

HIGH-Z SURVEYS

The Hybrid Model Point of View

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Outline

Motivation

A Hybrid Model

SKA & GALICS

Summary

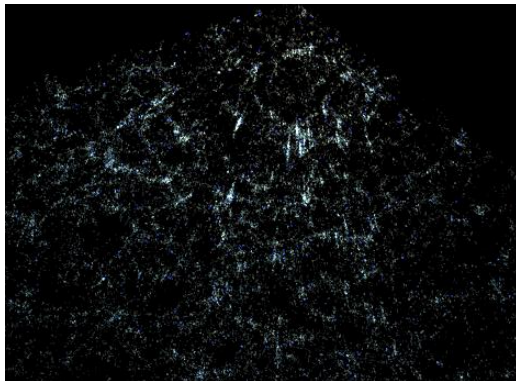
Surveys

Examine and record the area and features of (an area of land) so as to construct a map, a plan, or description

- ▶ Sample a population of individuals
- ▶ Find correlations among the parameters describing the individuals
- ▶ Make hypothesis. Ask questions
- ▶ Make a new survey

Surveys

Understand this



SDSS

Surveys

While resolving this



Hybrid Models

A taste

Between the fully numerical and the fully semi-analytical.

- ▶ Realistic treatment of large scale distribution (DM numerical simulations)
- ▶ Tool for testing poor known gas astrophysics (semi-analytic)
- ▶ Loads of temporal and spatial statistics
- ▶ **Flexibility**

Our Semi Analytic Model

Code Name: GALICS

`http://www.projet-horizon.fr`

Project Horizon - Horizon Project :: The Horizon Project

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INSU IN2P3
UNIVERSITÉ PARIS 6 MARIE CURIE Institut de physique
UFR
CRAL Lyon Observatoire de Lyon API

The Horizon Project

by Legrand François (Saturday 2 September 2006)

The objective of the HORIZON Project is to federate numerical simulations activities with a program focussed on Galaxy and Large Scale Structure Formation. In a context favorable to HPC (High Performance Computing), the PNC (Programme National Cosmologie), the PNG (Programme National Galaxies) and the PAP (Programme AstroParticule), express their needs to stimulate and coordinate individual efforts in HPC among each domain.

The HORIZON Project was built on several research teams in different institutes. The scientific objective is specifically oriented towards studying galaxy formation in a cosmological framework. Its transverse and federative nature will however allow to develop in a few years

Oct 2006						
M	T	W	T	F	S	S
25	26	27	28	29	30	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	1	2	3	4	5

News

- **Fourth Horizon Workshop 2006b**
The 4th workshop takes place from December, the 11th to December, the 12th at Paris Observatory. Registration form available here.
- **MareNostrum simulation has started at BSC**

Our Semi-analytic Model

People (1/2)

Dominique Aubert

Emmanuel Bertin

Jérémy Blaizot

François Bouchet

Andrea Cattaneo

Pierre Emmanuel

Chapellat

Stéphane Colombi

Julien Devriendt

Jaime Forero

Bruno Guiderdoni

Our Semi-analytic Model

People (2/2)

Steve Hatton

Barbara Lanzoni

Olivier Le Fèvre

Gary Mamon

Stéphane Ninin

Christophe Pichon

Felix Stoher

Thierry Sousbie

Dylan Tweed

Yogesh Wadadekar

Hervé Wozniak

The Pipeline

- ▶ Make a N-body simulation
- ▶ Identify DM halos
- ▶ Construct their merging history
- ▶ Put galaxy seeds and follow their evolution
- ▶ Compare them with observations

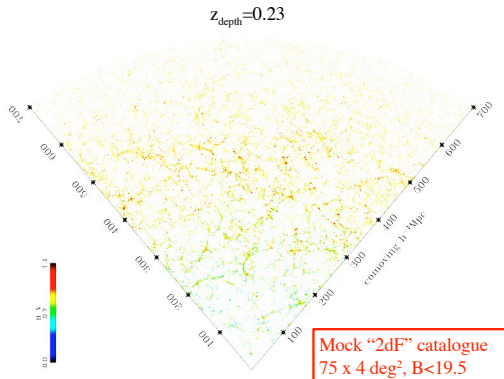
The Pipeline

The missing link

How can I compare a box of galaxies to an image from a survey?

