The Cosmic Evolution of Molecular Gas in Galaxies

Chris Power (ICRAR/UWA)
Claudia Lagos, Cedric Lacey & Carlton Baugh
(ICC/Durham), Hansik Kim (Melbourne)

Australian ALMA Community Workshop,
ATNF, May 5th/6th 2011

International
Centre for
Radio
Astronomy
Research

Curtin University

THE UNIVERSITY OF
WESTERN AUSTRALIA
Achieve International Excellence

The Cosmic Evolution of Molecular Gas in Galaxies

Chris Power (ICRAR/UWA)
Claudia Lagos, Cedric Lacey & Carlton Baugh
(ICC/Durham), Hansik Kim (Melbourne)

Australian ALMA Community Workshop,
ATNF, May 5th/6th 2011

Outline

- Modelling Galaxy Formation
  - Focus on Semi-Analytics

- Cosmic Evolution of Cold Gas…
  - Easy to make predictions

- … and Molecular Gas in Galaxies
  - Harder to make predictions

Community resource – please use!

Modelling Galaxy Formation

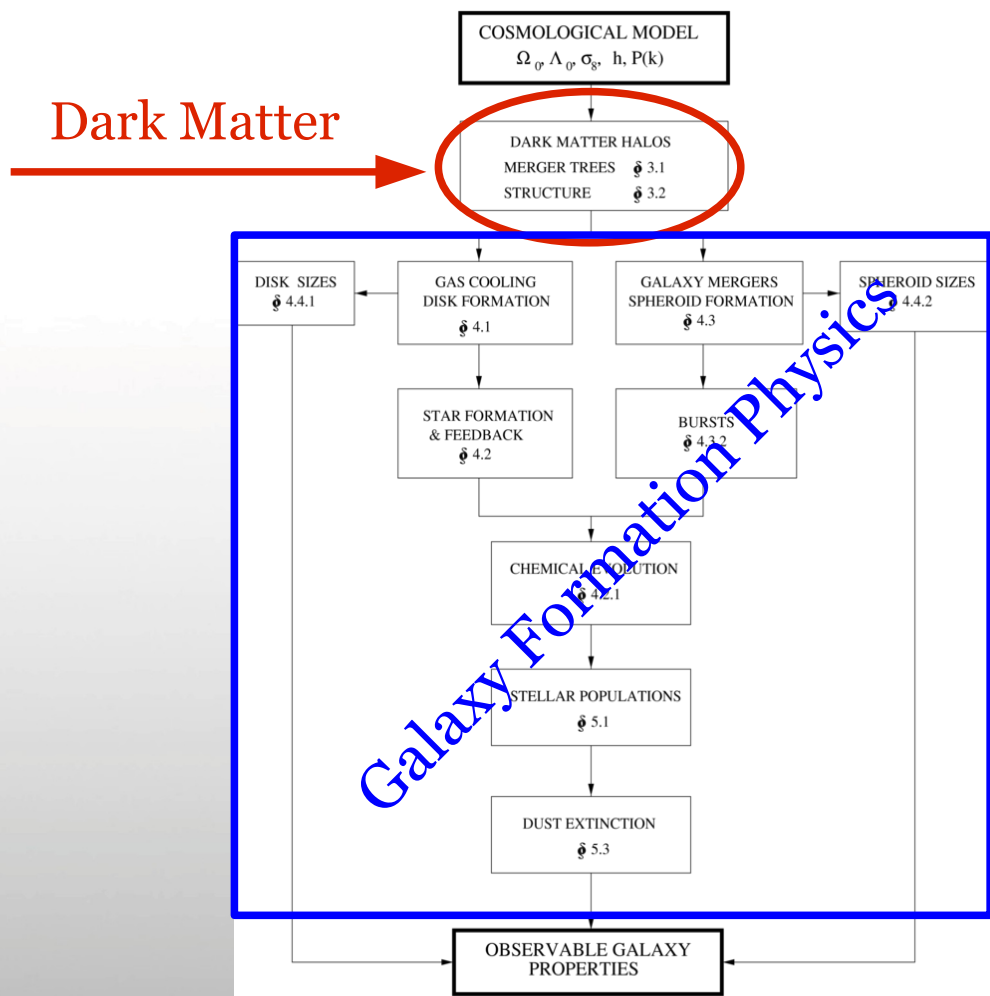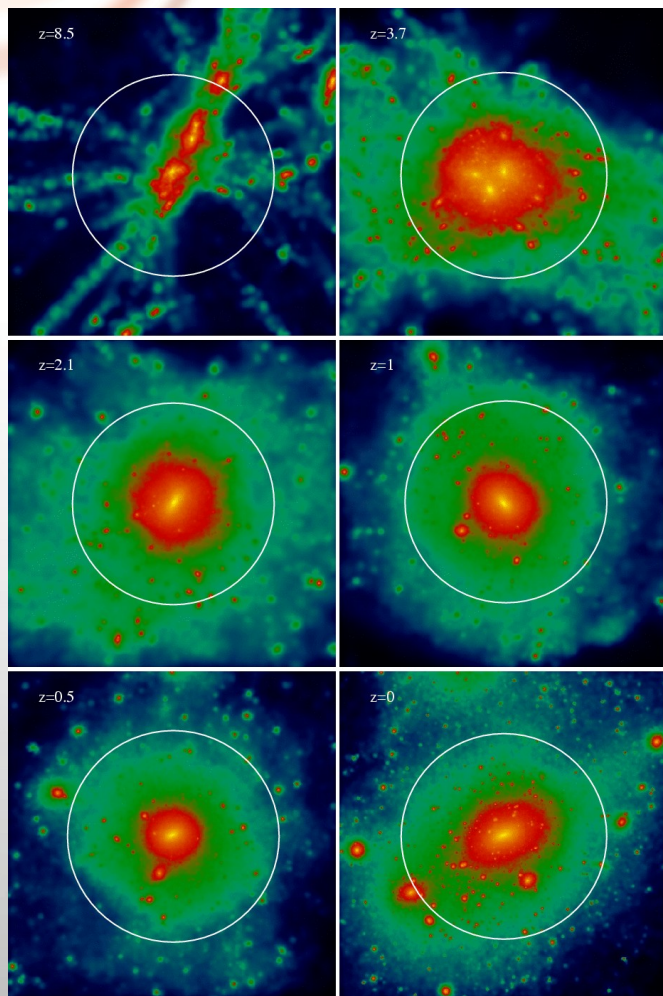We know how to model the dark matter framework – but how do we model galaxies?

