"All of the ISM is a PDR"

...okay, so let's get out of the neighborhood...

- ...toward the inner parts of galaxies ($R_G \lesssim R_d$)
  - higher dust abundances (H_2 production, FUV attenuation)
  - higher cosmic ray densities (heating)
  - higher or lower FUV brightness, BUT...
  - much higher stellar densities
- ...and the outer parts ($R_G \gtrsim \text{few} \times R_d$)
  - lower dust abundances (but not zero!)
  - low CR densities (gas will be c...c...cold!)
  - little starlight, BUT...
  - young stars and FUV emission ARE present!

Metallicity dependence of HI production in PDRs

References: Sternberg 1988, ApJ, 332, 400
Goldshmidt & Sternberg 1995, ApJ, 439, 256
Allen, Heaton, & Kaufman 2004, ApJ, June (fit coefficients)

$$N(HI) = \frac{7.8 \times 10^{20}}{(\delta/\delta_0)} \ln\left[\frac{106 G_0}{n}\left(\frac{\delta}{\delta_0}\right)^{-1/2} + 1\right] \mathrm{cm}^{-2}$$

where $n = n(HI) + 2n(H_2)$. G_0 and δ/δ_0 are the FUV flux and dust/gas ratio w.r.t. the Galaxy near the sun.

The limiting cases are:

- $G_0/n \gtrsim 10^{-2}$ (dust shielding):

$$N(HI) \sim \frac{1}{(\delta/\delta_0)} \ln\left[\frac{106 G_0}{n}\left(\frac{\delta}{\delta_0}\right)^{-1/2} + 1\right] \mathrm{cm}^{-2}$$

- $G_0/n \lesssim 10^{-2}$ (H_2 shielding):