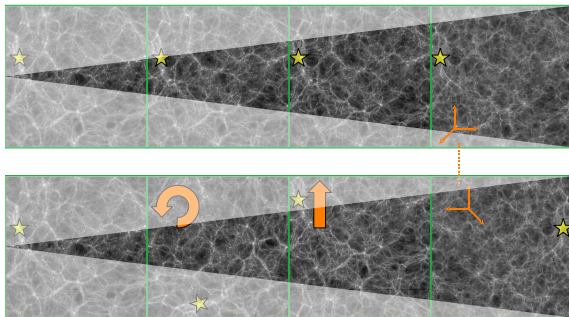
Mock Catalogues

Code Name: momaf



Mock Catalogues

Random Tiling Technique



Mock Images

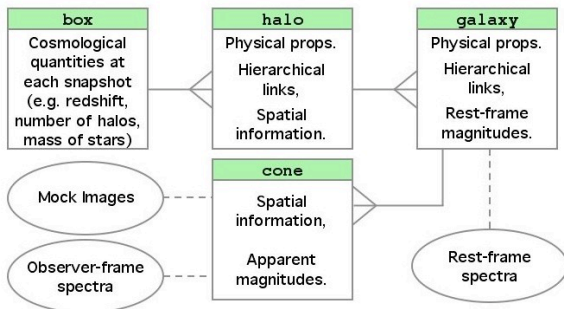
Powerful coupled to SkyMaker

JOHNSON I_{AB} 0.20 deg^2

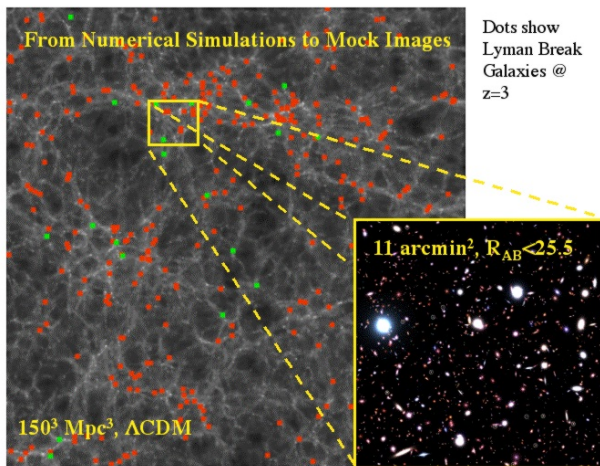


Into The Data Base

Virtual Observatory



The Pipeline

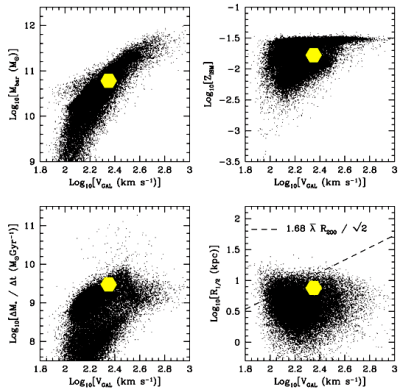


Strong Points



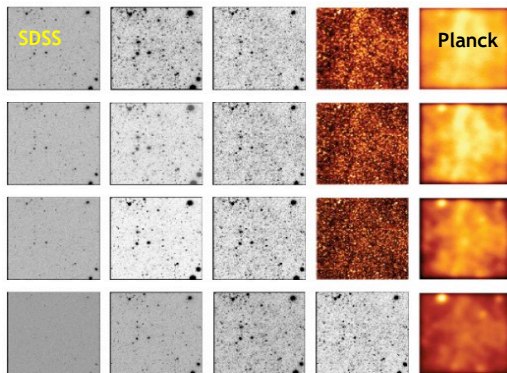
Strong Points

1. Statistics



Strong Points

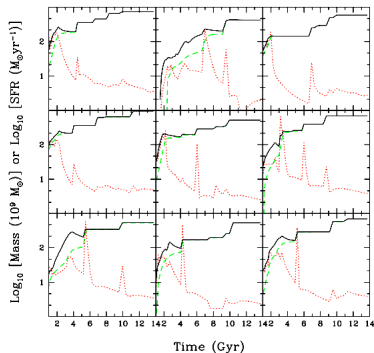
2. Multi Wavelength



Strong Points

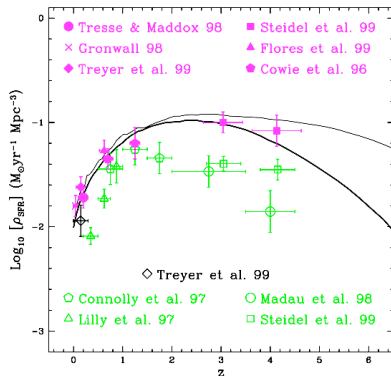
3. Temporal Resolution (histories of typical local ellipticals)

Stellar mass - Star Formation Rate - Total mass



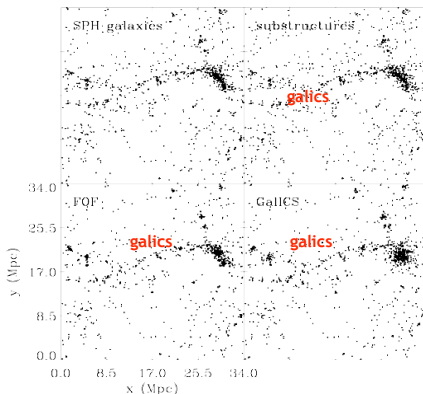
Strong Points

3. Temporal Resolution



Strong Points

