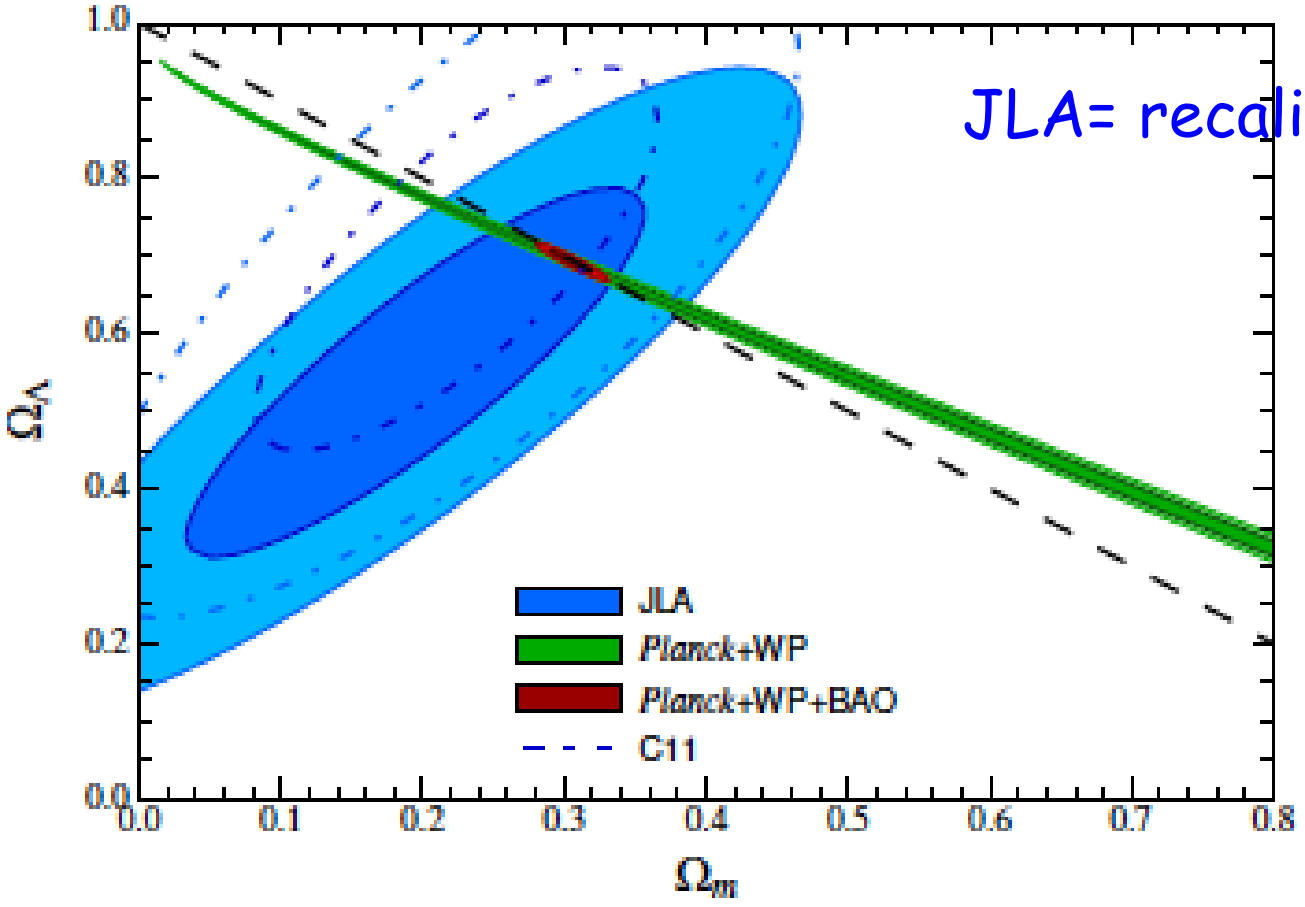
Sino-French Cosmology 2015

Charling Tao

FCPPL Hefei, April 9, 2015

+ 2015 Cosmology Highlights
+ Status Sino-French FCPPL collaborations (+LIA Origins)
+ Chinese/International cosmology projects

