

Massive stars formed in atomic hydrogen reservoirs

Michał Jerzy Michałowski
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Institute for Astronomy, University of Edinburgh

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East Asian Observatory

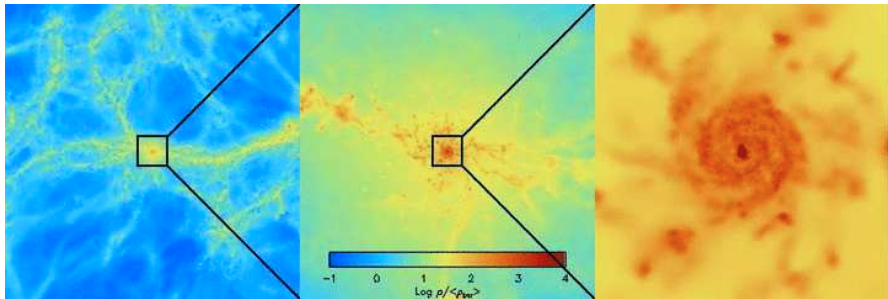
Outline

- 1 Introduction
- 2 HI survey of gamma-ray burst (GRB) host galaxies

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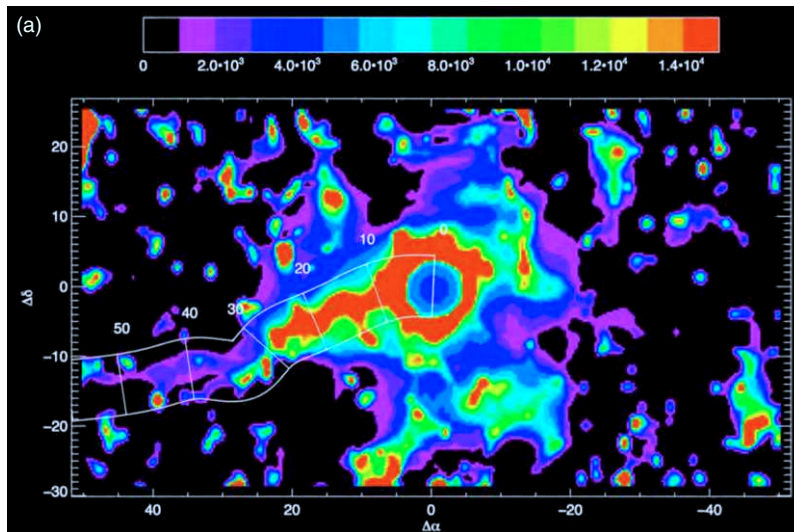
- 1 Introduction
- 2 HI survey of gamma-ray burst (GRB) host galaxies

Gas fuelling



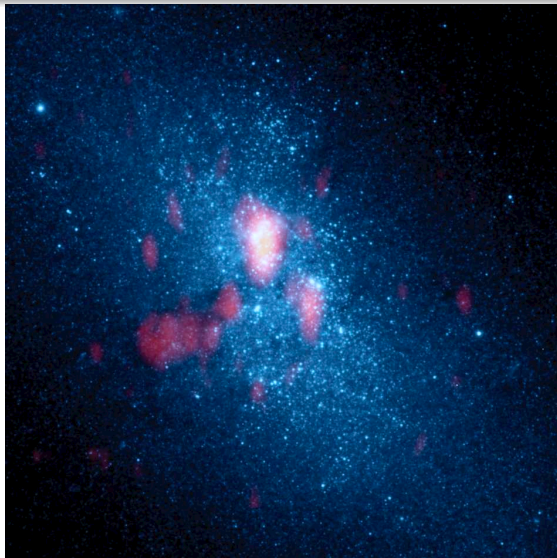
Schaye et al. (2010, MNRAS, 402, 1536)

Observational evidence



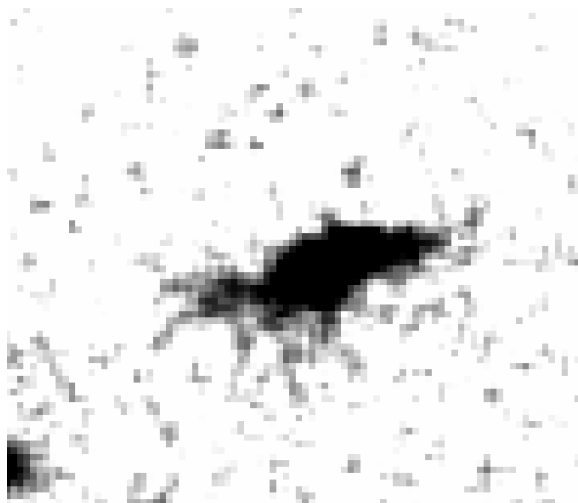
QSO 1549+19 (Martin et al. 2014, ApJ, 786, 106)