4. Spatial Resolution (clustering)



GALICS

In Galics for each galaxy component:

- ▶ Mass of gas (H, He)
- ▶ Velocity (rotational/dispersion)
- ▶ Size
- ▶ Inclination

GALICS

For the gas:

- ▶ $H \sim 0.76$
- ▶ Molecular/Atomic $\sim \rho_{H_2}/\rho_{HI}$
- ▶ ρ_{H_2} (Keres et al. 2003) from CO luminosity
- ▶ ρ_{HI} (Zwaan et al. 2003)

GALICS

Conversion factor:

$$HI = 0.76 \times \frac{G}{1 + (3.1/8.1)} \sim \frac{G}{2}$$

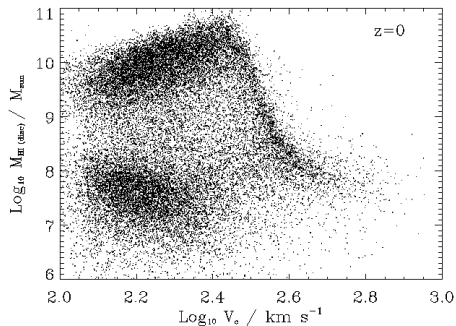
GALICS

Implicit conventions:

- ▶ DM simulation 100Mpc h^{-1} 256^3 particles
- ▶ Halo resolution: $1.7 \times 10^{11} M_{\odot}$
- ▶ HI resolution $\sim 1.7 \times 10^9 M_{\odot}$

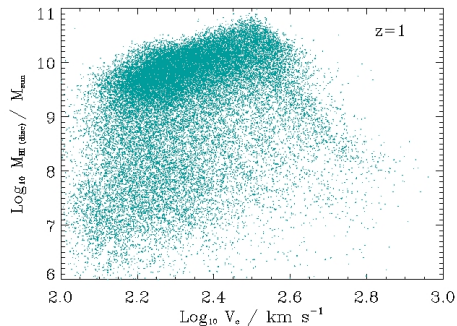
Preliminaries

V_c vs M_{HI} ($z = 0$)



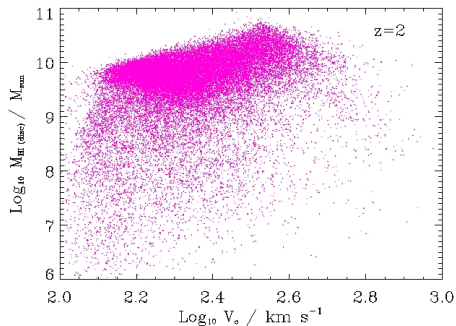
Preliminaries

V_c vs M_{HI} ($z = 1$)