Probe combination 2014
SN, CMB,BAO,

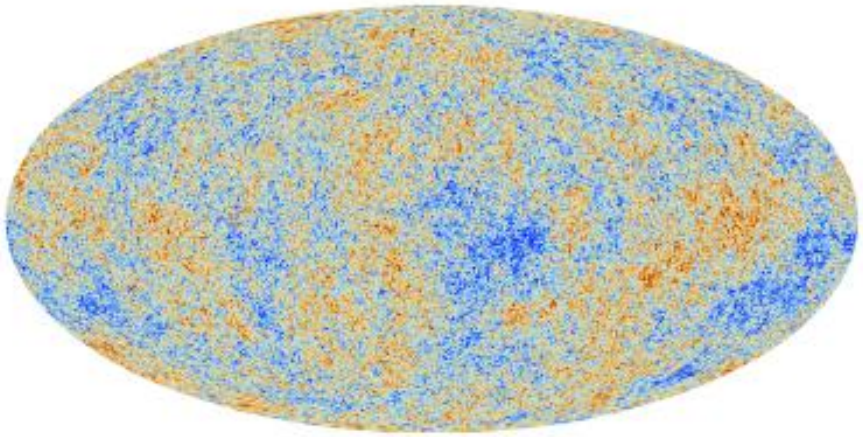


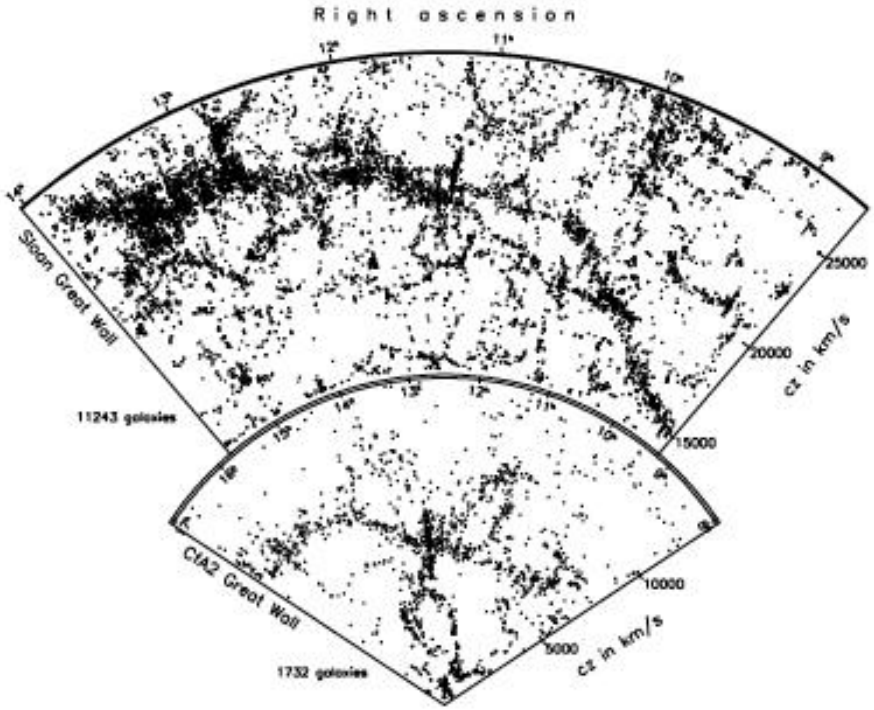
JLA= recalibrated SN

Betoule et al, arxiv: 1401.4064

IN2P3 lead

Era of Sky maps



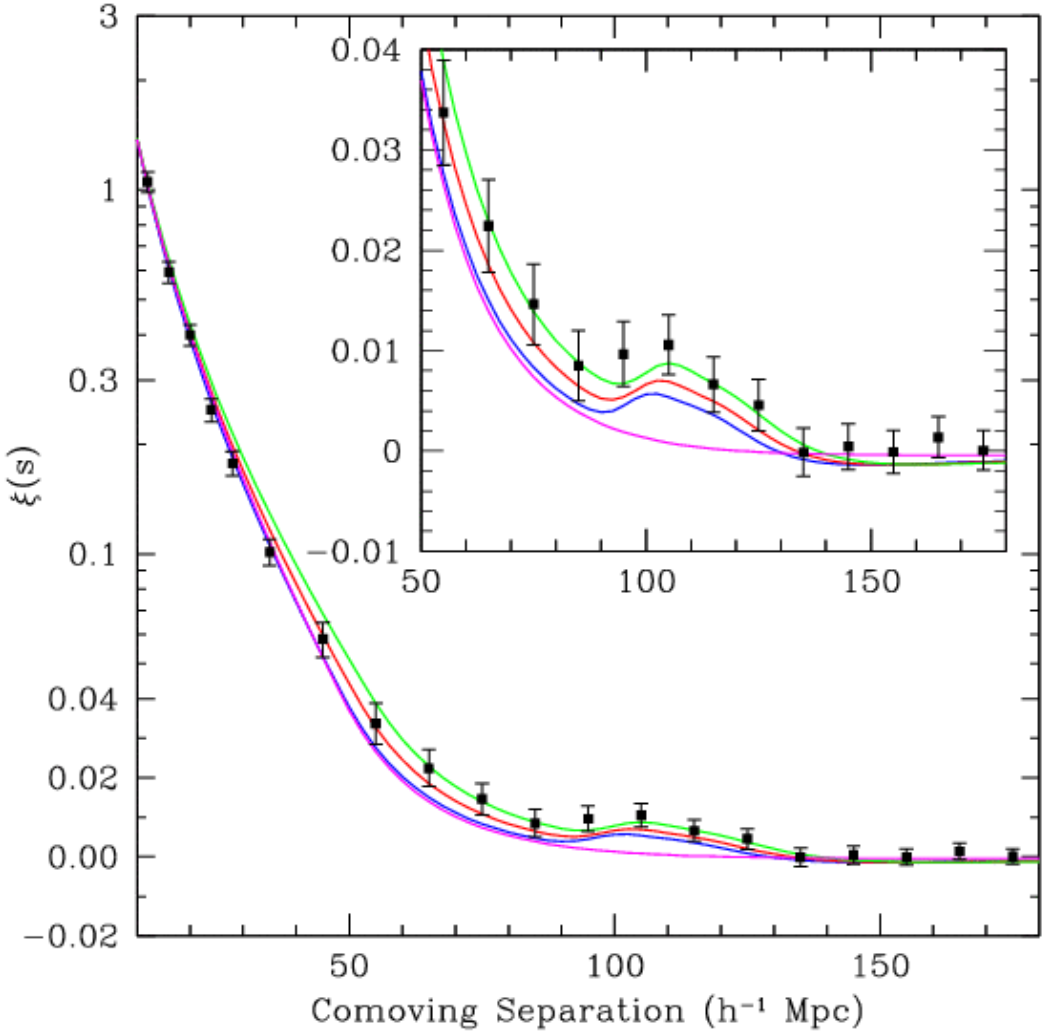


Planck CMB temperature map

French lead project

