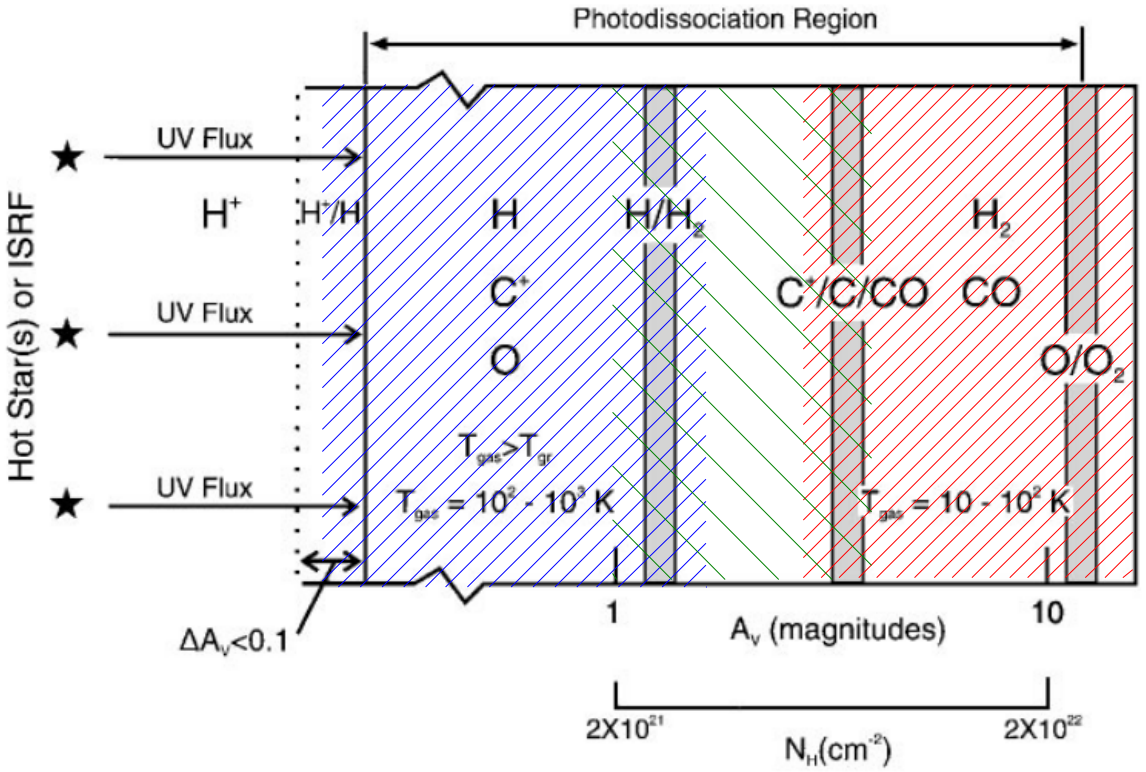
Molecular tracers at low metallicity

Hollenbach & Tielens (1997)