Observational evidence



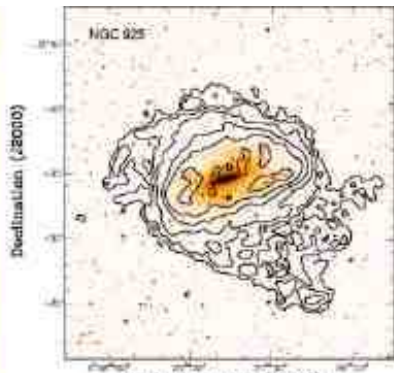
dwarf NGC 5253 (Turner et al. 2015, Nature, 519, 331)

Observational evidence



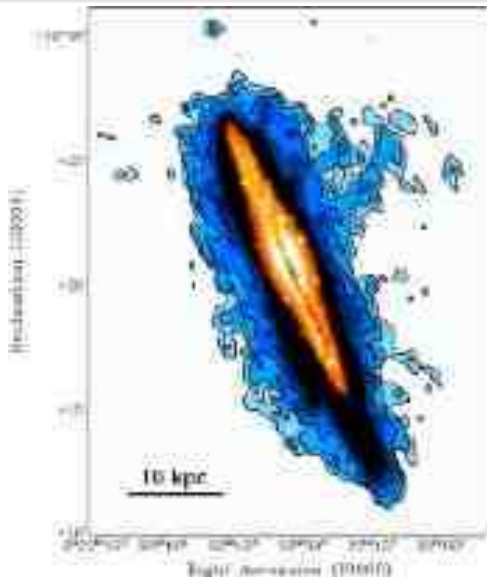
$z = 3.344$ Lyman alpha emitter (Rauch et al. 2016, MNRAS, 455, 3991)

Indirect evidence



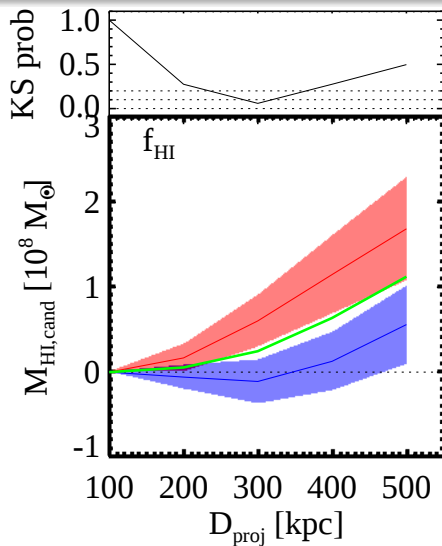
interaction with dwarfs (Sancisi et al. 2008, A&AR, 15, 189)

Indirect evidence



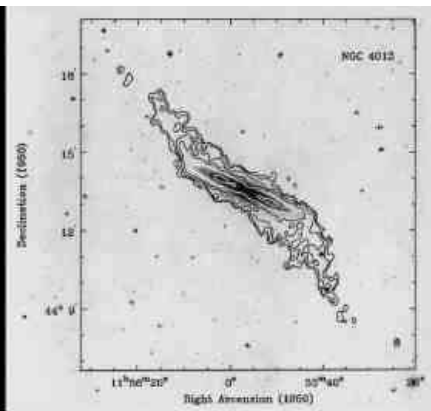
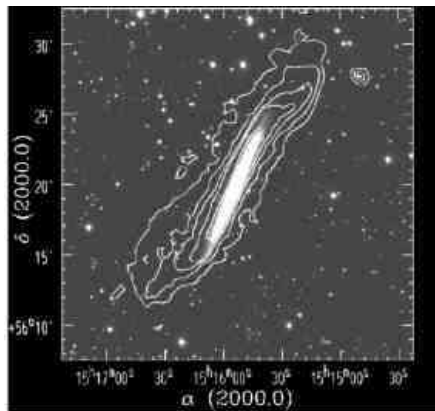
Extra-planar HI (Sancisi et al. 2008, A&AR, 15, 189)