$$N(HI) \sim \frac{G_0/n}{(\delta/\delta_0)^{-3/2}} \mathrm{cm}^{-2}$$

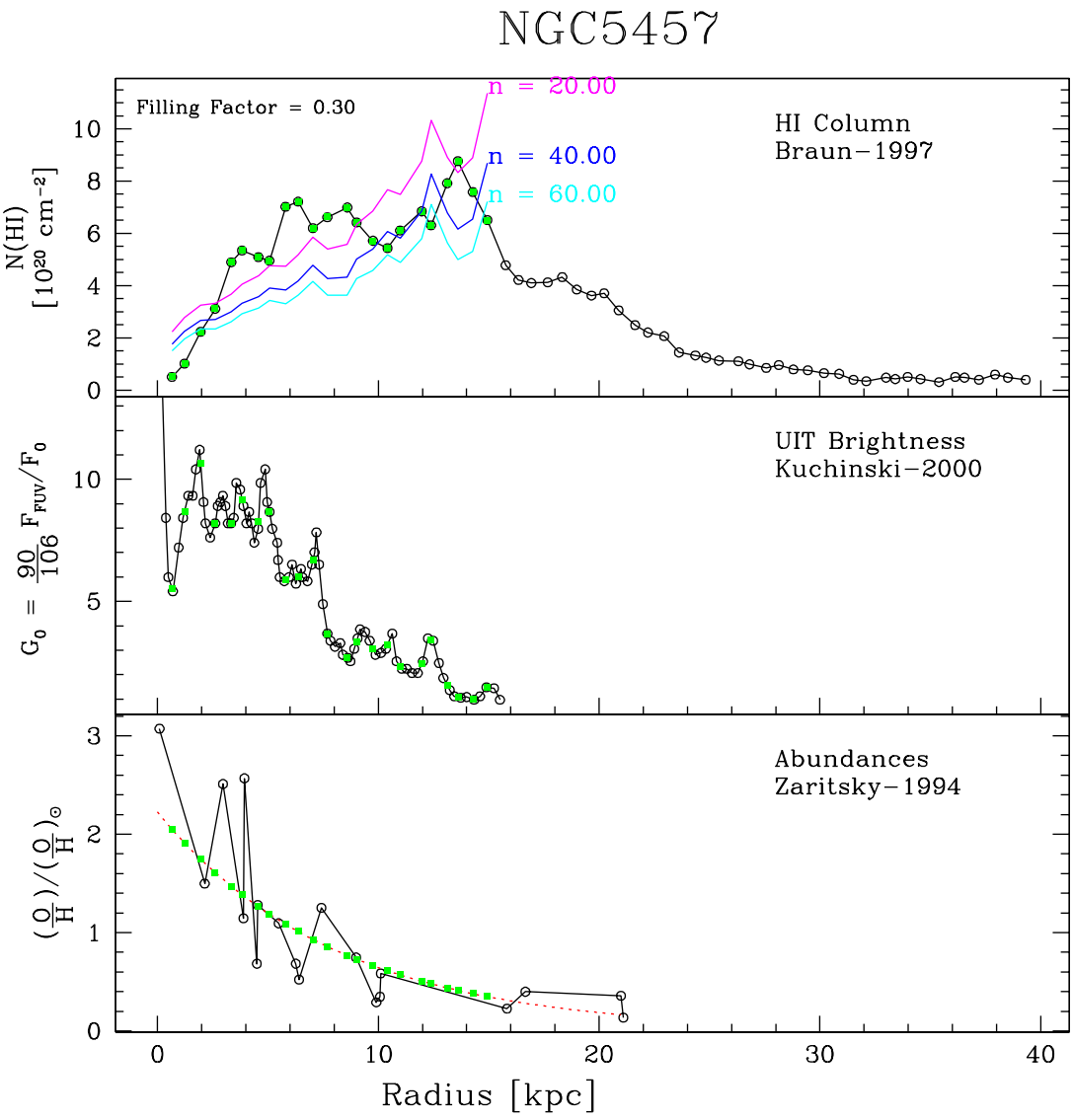

Figure 1: M 101

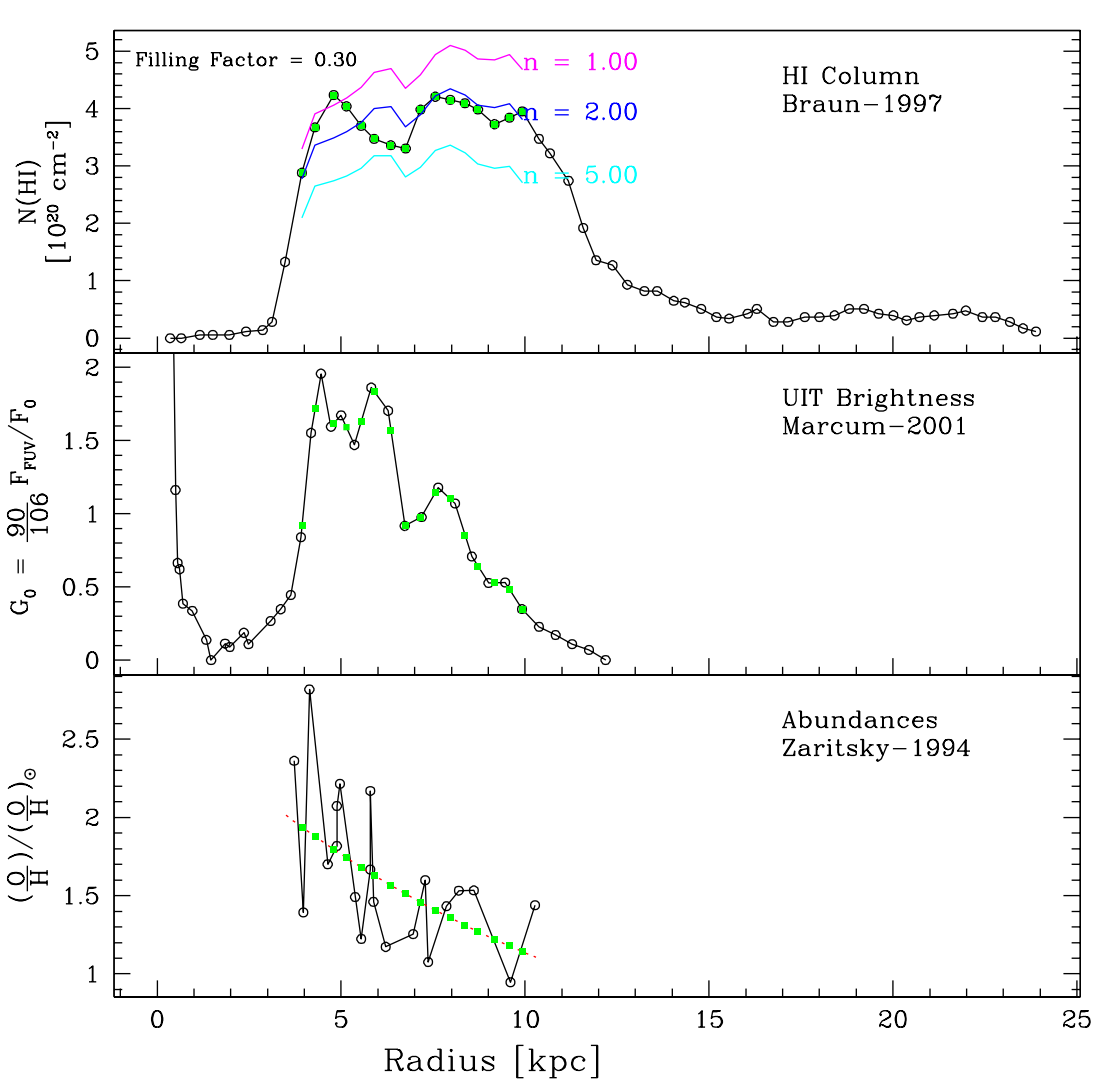
NGC3031
Filling Factor = 0.30
n = 1.00
n = 2.00
n = 5.00
HI Column
Braun−1997
N(HI)
[10²⁰ cm⁻²]
UIT Brightness
Marcum−2001
G₀ = 90/106 F_FUV/F₀
Abundances
Zaritsky−1994
(O/H)/(O/H)⊙
Radius [kpc]