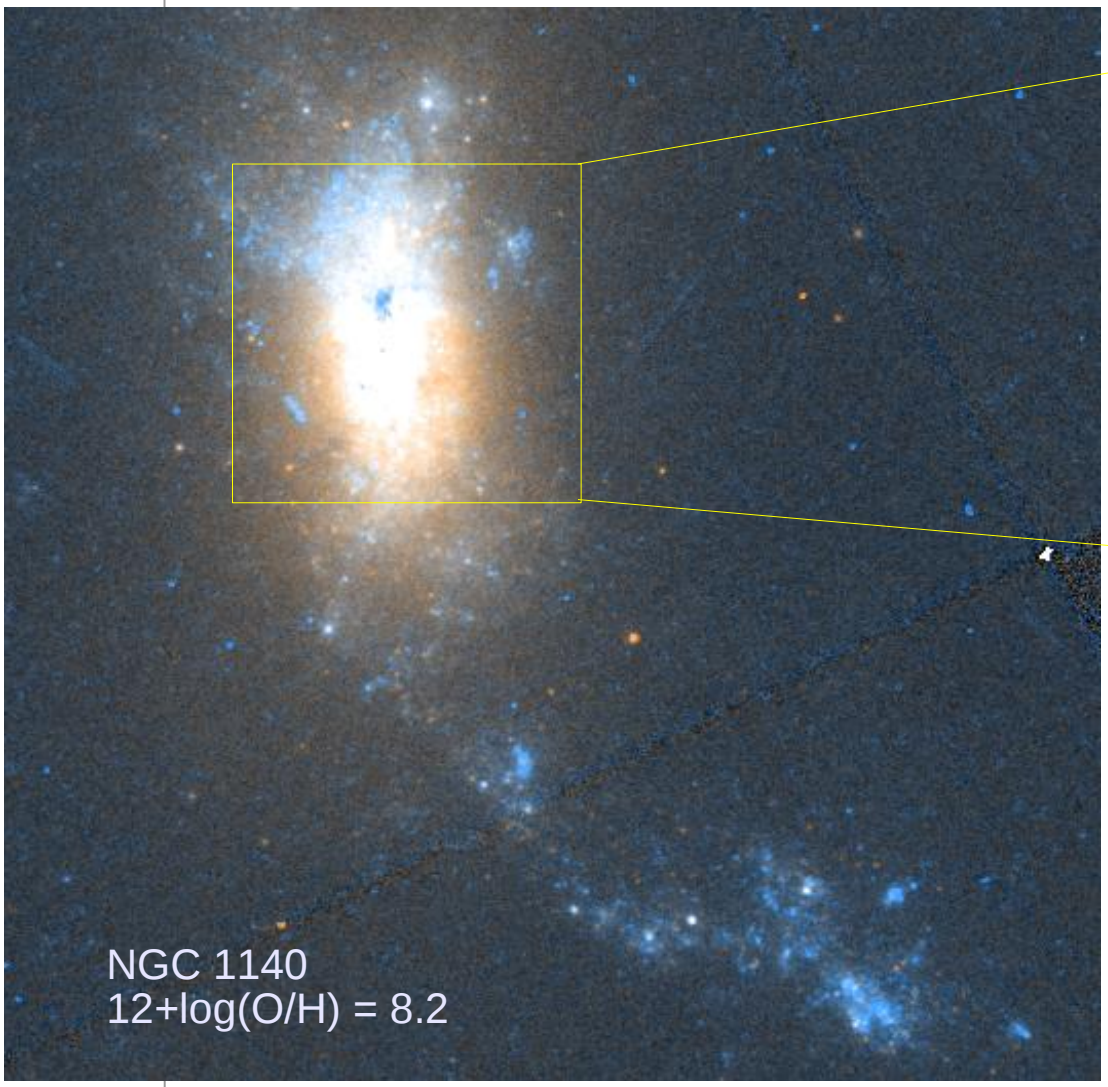
...will help understand abundance constraints (raw material) of a metal-poor ISM and assess the effects of its harder and more intense radiation field on the molecular component...

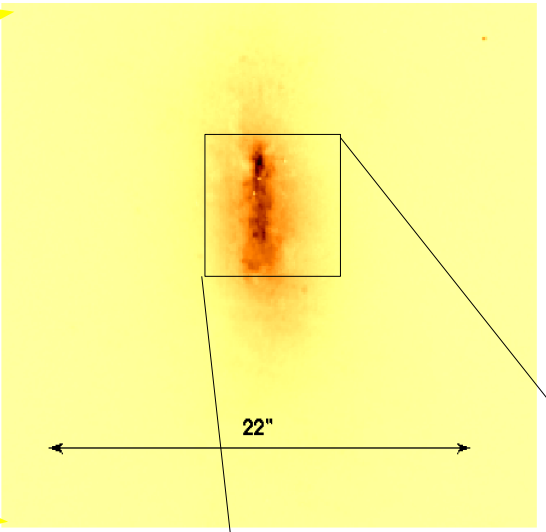
Warm dense gas tracers (e.g., higher-order CO, and large-dipole moment molecules such as HCN, CS, HCO+)

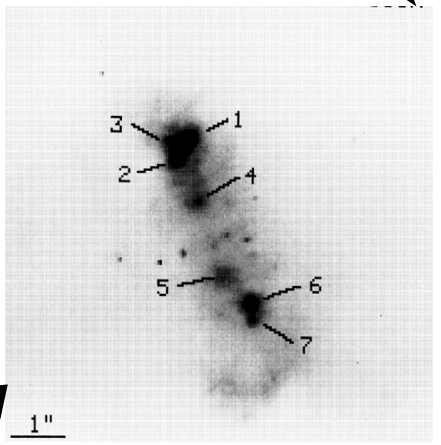
Molecular PDR tracers (e.g., CN, HCO+ since could trace less-dense gas on PDR surfaces and thus be more extended, as in the Magellanic Clouds)

Atomic gas PDR tracers (e.g., [CII], [CI], ...)

