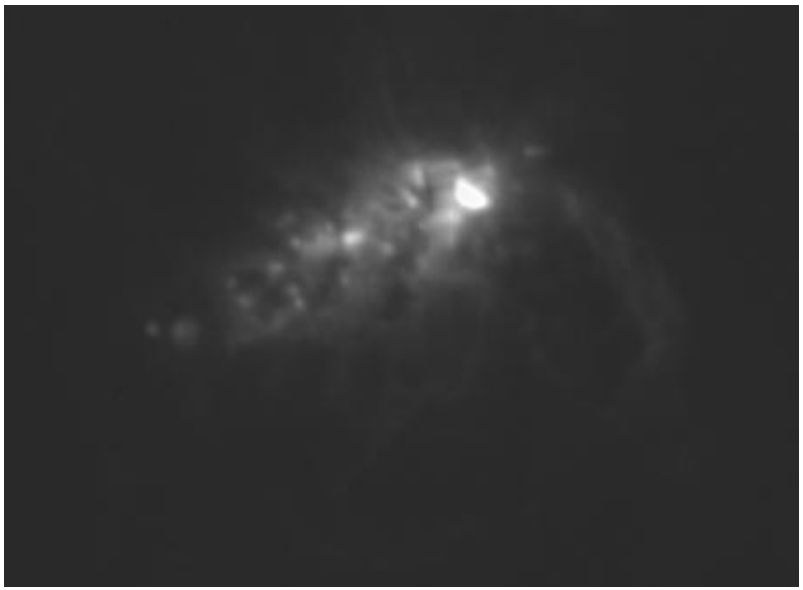
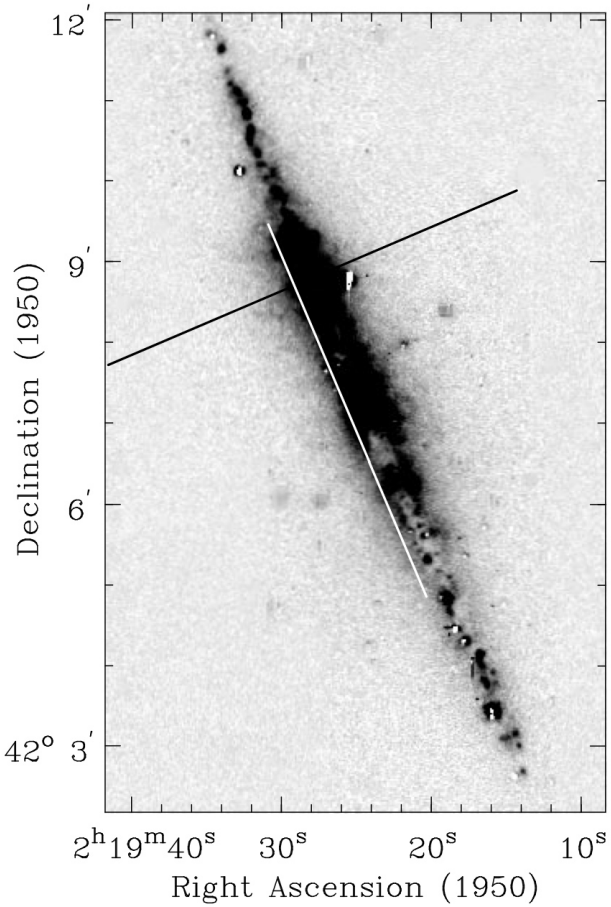
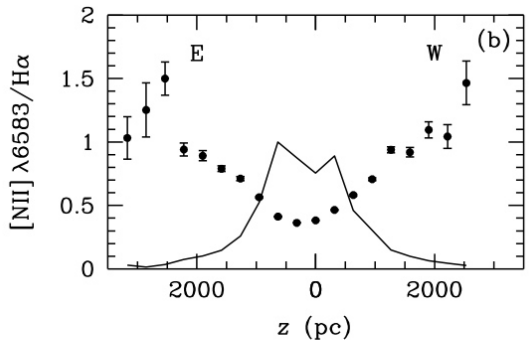
Hα image - NGC 1569

