Cold HI in faint dwarf galaxies

Narendra Nath Patra[1] ⋆, Jayaram N. Chengalur[1], Igor D. Karachentsev[2], Serafim S. Kaisin[2]
Ayesha Begum[3]
[1] *NCRA-TIFR, Post Bag 3, Ganeshkhind, Pune 411 007, India*
[2] *Special Astrophysical Observatory, Nizhniy Arkhyz, Karachai-Cherkessia 369167, Russia*
[3] *IISER-Bhopal,ITI Campus (Gas Rahat)Building,Govindpura, Bhopal - 23, India.*

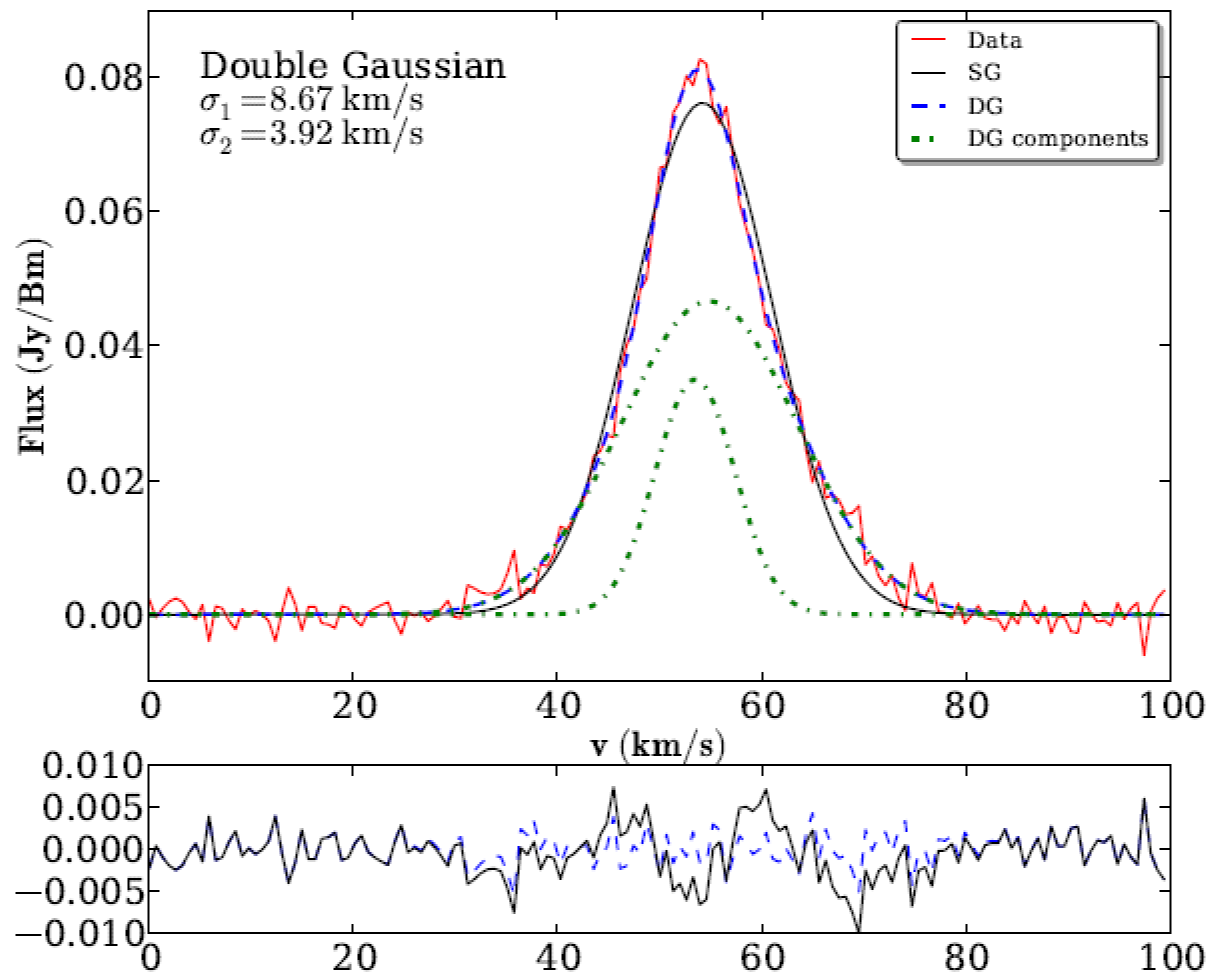
ABSTRACT
We present the results of a study of the amount and distribution of cold atomic gas, as well its correlation with recent star formation in a sample of extremely faint dwarf irregular galaxies. Our sample is drawn from the Faint Irregular Galaxy GMRT Survey (FIGGS) and its extension, FIGGS2. We use two different methods to identify cold atomic gas. In the first method, line-of-sight HI spectra were decomposed into multiple Gaussian components and narrow Gaussian components were identified as cold HI . In the second method, the brightness temperature (T_B) is used as a tracer of cold HI . We find that the amount of cold gas identified using the T_B method is significantly larger than the amount of gas identified using Gaussian decomposition. We also find that a large fraction of the cold gas identified using the T_B method is spatially coincident with regions of recent star formation, although the converse is not true. That is only a small fraction of the regions with recent star formation are also covered by cold gas. For regions where the star formation and the cold gas overlap, we study the relationship between the star formation rate density and the cold HI column density. We find that the star formation rate density has a power law dependence on the HI column density, but that the slope of this power law is significantly flatter than that of the canonical Kennicutt-Schmidt relation.