Case study: NGC 1140

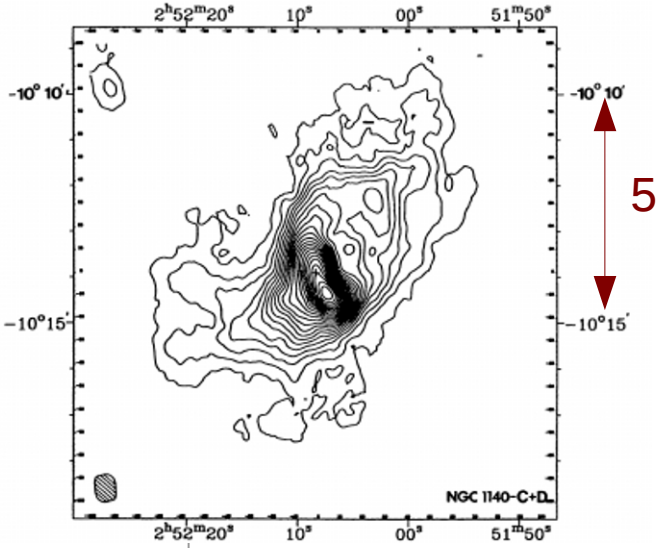




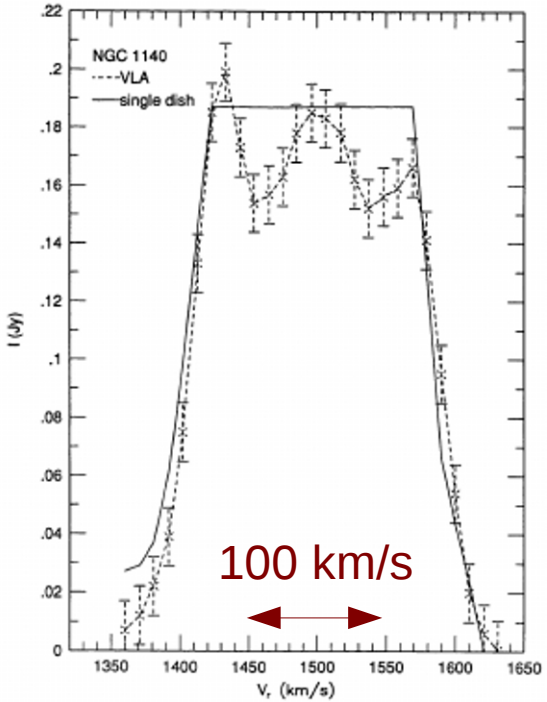


HII regions powered by SSCs containing ~4000 O4 stars (assuming 18.2 Mpc distance) (Hunter+ 1994a, de Grijs+ 2004): faintest of 6 clusters 3x 30Doradus.