Figure 2: M 81

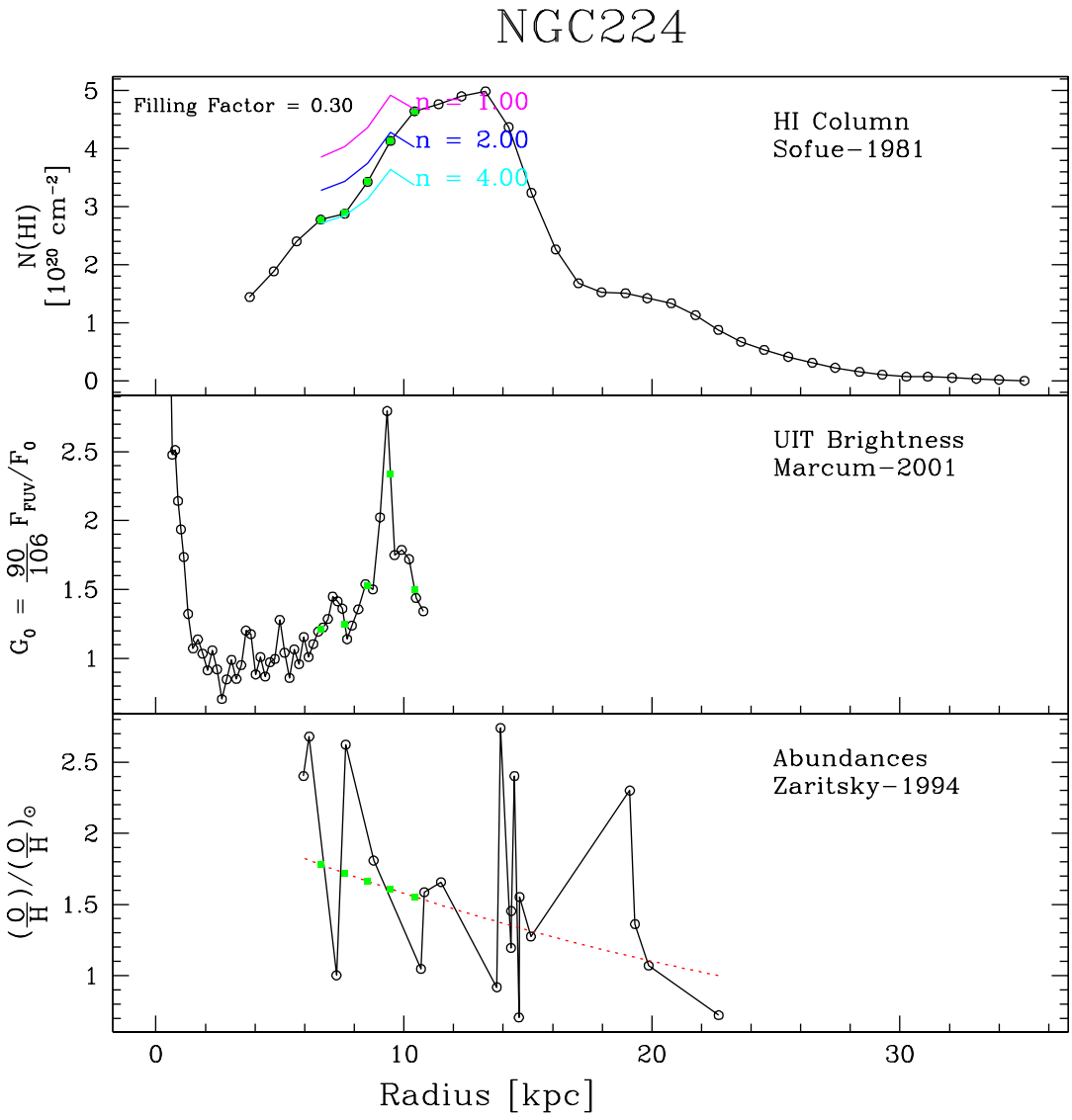
NGC224
Filling Factor = 0.30
n = 1.00
n = 2.00
n = 4.00
HI Column
Sofue−1981
N(HI)
[10²⁰ cm⁻²]
UIT Brightness
Marcum−2001
G₀ = 90/106 F_FUV/F₀
Abundances
Zaritsky−1994
(O/H)/(O/H)⊙
Radius [kpc]

Figure 3: M 31

One observer's wish list

- ...from the theorists, model results for...
  - a range of dust/gas ratios ($0.1 > \delta/\delta_0 > 10$)
  - a range of C.R. ionization rates ($0.1 > \zeta/\zeta_0 > 10$)
  - lower FUV fluxes (down to $G_0 \approx 0.1$)
  - account for a range of ambient starlight
  - better understanding of very low temperature dust properties
- ...and from other observers...
  - better quality and extent of abundance data on nearby galaxies
  - less religion about what CO emission means for N(H_2)
  - less religion about what HI emission means for $\Sigma_{\rm gas}$