Key words: galaxies: dwarf - galaxies: evolution - galaxies: ISM

1 INTRODUCTION

detect in absorption, and its properties hence remain observationally not very established. Theoretical studies however indicate that

- Недавние наблюдения выявли, что часть HI в Галактике находятся в области тепловой неустойчивости.
- Цель: выделение cold HI в 62 неправильных галактиках, связь со SF и выделение Unstable Neutral Medium (UNM).
- Два метода выделения: по профилю линии (разрешение 400 пк) и по высокой T_b (разрешение 100 пк).



Double Gaussian
$\sigma_1 = 8.67$ km/s
$\sigma_2 = 3.92$ km/s
Data
SG
DG
DG components
Flux (Jy/Bm)
0.08
0.06
0.04
0.02
0.00
0
20
40
60
80
100
v (km/s)
0.010
0.005
0.000
−0.005
−0.010
0
20
40
60
80
100

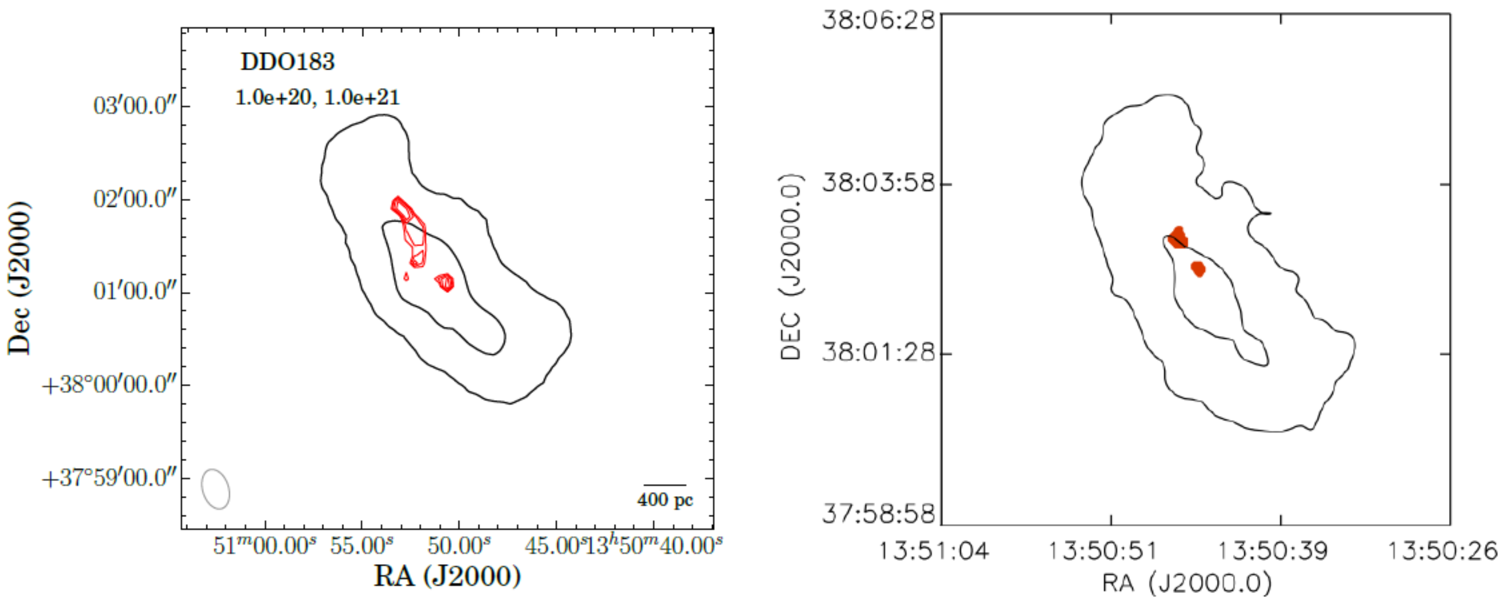


Figure 3. Left panel: Recovered cold HI in DDO183 using `'multigauss'` routine. Right panel: Recovered cold HI using Gaussian decomposition method by Warren et al. (2012)

T_b method значительно лучше выделяет холодный газ и коррелирует со SF

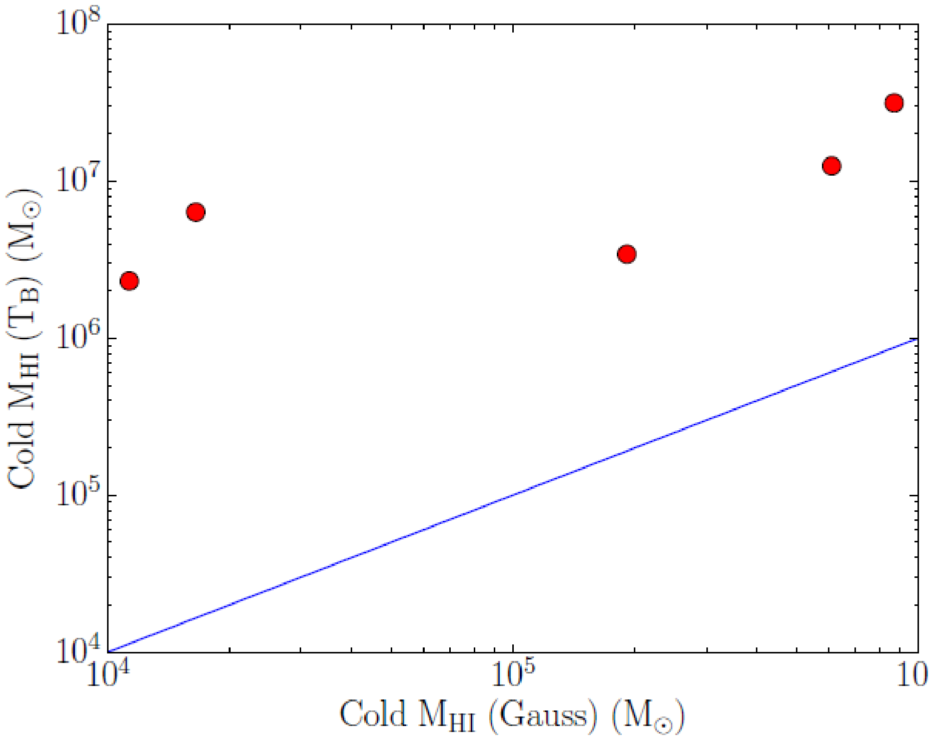


Figure 7. Comparison of cold HI mass estimated in the two different metl
ods as discussed in the text. The blue solid line represent the 1:1 limit. Froi
the figure it can be seen clearly that T_B method recovers more cold HI a
compared to Gaussian decomposition method, however no obvious tren
between the detected cold HI in T_B method and in Gaussian decompos
tion method can be found.