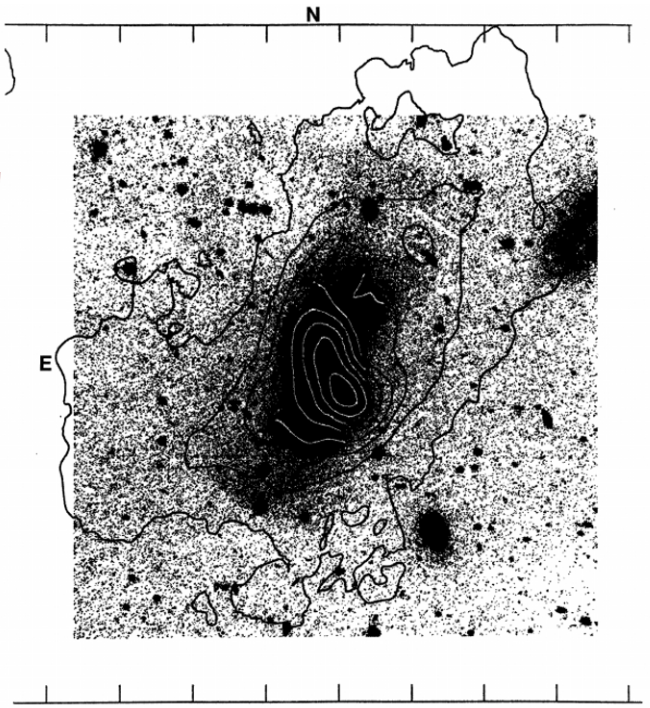
HI content of NGC 1140



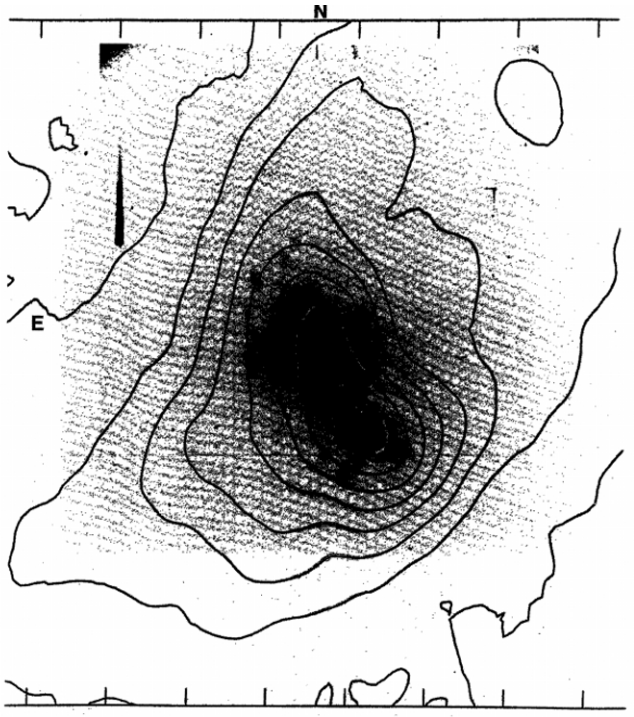
5'



100 km/s



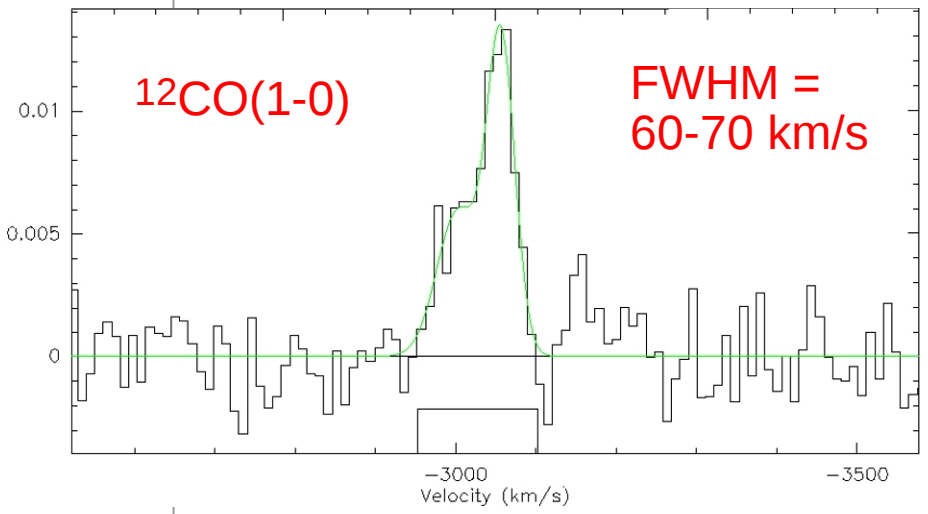
HI on V: ticks 60”

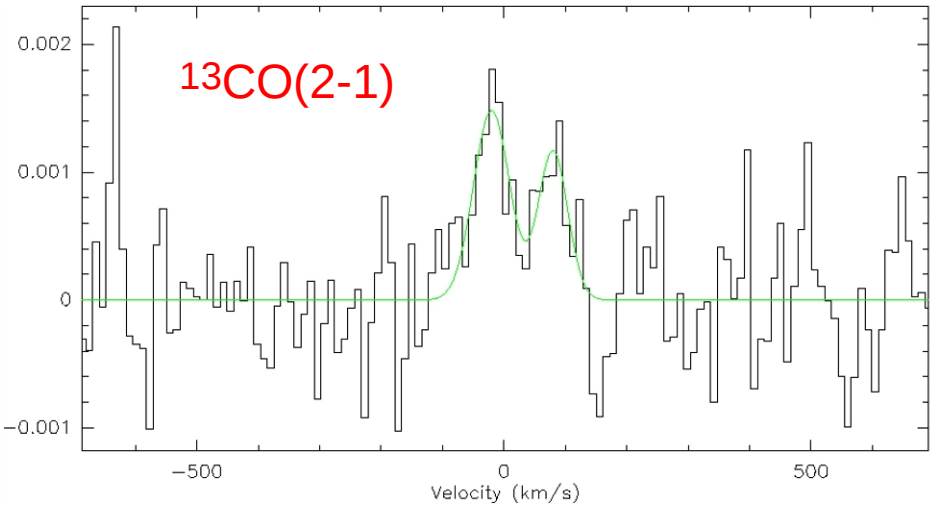


HI on Hα: ticks 30”