LSS

Baryonic Acoustic oscillations smoking gun confirmation for ΛCDM



Eisenstein et al.
SDSS DR3
2005: BAO

LRG: 2 point correlation function

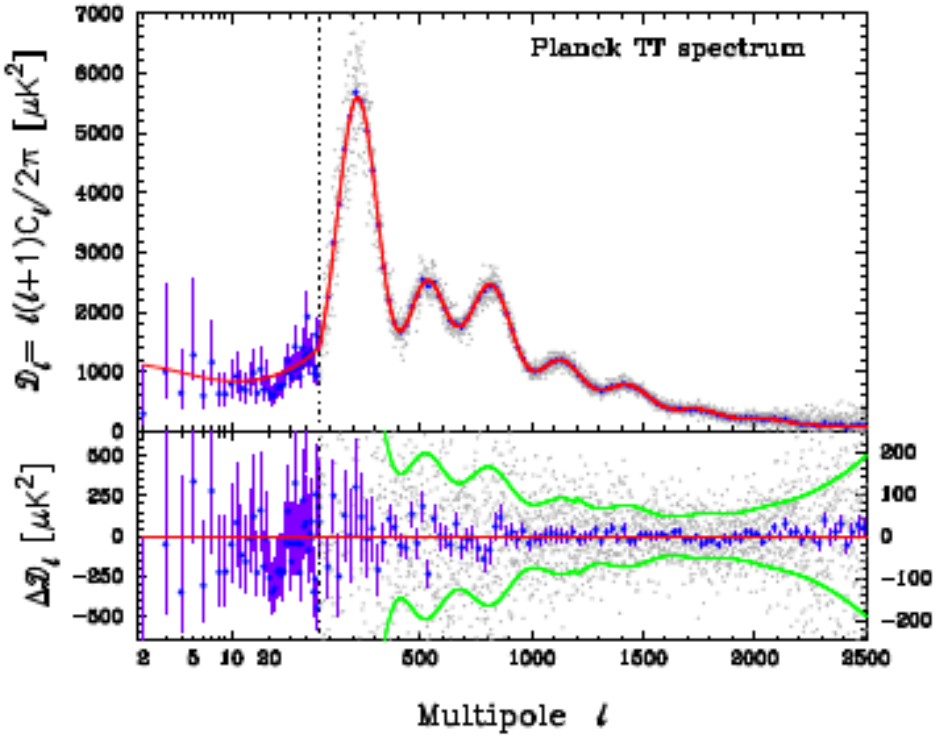
$$\xi(\mathbf{x}_1, \mathbf{x}_2) = \langle \delta(\mathbf{x}_1)\, \delta(\mathbf{x}_2) \rangle$$