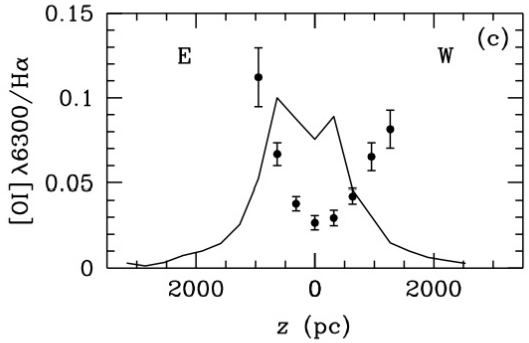


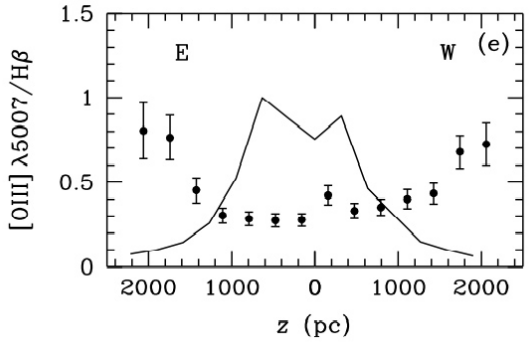
- 1963 - Hoyle and Ellis: "ionized layer along the Galactic plane ... of 5×10^8 $M_\odot$"
- 1971-89 - Reynolds established the existence of the Diffuse Ionized Gas in our Galazy
- 1990's - This component is present in other galaxies
- $T_e \sim 10^4\,K$; $n_e \sim 10^{-1}\,cm^{-3}$
- Ionized by leaked photons from OB stars