HI 16”x22” resolution (Hunter+ 1994b), with peak N(HI) = 2.5×10^{21} cm^{-2}

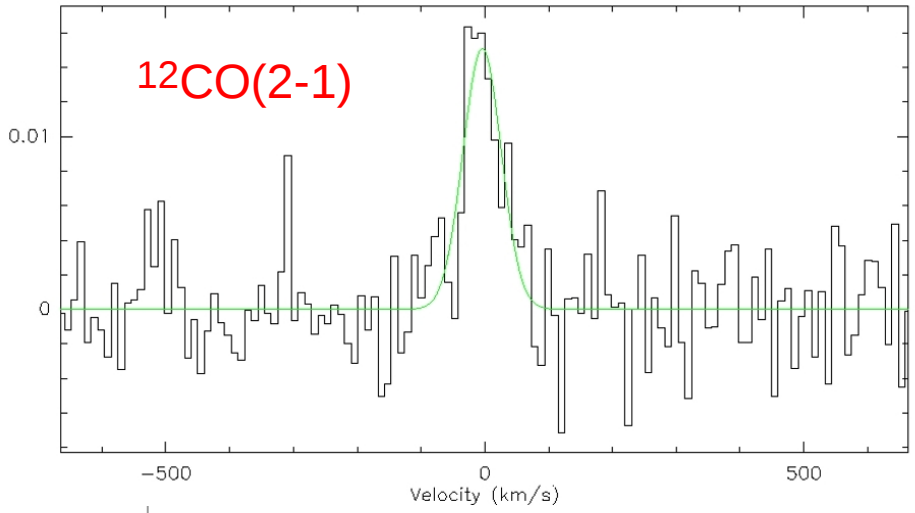
Molecules in NGC 1140: Results from the 30-m (86.5 hrs assigned, 37.5 hrs lost to bad weather) + APEX

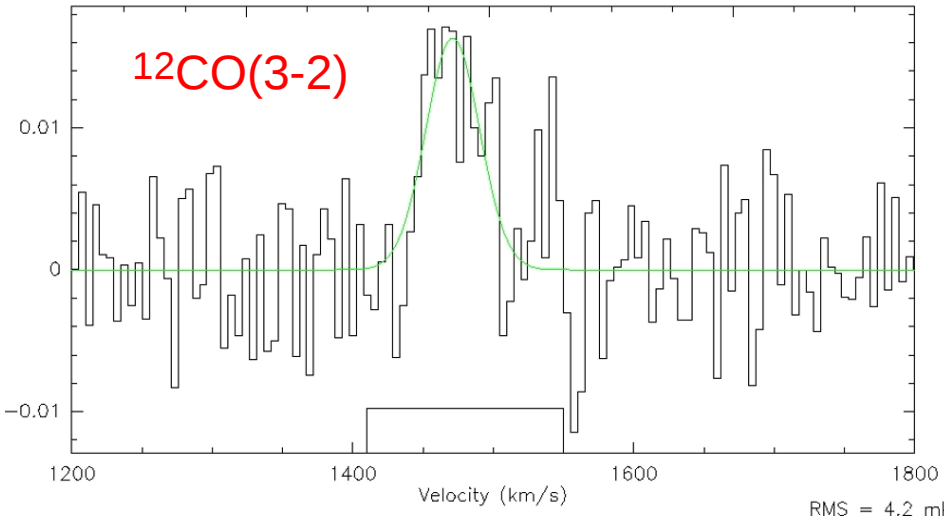




Two CO kinematic components (^{12}CO(2-1) maybe insufficient S/N): strongest blueward

^{13}CO(1-0) not detected (σ=0.6mK, 10.6km/s channels with 20.5 hrs ON +OFF)





Undetected molecules in NGC 1140

Molecule	Trms (mK)	Ratios relative to 12CO(1-0)*
13CO(1-0), 18CO(1-0)	0.6, 0.5	> 15.4
CN(1-0)	1.3	> 6.7
CS(2-1)	0.6	> 15.1
HCN(1-0)	0.4	> 21.1