Indirect evidence



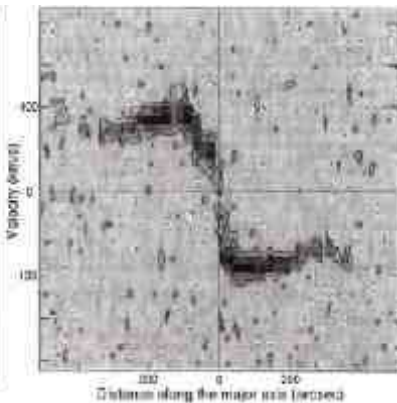
HI outside galaxies (Wang et al. 2015, MNRAS, 453, 2399)

Indirect evidence



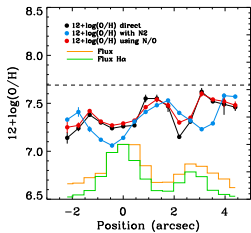
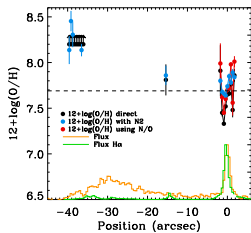
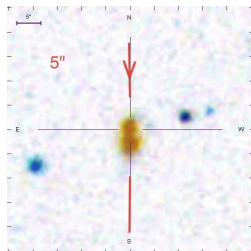
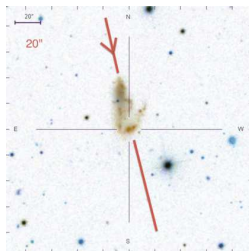
Extended, warped HI disks (Sancisi et al. 2008, A&AR, 15, 189)

Indirect evidence



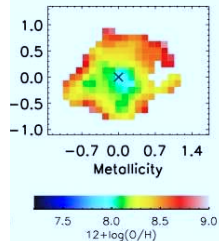
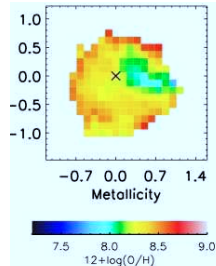
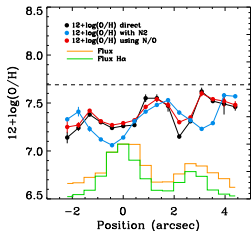
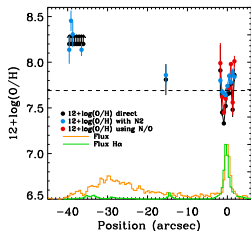
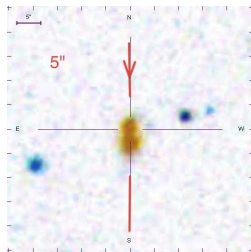
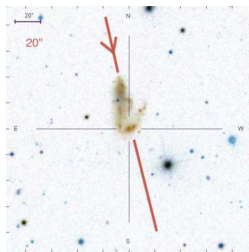
Lopsidedness (Sancisi et al. 2008, A&AR, 15, 189)

Metal-poor regions in galaxies: recent gas accretion



Sánchez Almeida et al. (2014, ApJ, 783, 45)

Metal-poor regions in galaxies: recent gas accretion



Molecular vs atomic gas

Before bonding

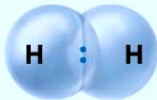


Hydrogen atom



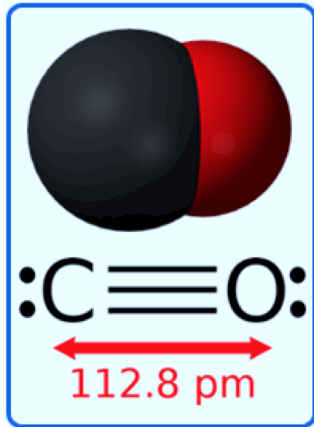
Hydrogen atom

Covalent bond formed



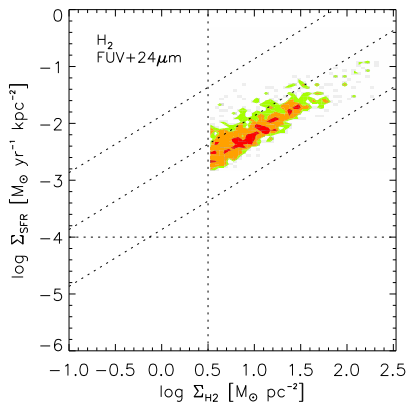
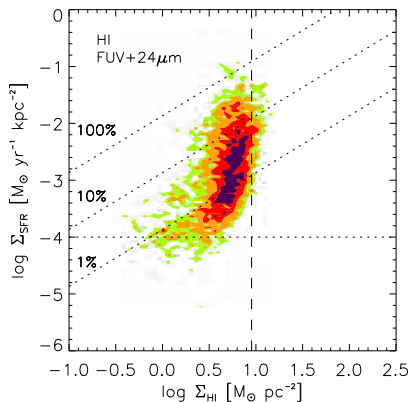
Hydrogen molecule, H_2