Rand, 1998 - NGC 891









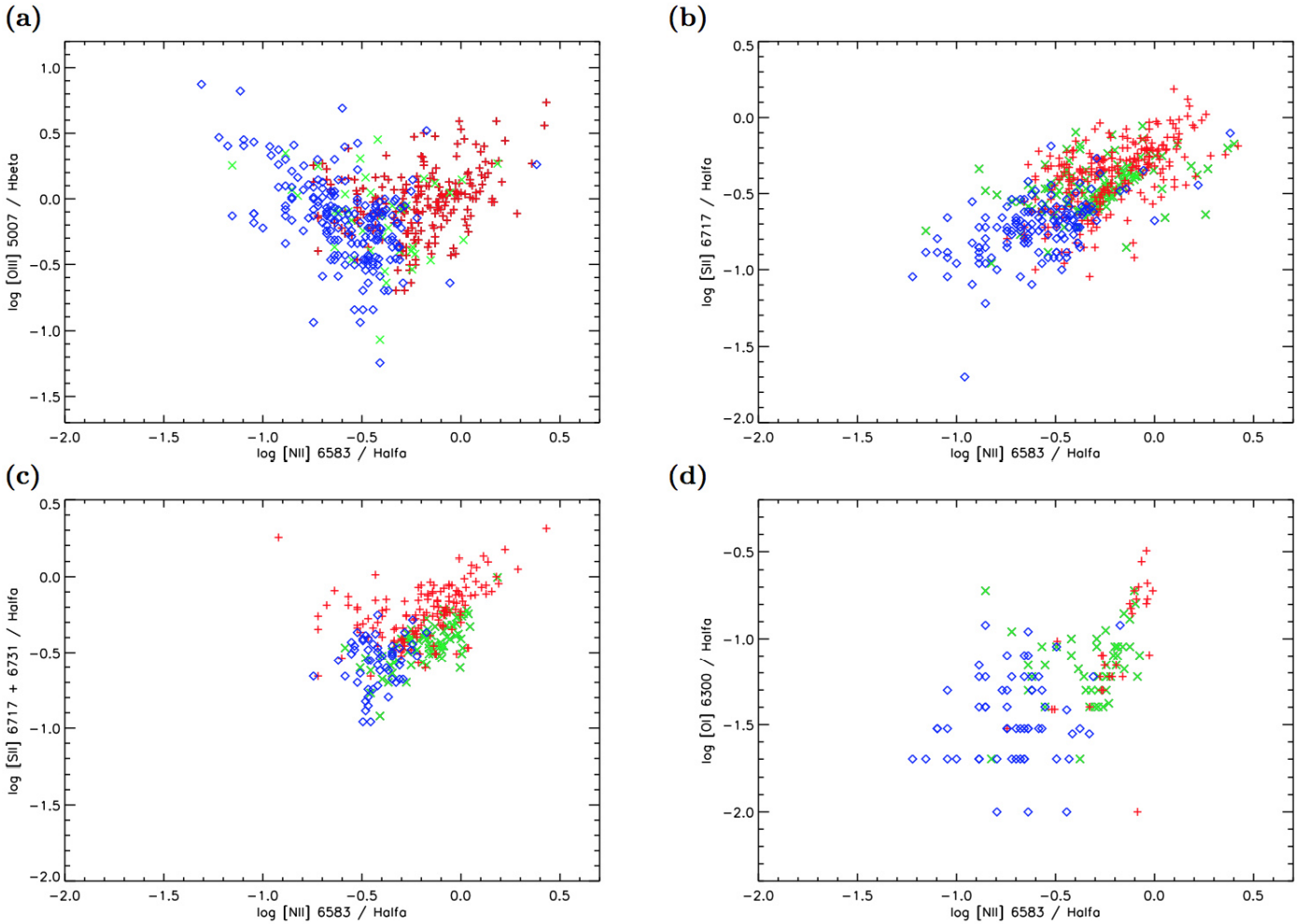
What is the ionization/heating source of the DIG?

- Shocks - Martin 1997
- Turbulent mixing layer - Slavin 1993; Binette et al. 2009
- Compact hot sources - Lyon 1975; Sokolowski & Bland-Hawthorn 1991
- Decay of heavy neutrinos - Dettmar & Schultz 1992
- ...

WHAT IS THE BIG PICTURE OF THE DIG BEHAVIOR ?

Diffuse Ionize Gas Extragalactic DAtabase (DIGEDA)

Diffuse Ionize Gas Extragalactic DAtabase (DIGEDA) analysis - Flores-Fajardo et al. 2009



Elementary my dear Watson ...