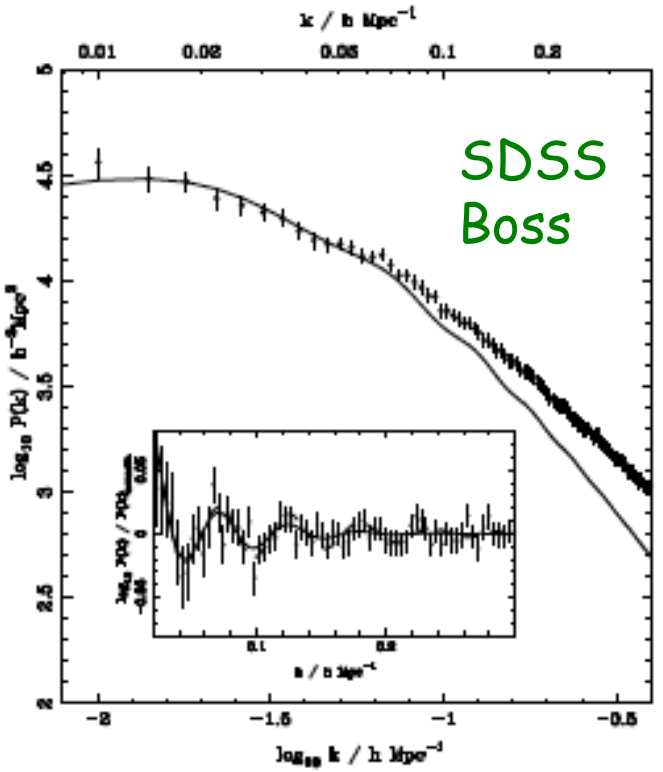
Large scale structure statistics

Correlations in CMB map

$$\langle \Delta T_1 \Delta T_2 \rangle \propto \sum (2\ell+1)\, C_\ell P_\ell(\cos\theta)$$

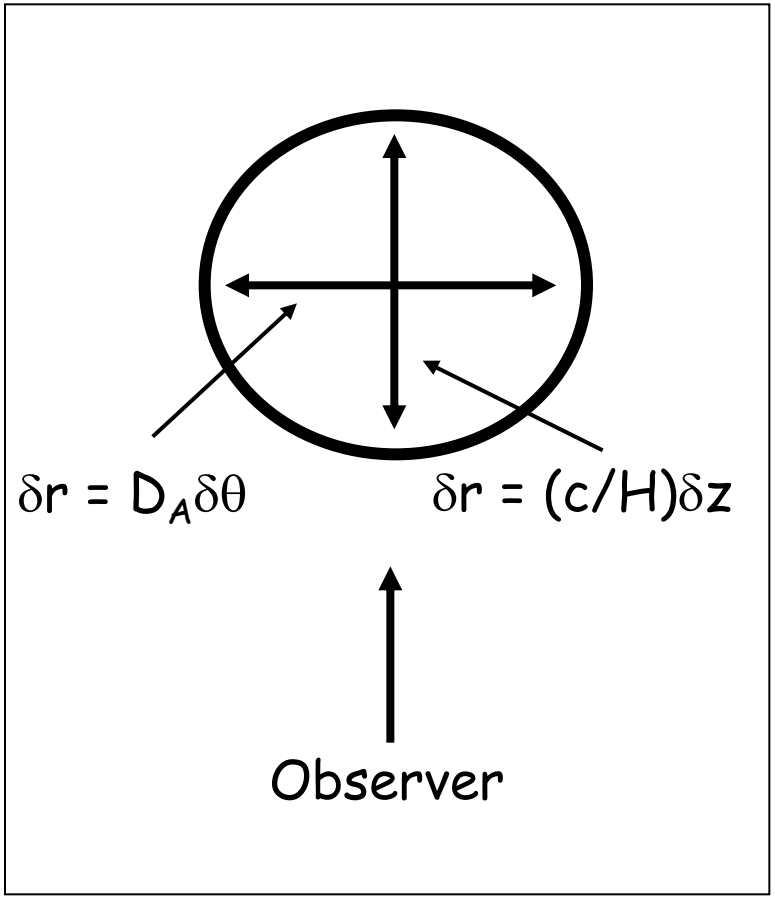
Galaxy
power spectrum=
Fourier transform of
2-pt correlation function