Problem: Physics of galaxy formation uncertain.
Approximation: Simple parameterised models.

Can models reproduce observed galaxy properties?

Semi-Analytical Galaxy Formation
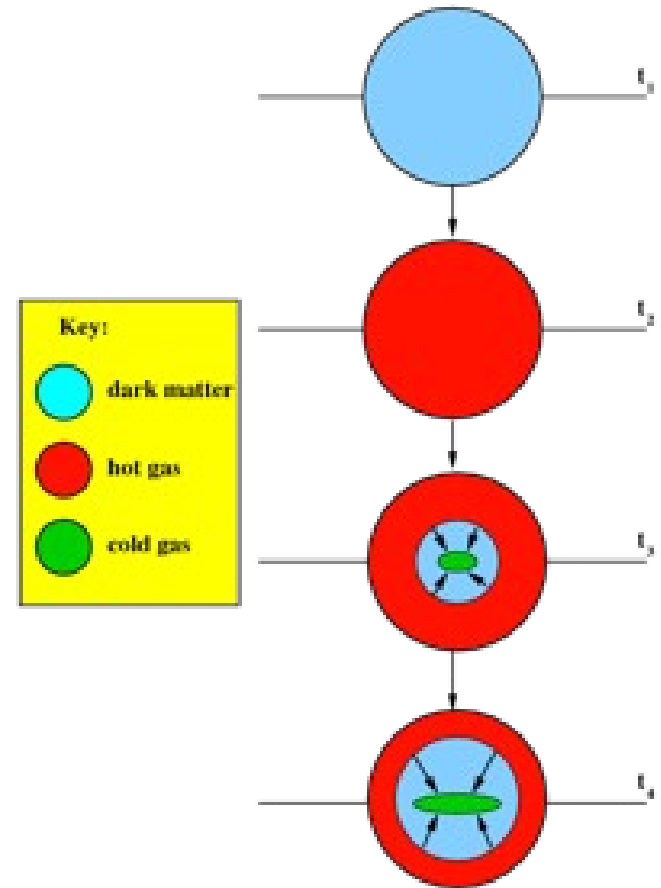

Dark Matter

From Cole et al 2000

Cold Gas in Galaxies

Cold gas fundamental to forming galaxies.