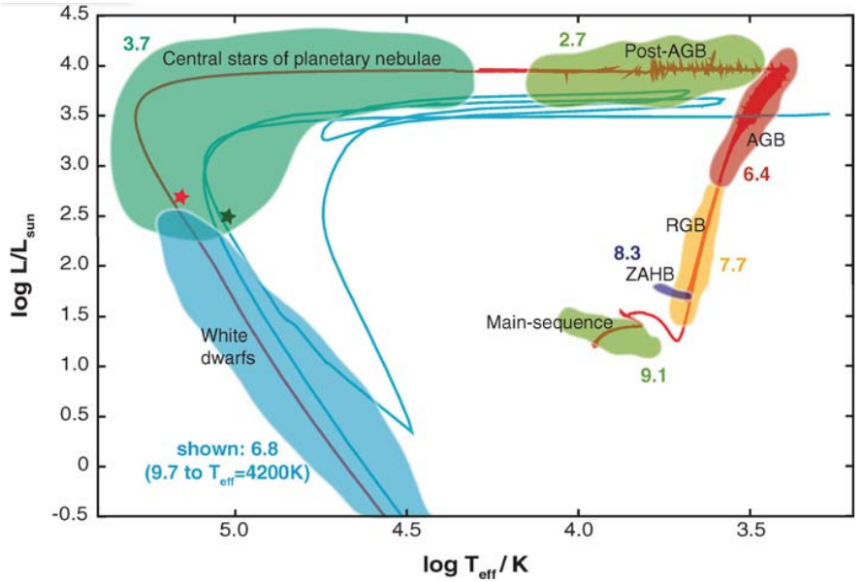
Harder Ionizing Spectrum

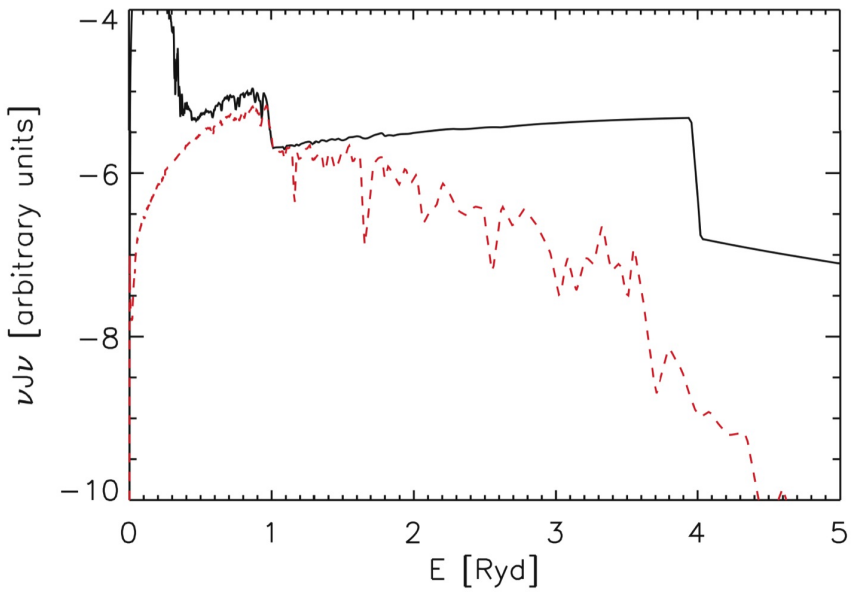
$$\text{Increase } T_e \;=\; \text{increase } \bar{\nu}_e \;=\; \text{increase } \bar{E}_{photon}$$