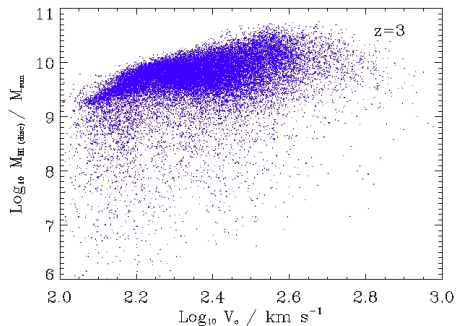
Preliminaries

V_c vs M_{HI} ($z = 2$)



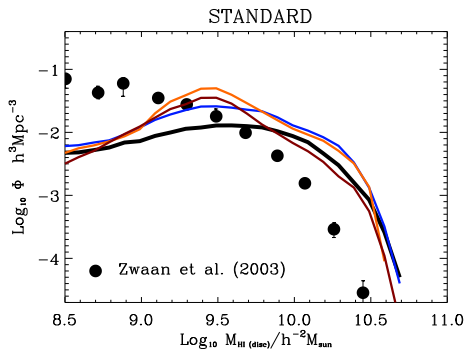
Preliminaries

V_c vs M_{HI} ($z = 3$)



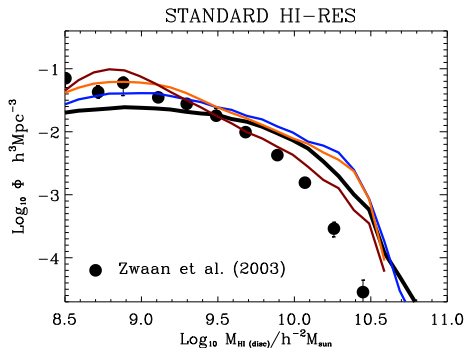
Results

HI Luminosity Function



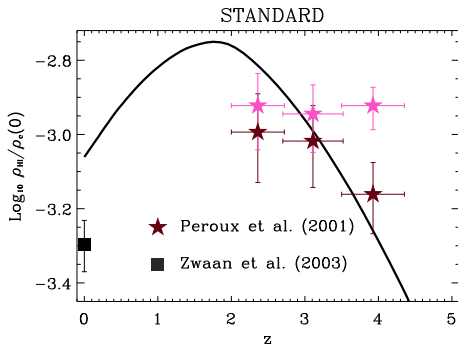
Results

HI Luminosity Function [512³ particles]



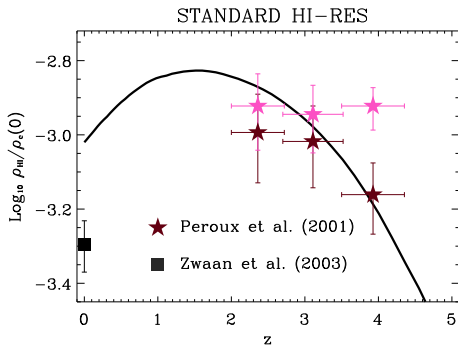
Results

Cosmic Density of HI



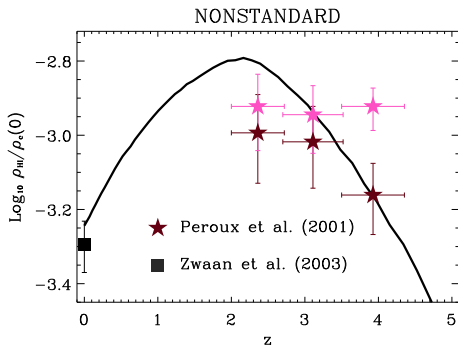
Results

Cosmic Density of HI [512³ particles]



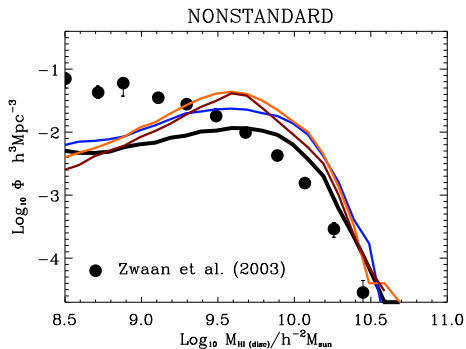
Results

Cosmic Density of HI [Binney Cattaneo Dekel]



Results

HI Luminosity Function [Binney Cattaneo Dekel]