- Gas cools from hot gaseous halo.
- Angular momentum conserved, so disc forms.

- Dense cold gas forms stars.
- Supernovae expel gas from disc.
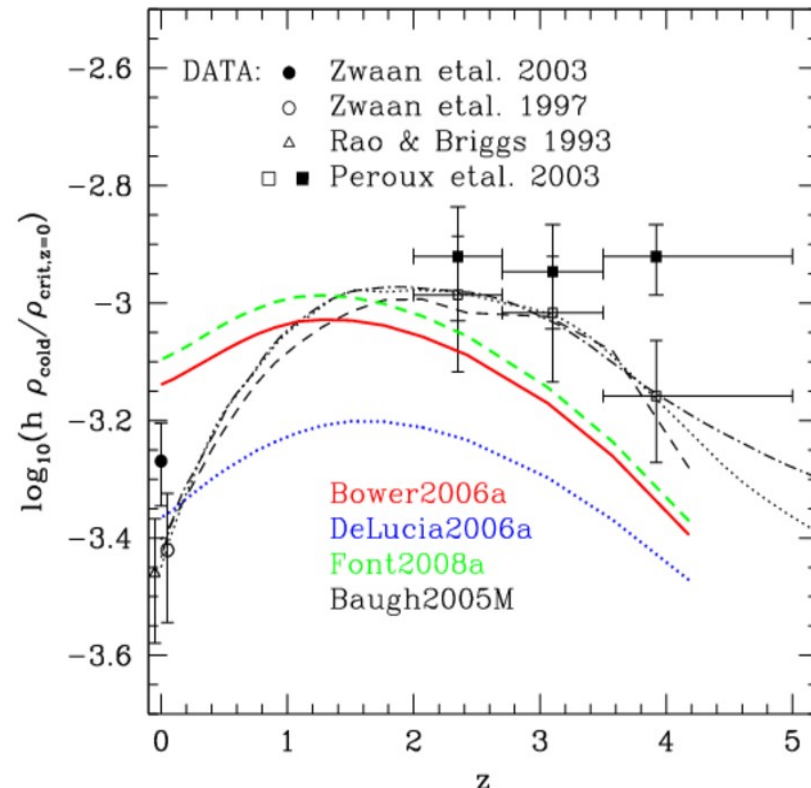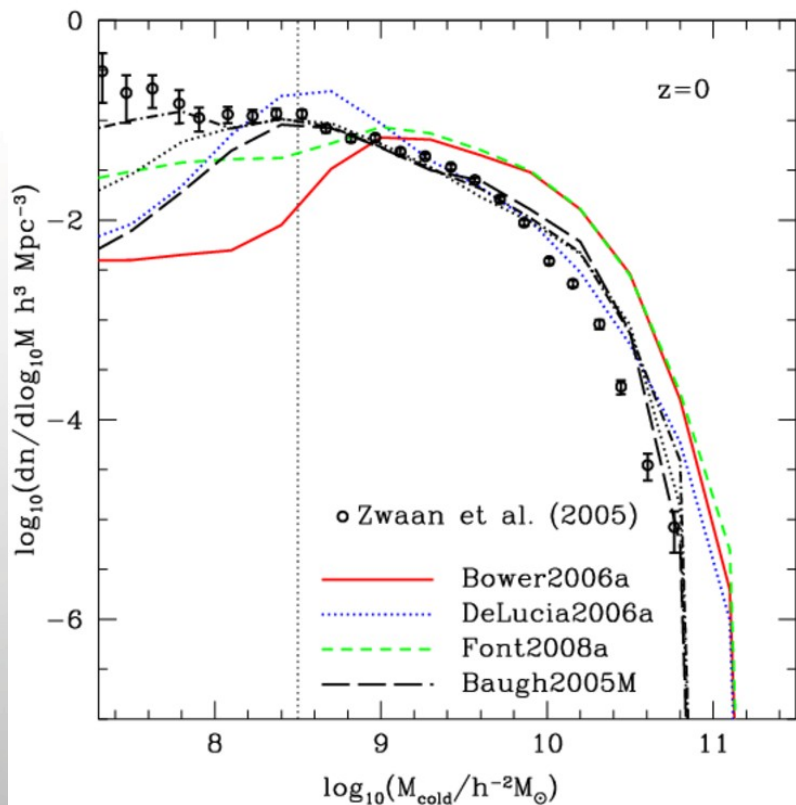- Replenishes and enriches hot halo.
- Self-regulating cycle? Mergers?