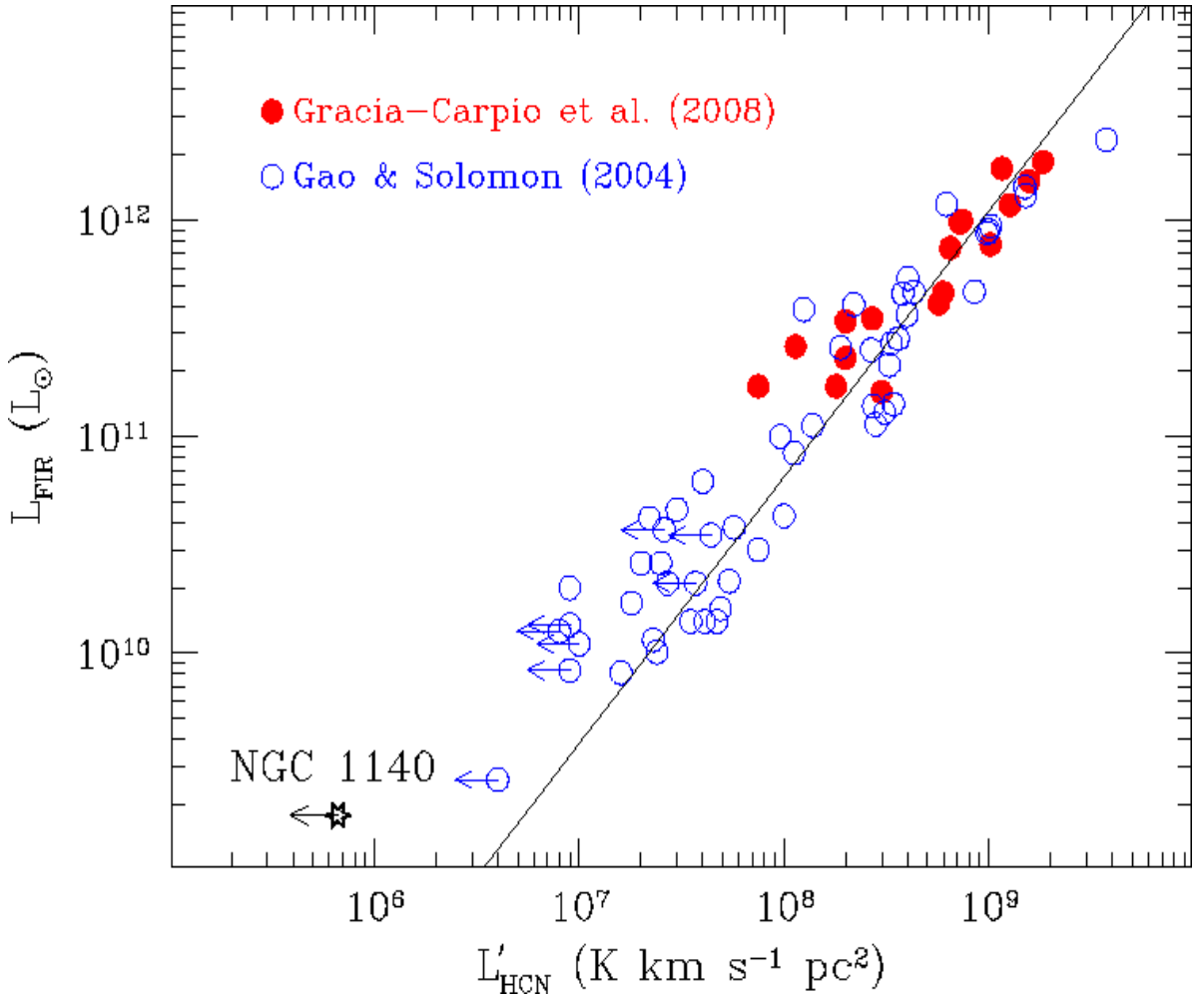
*assuming FWHM 70 km/s

With ^{12}CO(2-1)/^{13}CO(2-1)~6.4, ^{12}CO(1-0)/3σ UL ^{13}CO(1-0)] > 19.2, and assuming abundance ratio ^{12}C/^{13}C~50:

τ(^{13}CO) ~0.05 and 0.2 for the (1-0) and (2-1) transitions, respectively;

τ(^{12}CO) ~ 2.4 and 9 for (1-0), (2-1). Hence, approximately normal behaviour with ^{12}CO emission from warm, optically thick gas, and ^{13}CO optically thin emission.