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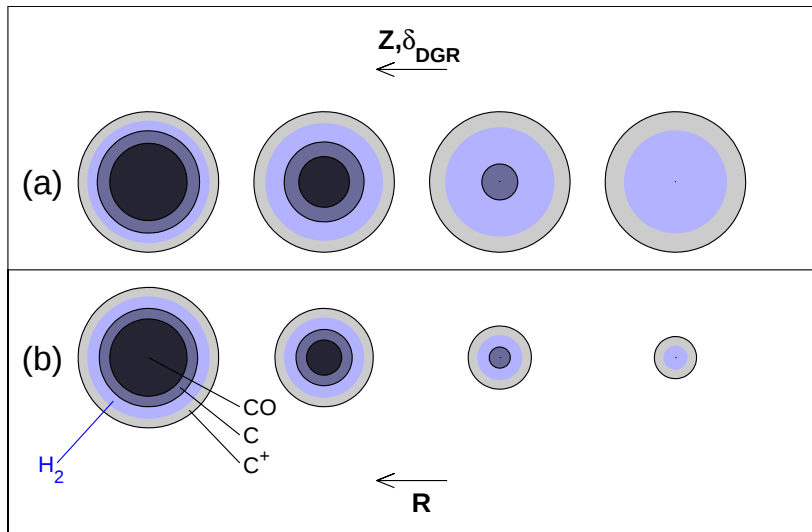
<http://floridaindoorairquality.com/content/carbon-monoxide-poisoning>

What fuels the star-formation: molecular vs atomic gas

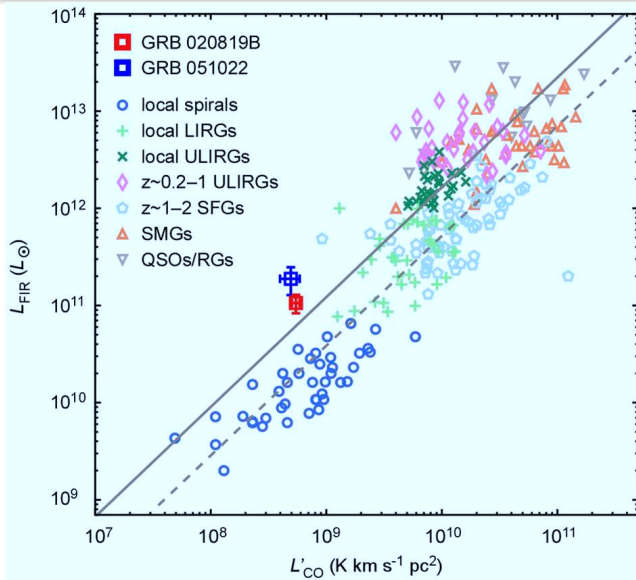


Bigiel et al. (2008, AJ, 136, 2846)

Shielding from radiation



Molecular gas deficiency?

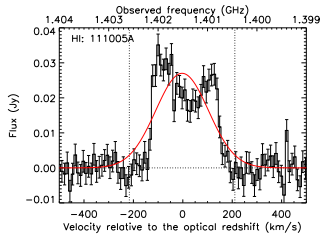
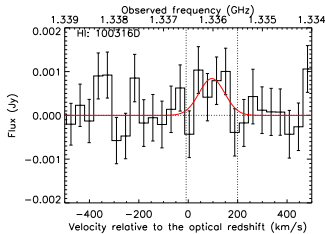
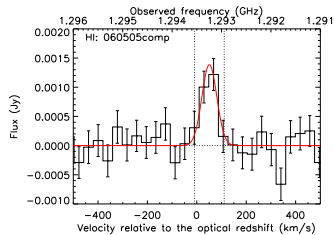
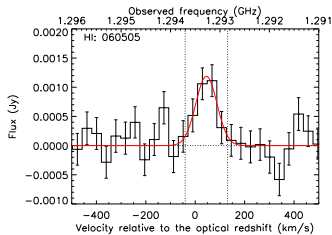
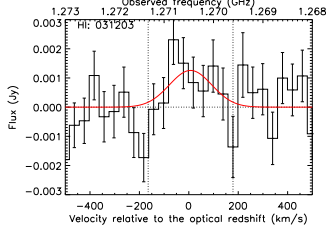
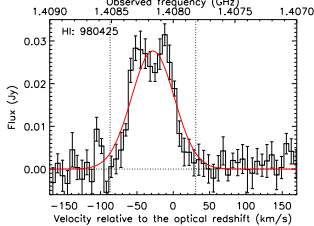