Key:
- dark matter
- hot gas
- cold gas

From Baugh 2006

Cosmic Evolution of Cold Gas

Cold Gas Mass Function

Global Density of Cold Gas

Conversion to HI/H2 ?!

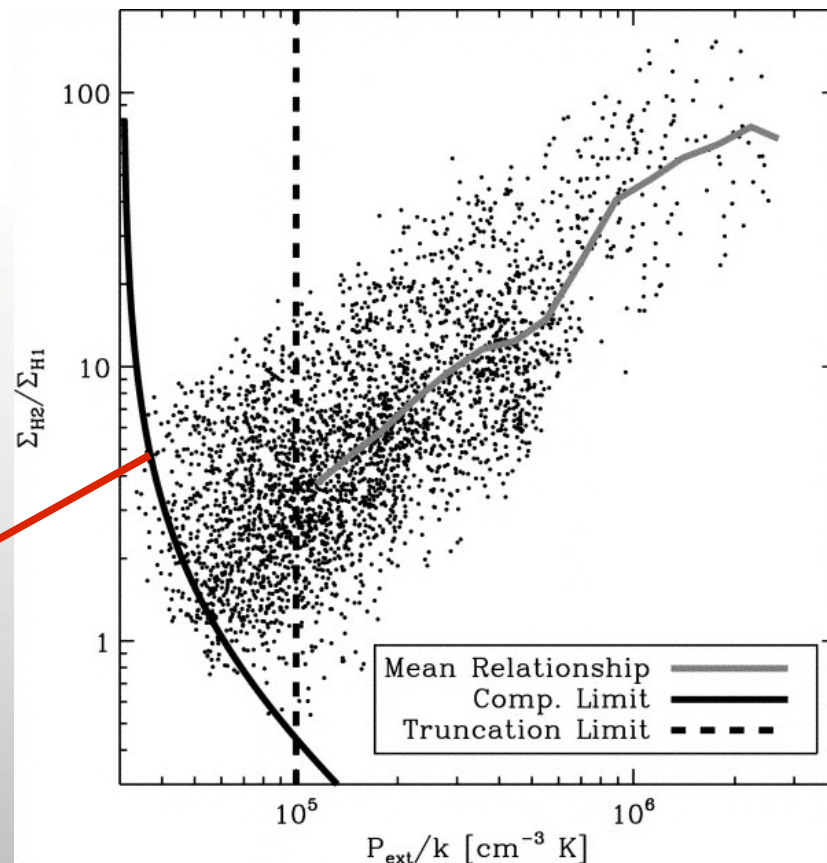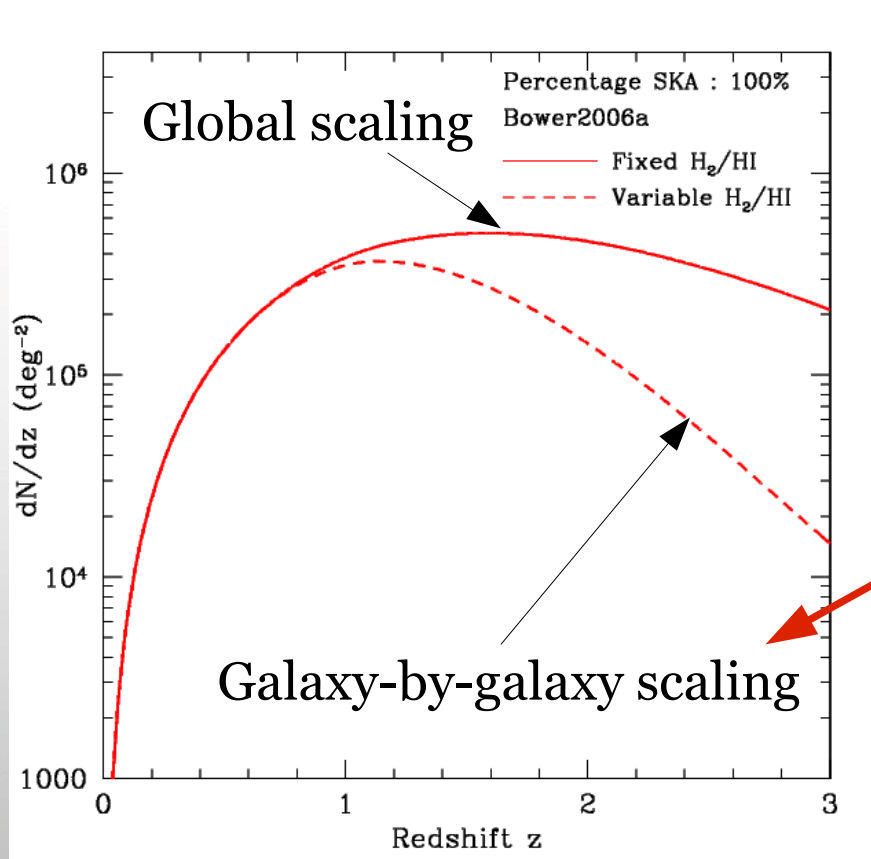From Power, Baugh & Lacey 2010