High mean energy of (ionizing) photons

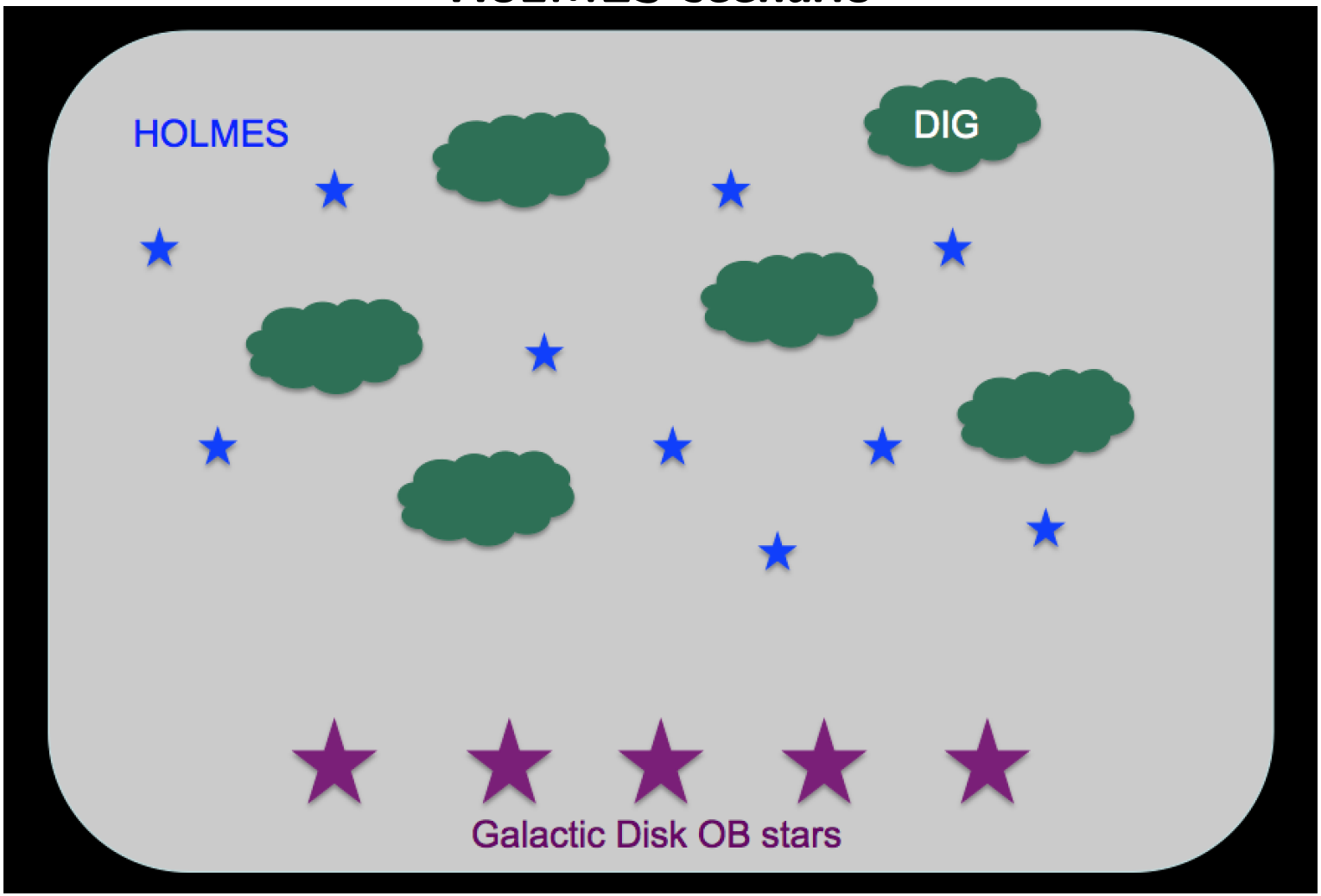
1. Increase energetic photons
2. Reduce low energy photons