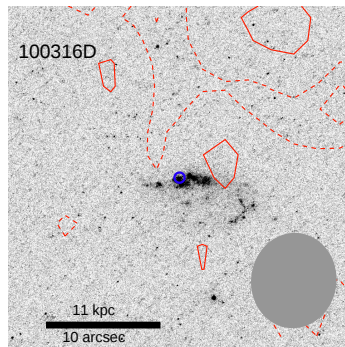
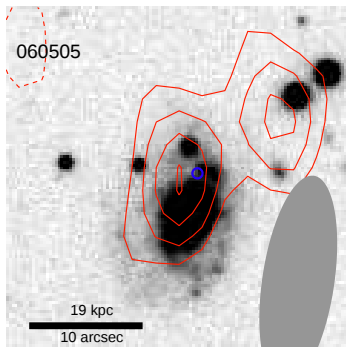
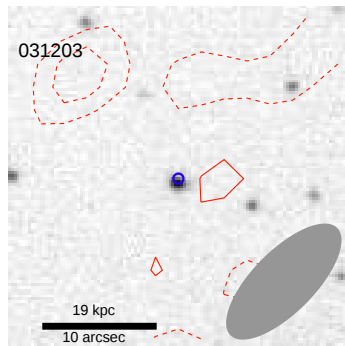
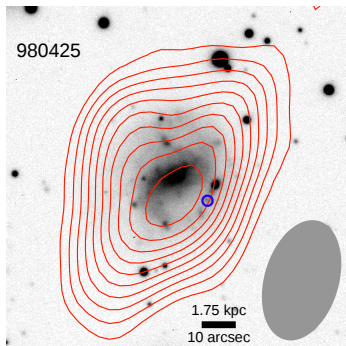
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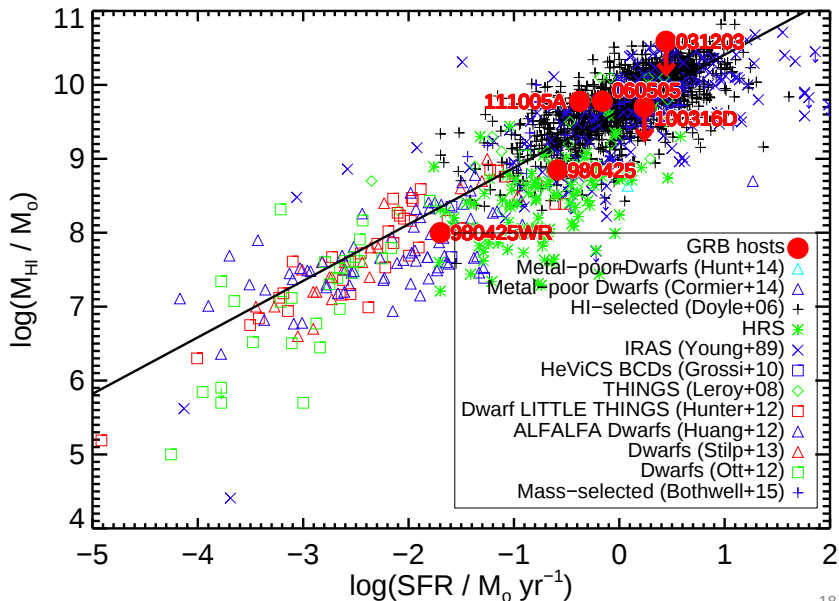
ATCA HI GRB host survey details

- Australia Telescope Compact Array (ATCA)
- 5 targets at $z = 0.0085\text{--}0.105$
- 12 Apr 2012, 18–25 Apr 2013, 11–14 Apr 2014
- ~ 150 hr on source (plus calibration)