Cosmic Evolution of HI

Post-processing of cold gas mass.

HI Number Counts

Global scaling

Percentage SKA : 100%
Bower2006a

— Fixed H_2/HI
- - Variable H_2/HI

Galaxy-by-galaxy scaling

Mean Relationship
Comp. Limit
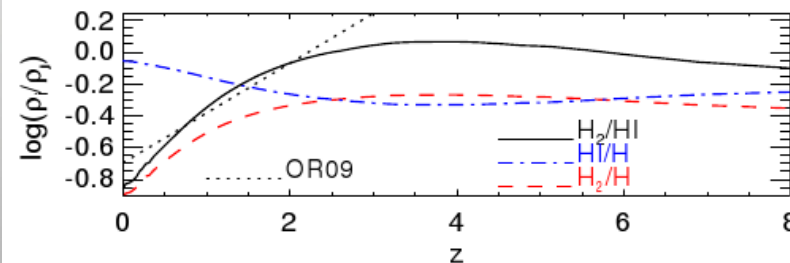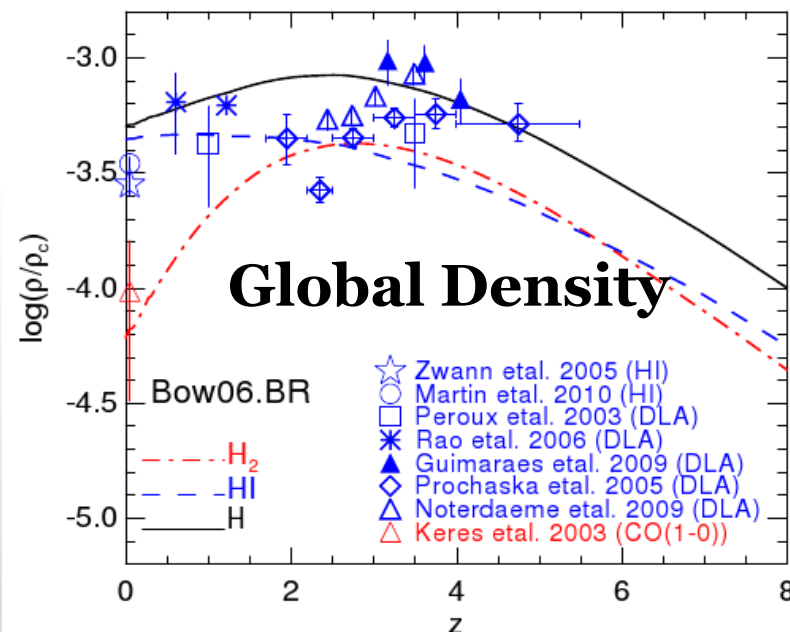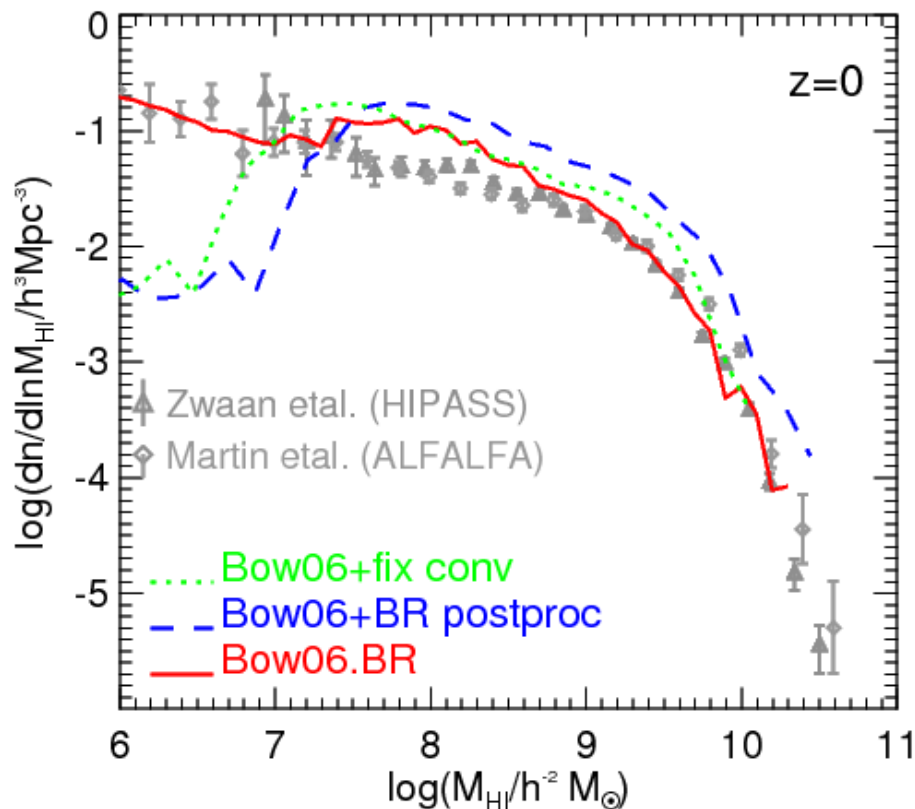Truncation Limit