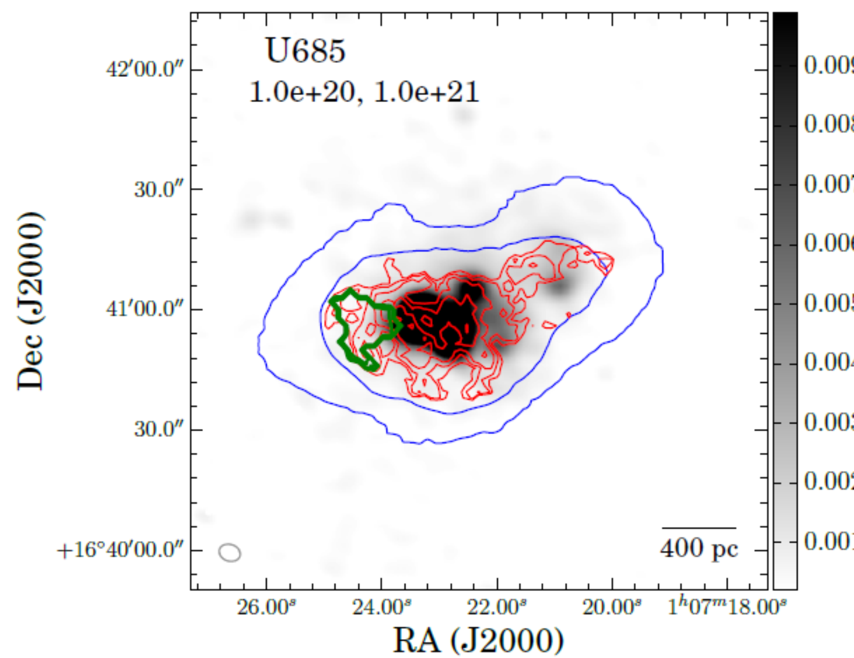


Figure 6. Cold HI as recovered by two different methods shown in contours overlaid on Hα map in gray scale. The red solid contours represent cold HI recovered by T_B method and the green thick contours are the same for Gaussian decomposition method. The contours levels are $(1, 1.4, 2, 2.8, 4, 5.6, 8, 11.2, 16, 22.4, \ldots)\ 1.5 \times 10^{21}$ atoms cm^{-2} for cold HI detected by T_B method (red solid contours) and $(1, 1.4, 2, 2.8, 4, 5.6, 8, 11.2, 16, 22.4, \ldots)\ 6.2 \times 10^{20}$ atoms cm^{-2} for cold HI recovered by Gaussian decomposition method (green thick contours). The spatial resolution of Hα data and the T_B data is $\sim$ 100 pc.