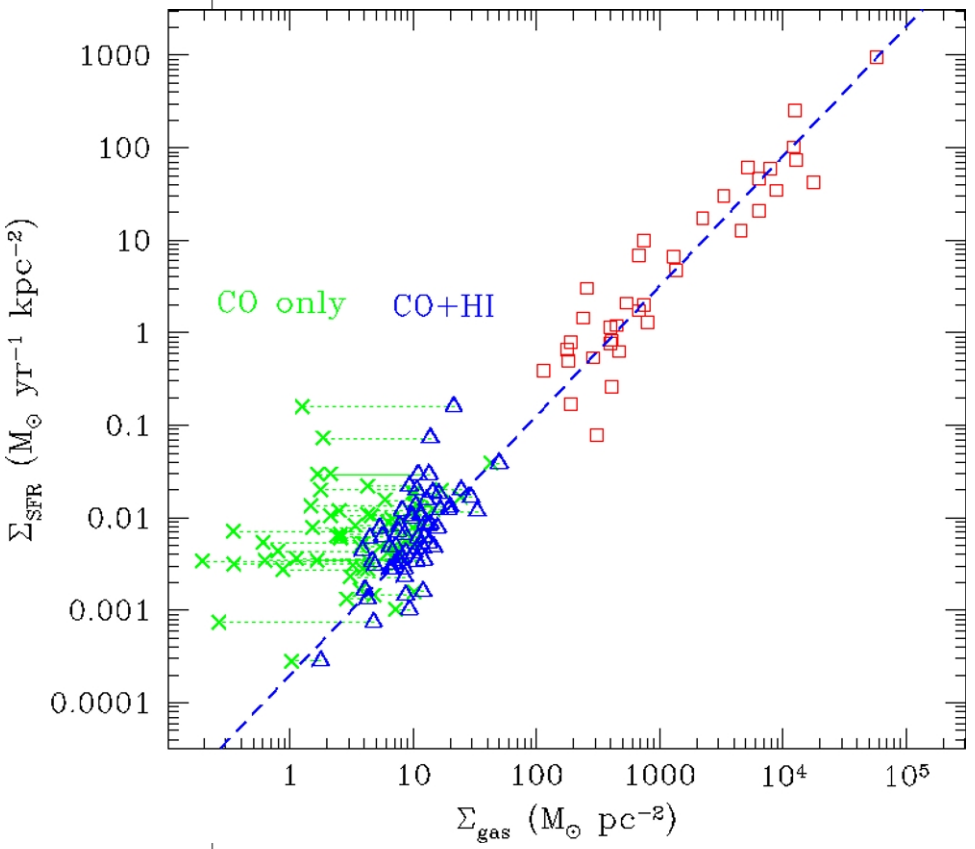
HCN(1-0): (no) dense gas in NGC 1140



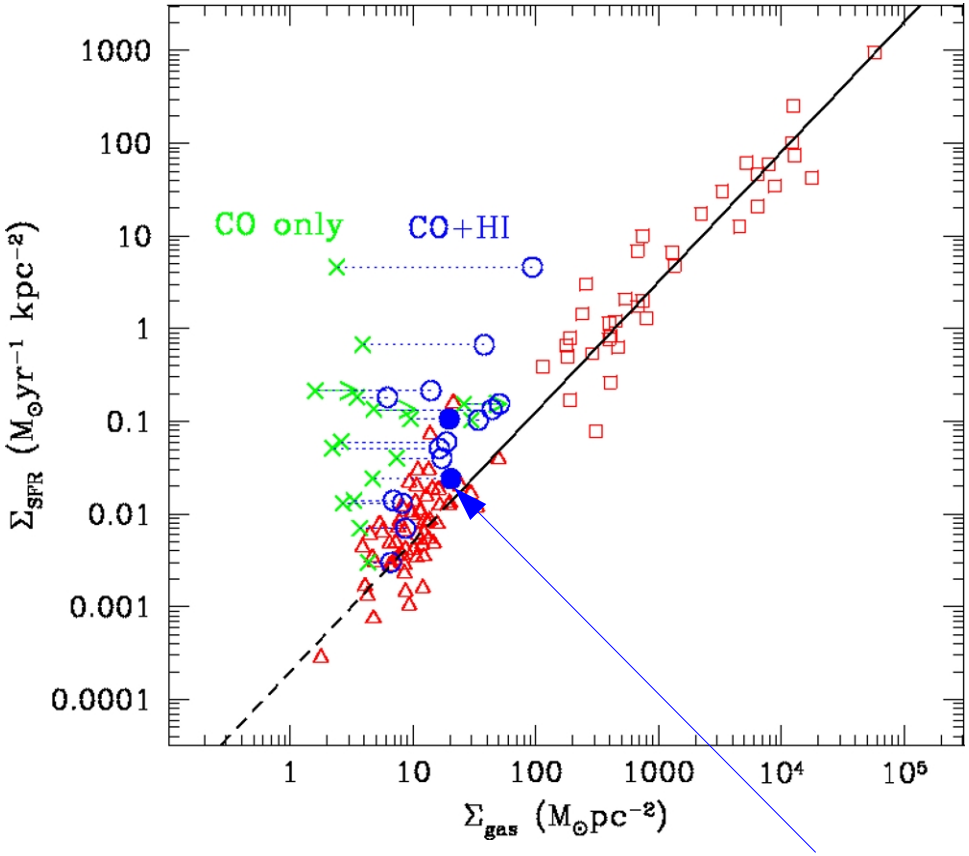
HCN(1-0) 3σ UL low compared to FIR luminosity:
Is there generally less dense gas at low metallicity?