GALICS

Mock Catalogue Specifications

- ▶ $2^\circ \times 2^\circ$
- ▶ $z_{max} \sim 4.0$
- ▶ ra, dec, z, D_L + physical properties
- ▶ Just one catalogue shown

SKA

Signal to Noise

$$S/N \sim f \times \frac{\int S dV}{\sigma_{4h} V} \times \sqrt{\left(\frac{V}{\Delta V}\right)} \times \sqrt{\left(\frac{4}{t}\right)}$$

$$f \sim 1 \quad \sigma_{4h} \sim 2 \mu\text{Jy} \quad \Delta V \sim 30 \text{ km/s}$$

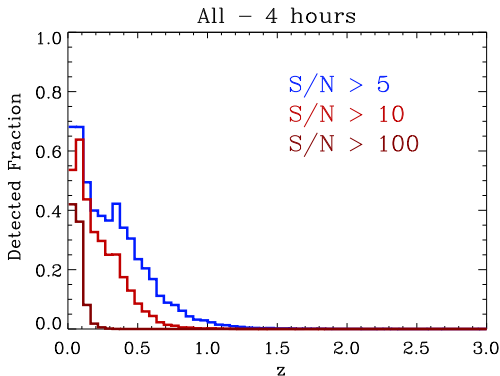
(Abdalla & Rawlings 2004)

Numerical Experiments

- ▶ Get S/N for every galaxy (M_{HI} , i , V_c)
- ▶ In 4 hours of observation: which is the fraction of detected galaxies over a given S/N?
- ▶ Which is its redshift distribution?

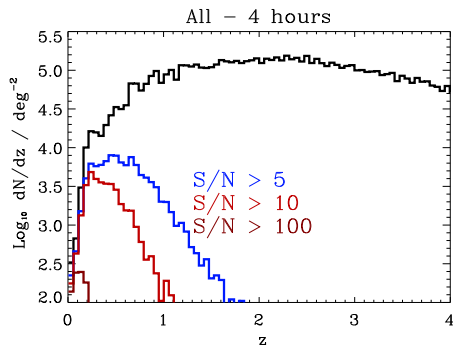
Results

Detection Limits



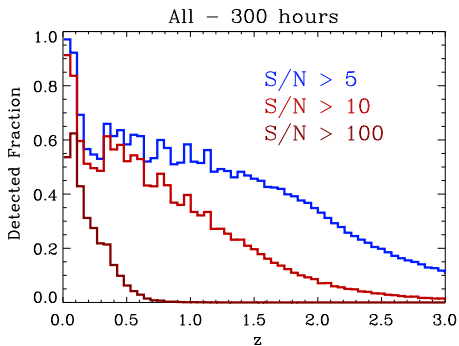
Results

Redshift Distribution



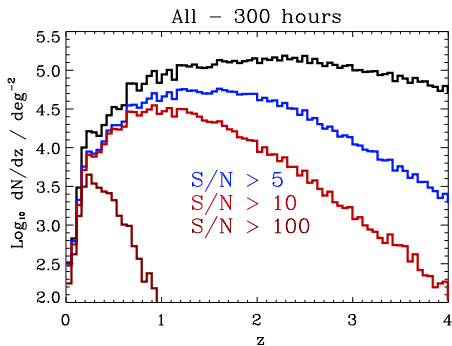
Results

Detection Limits



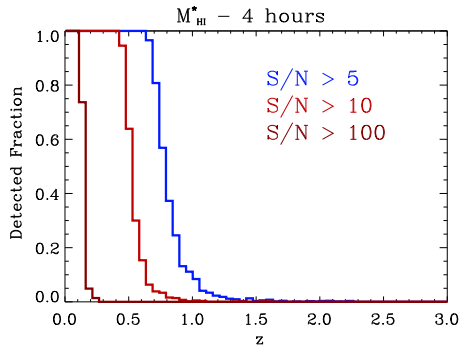
Results

Redshift Distribution



Results

Sensitivity to $M_{HI}^* \sim 10^{10} M_{\odot}$ galaxies



Summary

- ▶ Powerful tool to turn models into predictions for surveys
- ▶ SKA-LOFAR \leftrightarrow another λ ?
- ▶ Gas at $z \sim 4$... mystère

More Information

google: projet horizon
google: galics