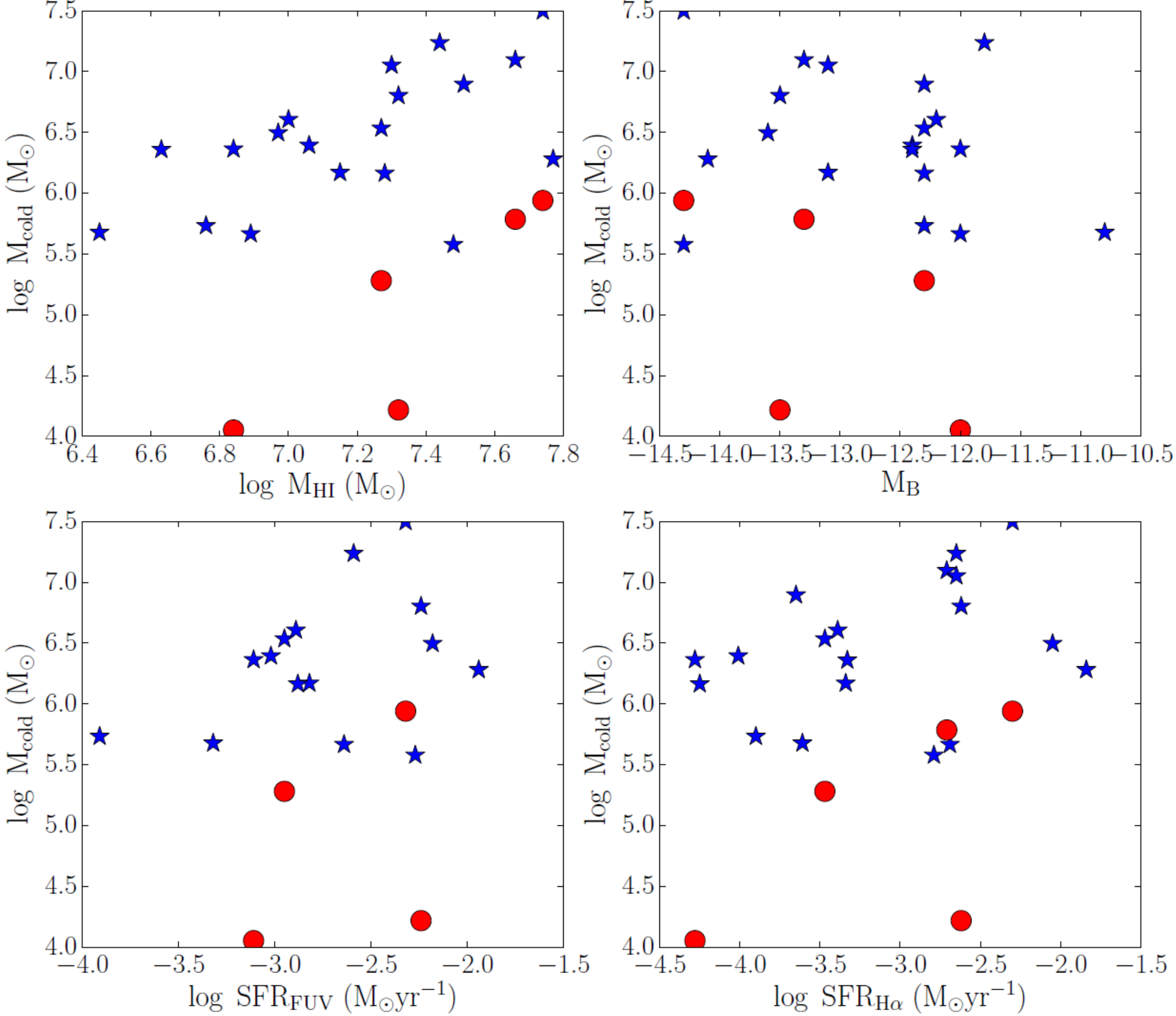


Figure 9. In all the panels, filled circles represents cold HI recovered by the Gaussian decomposition method while filled stars represents cold HI recovered by T_B method (optically thin approximation). Top left : The scatter plot of cold HI mass with total HI mass (M_{HI}) Top right : The scatter plot of cold HI mass with the absolute blue magnitude (M_B). Bottom left : The scatter plot of cold HI mass with star formation rate, as deduced from the FUV emission (SFR_{FUV}). Bottom right: The scatter plot of cold HI mass with star formation rate, as deduced from the Hα star-formation rates ($SFR_{H\alpha}$). See the text for more details on the derivation of the star formation rates.