HOt Low Mass Evolved Stars



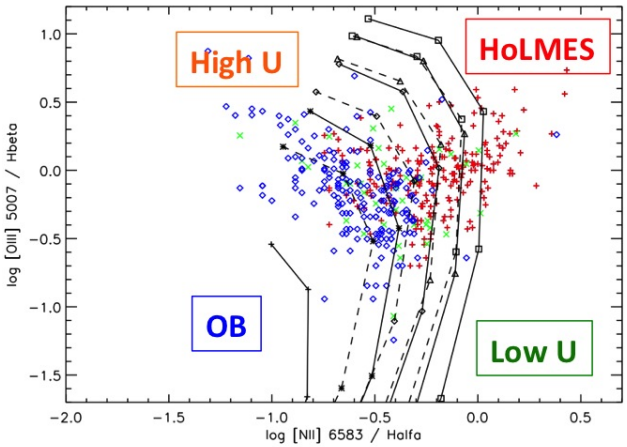


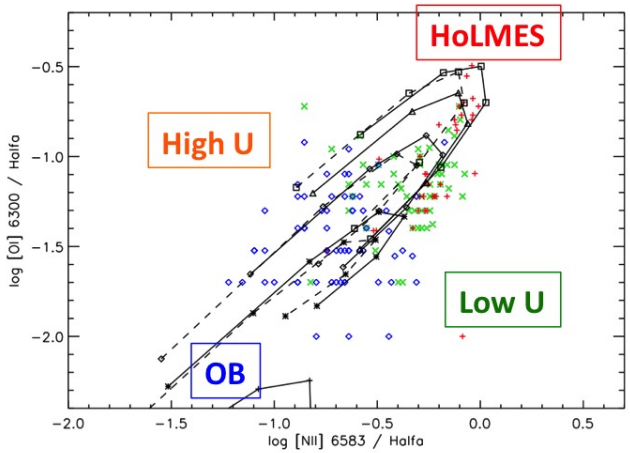
HoLMES scenario

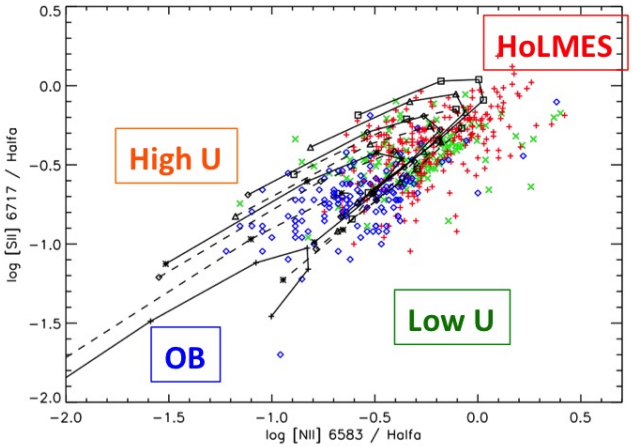


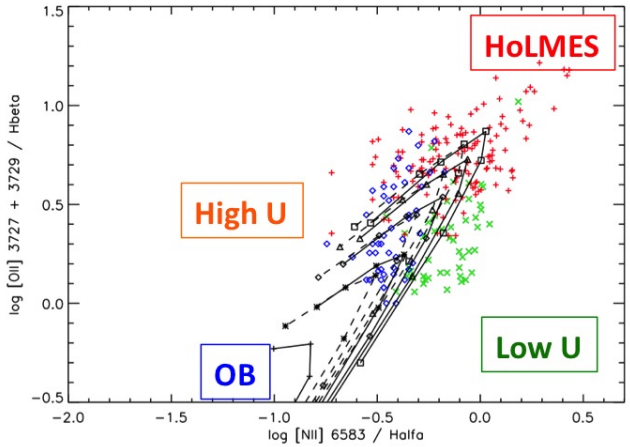
- Geometry $\rightarrow$ Plane-Parallel
- DIG is radiation bounded
- OB Flux $\rightarrow$ Variable (StarBurst99 : 15 to 40 $M_{\odot}$ of zero age)
- HoLMES Flux $\rightarrow$ Constant (Rauch : 50, 80, 120, 160 and 190 kK)
- OB/HoLMES Flux $\rightarrow$ z Function
- Metalicity (O/H, N/O) $\rightarrow$ Variable
- Density $\rightarrow$ z Function

First – statistical analysis









It works !!