HI and H2 in the Kennicutt-Schmidt law

Kennicutt global averages

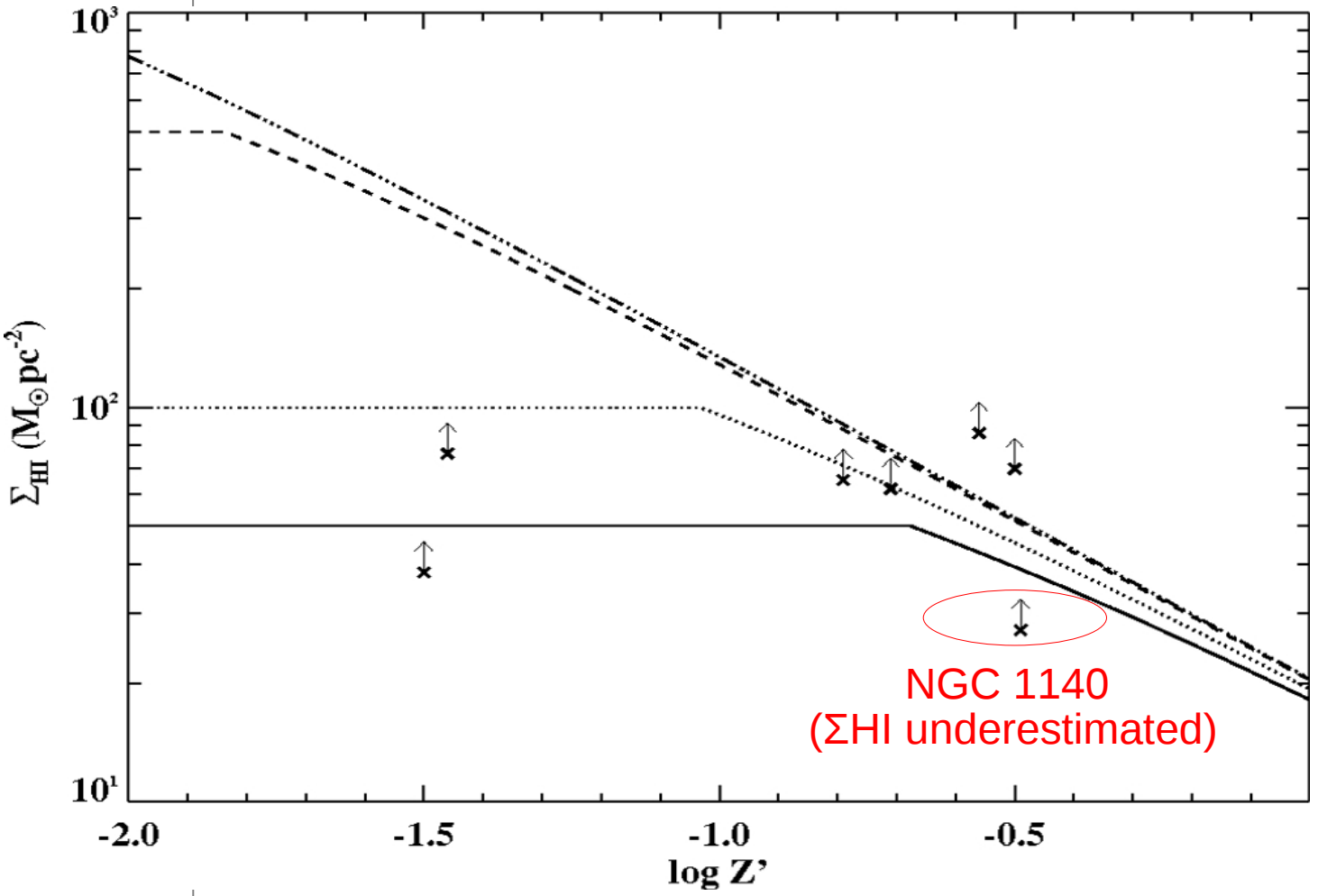


BCDs with Kennicutt in red



Is molecular content of low-metallicity starbursts “normal” (albeit with a larger conversion factor?) Is HI needed to put a galaxy GLOBALLY on the KS relation?

HI and metallicity in the KMT models



Curves correspond to different total gas column densities ((Σ_{gas}=50 M_{sun}/pc^2 for solid line, 100, 500, 1000 M_{sun}/pc^2)

HI saturation threshold at higher column densities for lower metal abundance (taken from Fumagalli, Krumholz, & Hunt 2010)