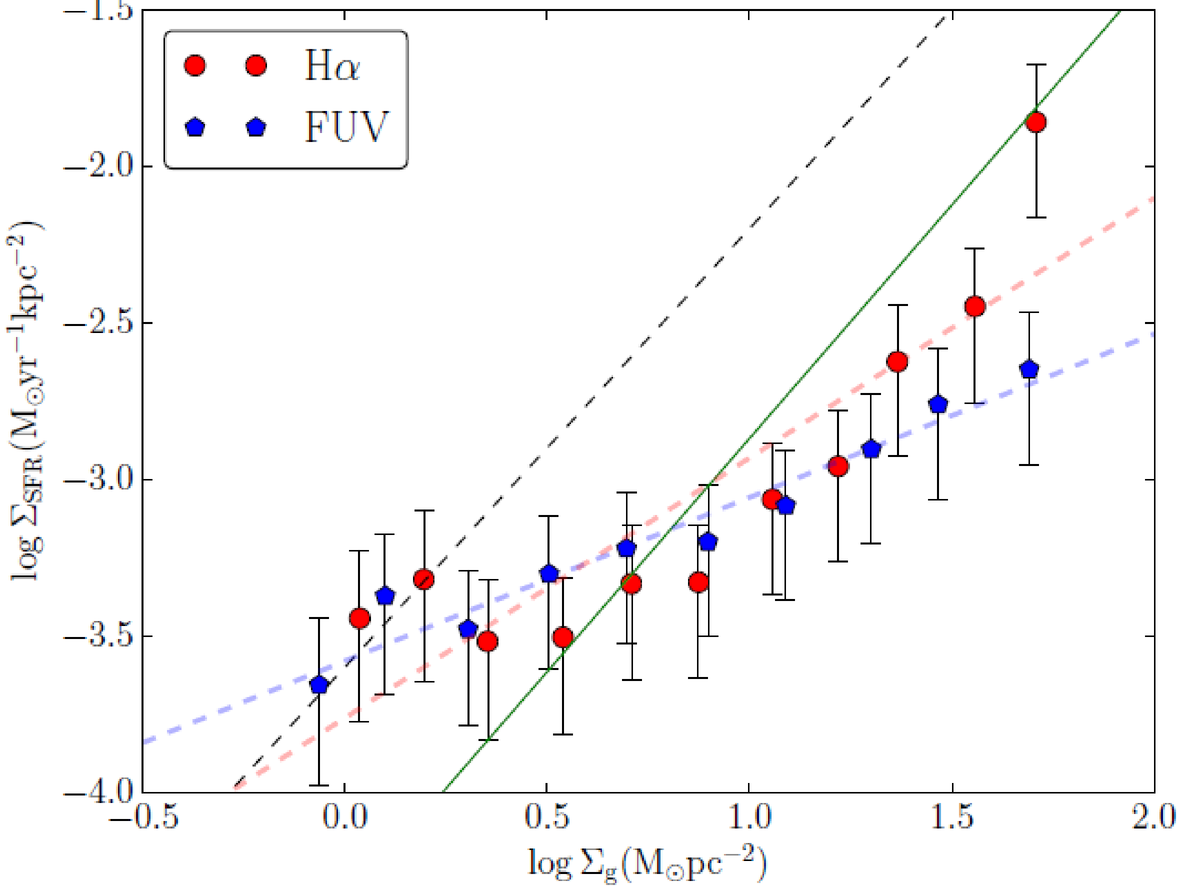


Figure 15. The Kennicutt-Schmidt law for cold HI . The red filled circles with error bars represent data points for our sample galaxies using the star formation rate as measured from the Hα emission and the red thick dashed line is the straight line fit to these data points. The blue filled pentagons represent the data points for which star formation rate density is measured using FUV maps and the thick blue dashed line represents a straight line fit to these points. The green solid line represents K-S law for FIGGS galaxies (Roychowdhury et al. 2009), measured using the total gas content (i.e. not just the cold gas) at 400 pc resolution. The thin black dashed line represents the canonical K-S law (Kennicutt 1998).

To summarize

- **We find that the narrow velocity dispersion components do not overlap with the locations of the highest column density HI or the locations of the brightest H \alpha emission. This is somewhat surprising if the narrow velocity dispersions are accurately tracing the cold gas content of the galaxies.**
- **The amount of gas identified as being cold by the T_{B} - method is significantly larger than the amount of gas identified as being cold using Gaussian . For our sample of galaxies**
- **70% of the cold gas has some associated recent star formation as traced by H emission and 90% of the cold gas are associated with star formation as measured by FUV emission.**
- **If we focus on the regions where SFR correlates to HI, we find a slope (0.83for H\alpha and 0.52 for FUV star formation), that is significantly flatter than that seen in earlier studies which used the total (as opposed to the cold) gas content.**

А ПОЧЕМУ???