From Power, Baugh & Lacey 2010

From Blitz & Rosolowsky 2006

Cosmic Evolution of HI

Self-consistent calculation of HI and H2 masses.
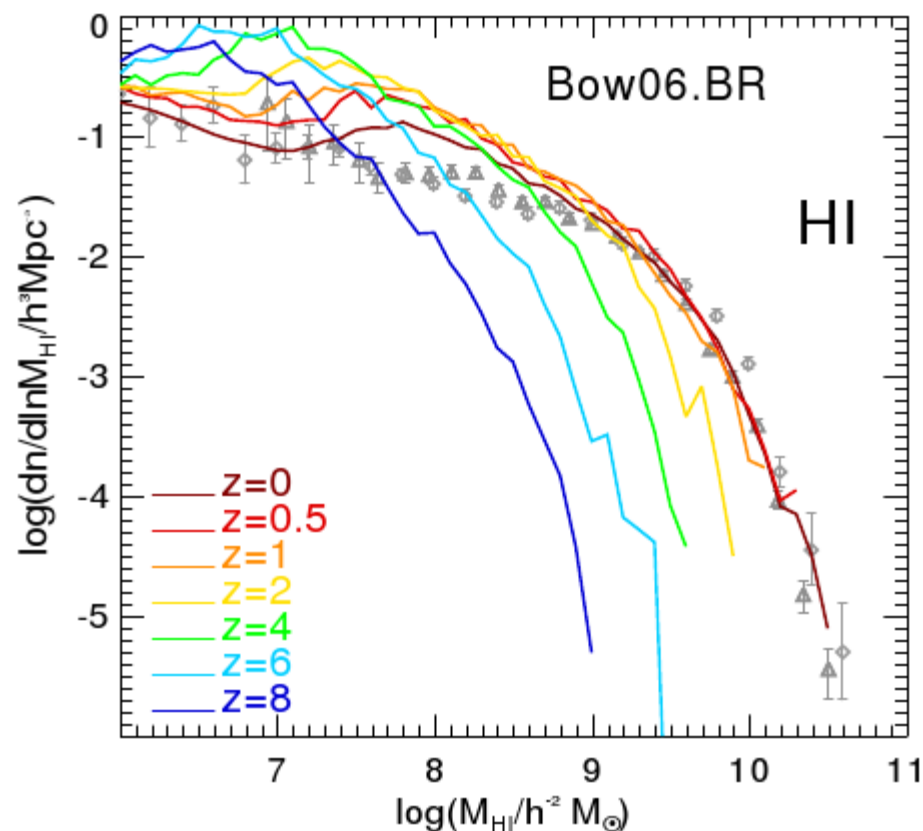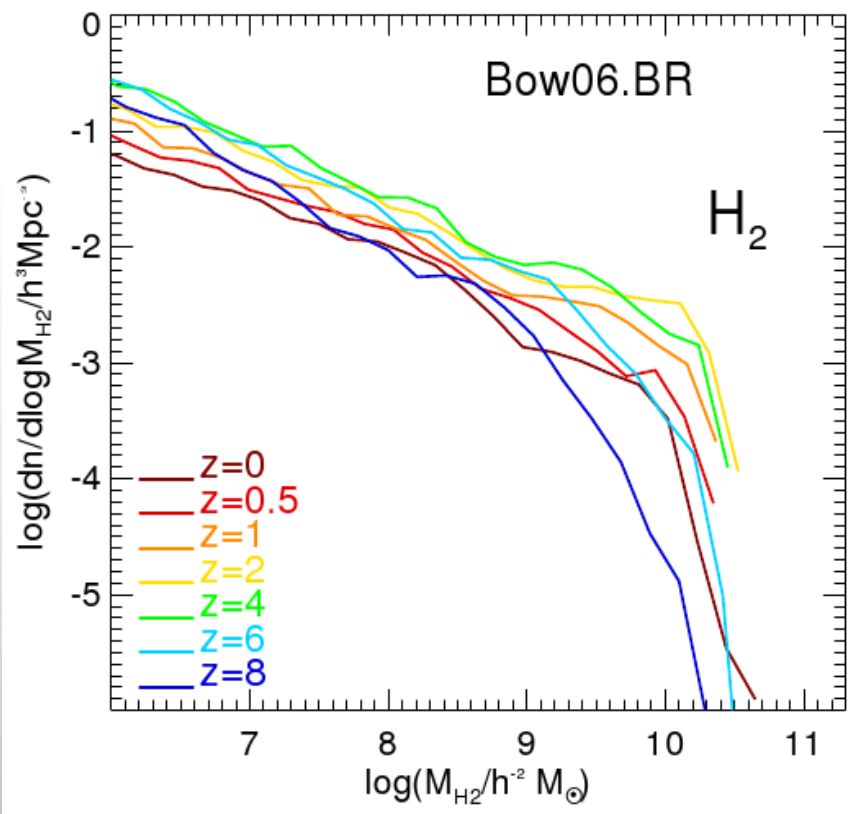
HI Mass Function

Global Density

From Lagos et al. 2011

Cosmic Evolution of H2

Self-consistent calculation of HI and H2 masses.

H2 Mass Function

From Lagos et al. 2011

Summary

- Semi-analytics – invaluable theoretical tool.
  - Widely exploited in optical surveys (2dF, SDSS).

- Predict evolution of cold gas content of galaxies over cosmic time (cf. Power, Baugh & Lacey 2011).

- Can now self-consistently calculate HI and H2 content of galaxies (cf. Lagos et al. 2011).

- ALMA, SKA – galaxy formation testbeds.

- **Community resource – if you need predictions, please come and talk to me!**