Second step – Individual and detail models

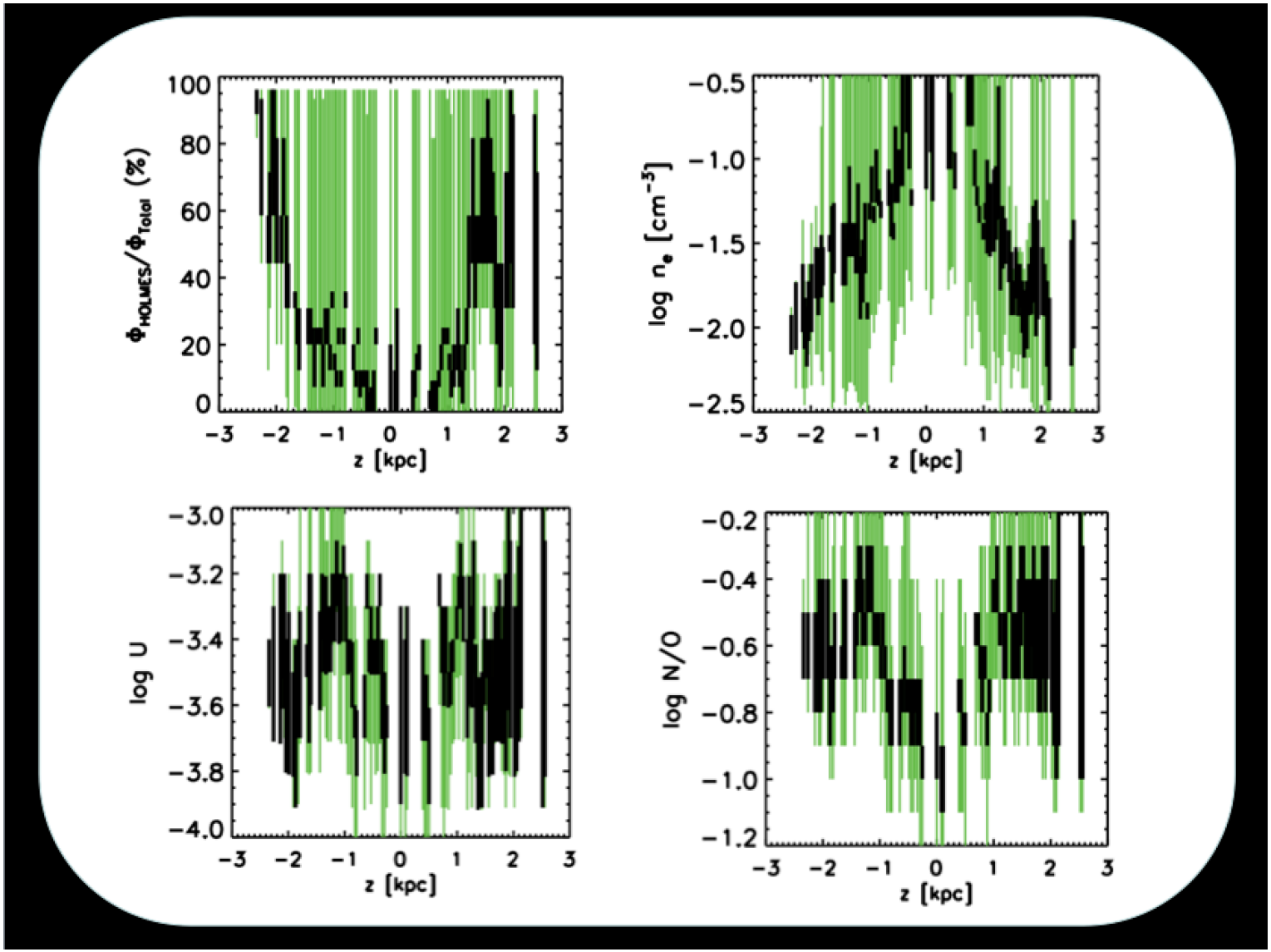
NGC 891

OB stars

– STARBURST99
– Kroupa et al. 1993 IMF
– Solar Metallicity
– Continue star formation of 10^7 years
– $L_{IR}(NGC891) \rightarrow$ SFR $\rightarrow$ OB Flux

HoLMES

– PEGASE
– Single star burst of 10 Gyr
– old disk mass + models $\rightarrow$ HoLMES Flux


$\Phi_{HOLMES}/\Phi_{Total}$ (%)
z [kpc]
log n_e [cm^{-3}]
z [kpc]
log U
z [kpc]
log N/O
z [kpc]

Models with Combined stellar population are able to reproduce:

1. DIG global behavior
2. Detail characteristics with z

The models predict:

1. $\mathrm{N_e}$ increase with z
2. $\Phi_{\mathrm{HOLMES}}/\Phi_{\mathrm{OB}}$ increase with z
3. N/O increase with z

Thank you!