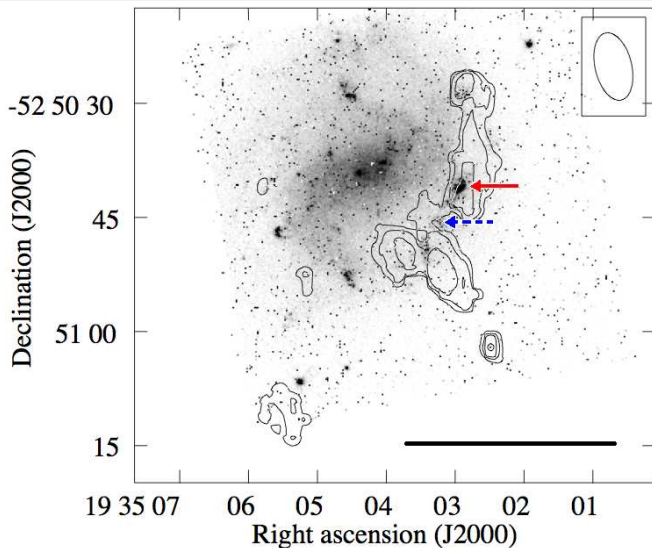




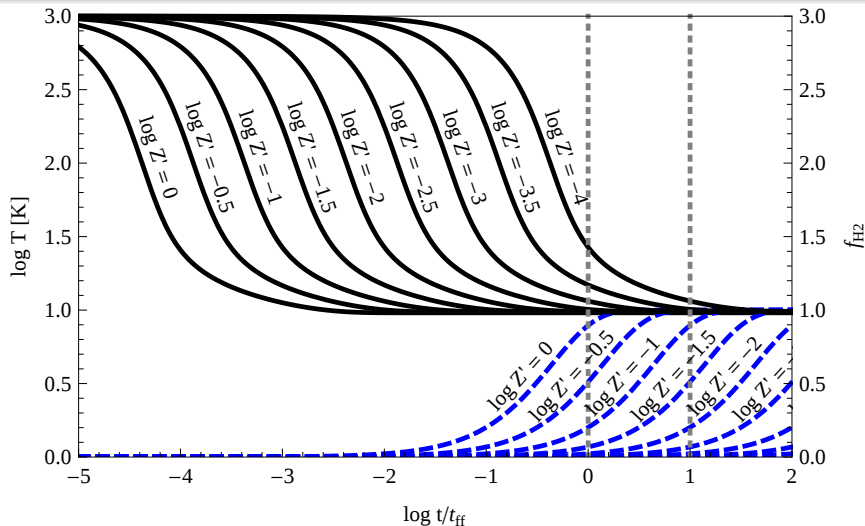
Star formation rate vs atomic gas mass



Follow-up high-resolution H I observations

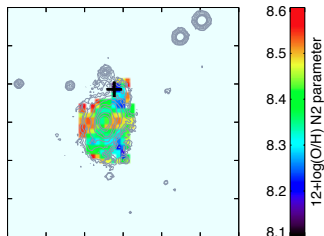
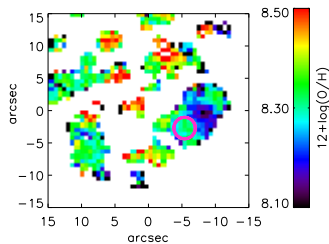


Star-formation fuelled directly in atomic gas



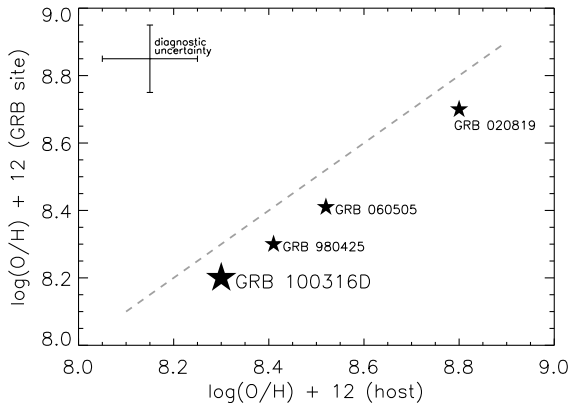
Krumholz (2012, ApJ, 759, 9)

GRBs explode in the metal-poor regions of their hosts



Christensen et al. (2008, A&A., 490, 45)

Thöne et al. (2014, MNRAS, 441, 2034)



Levesque et al. (2011, ApJ, 739, 23)

Conclusions

- Inflow of gas is required to fuel star formation, and should be ubiquitous
- However, it is difficult to detect the inflowing gas
- GRB hosts at early stages of a star formation episode (which implies low metallicity)
- HI-fuelled star-formation? Accretion of metal-poor atomic gas?
- Strong connection between star-formation and atomic gas
- More details in Michałowski et al. (2015, A&A, 582, A78)
- Next step: high-resolution H I observations