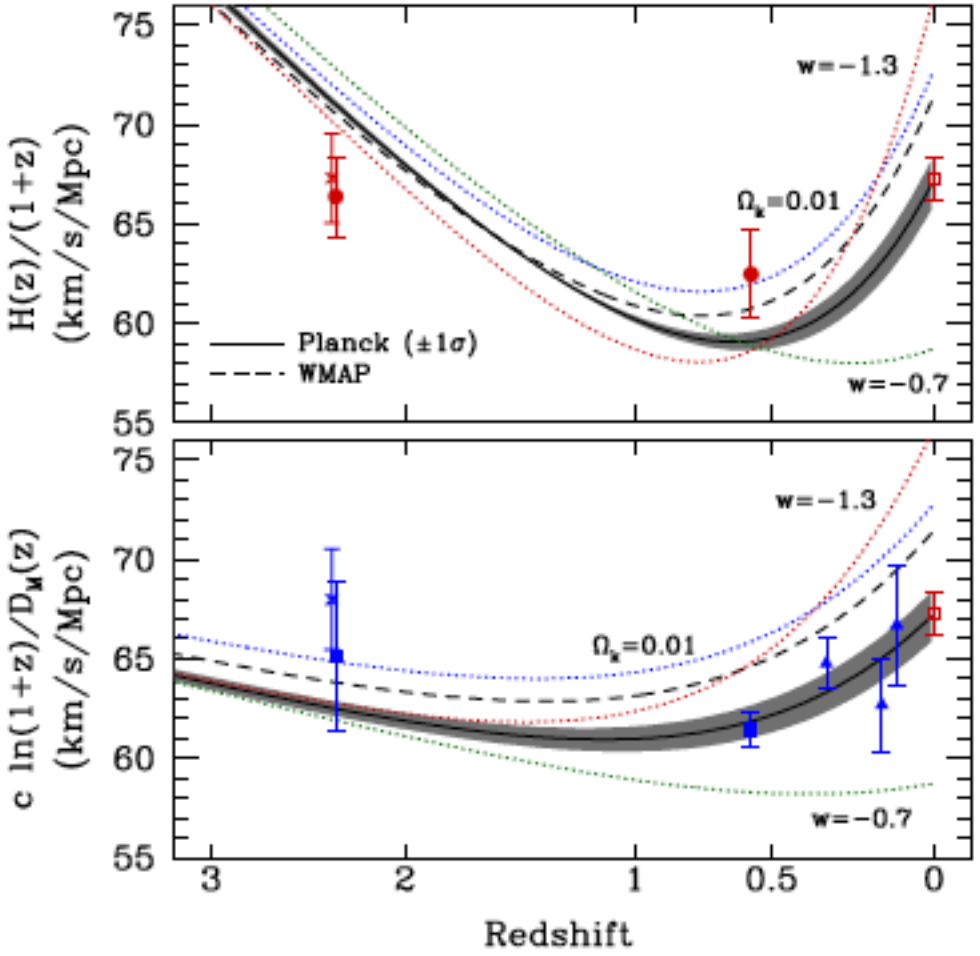


SDSS BOSS distance measurements

BAO: Standard ruler



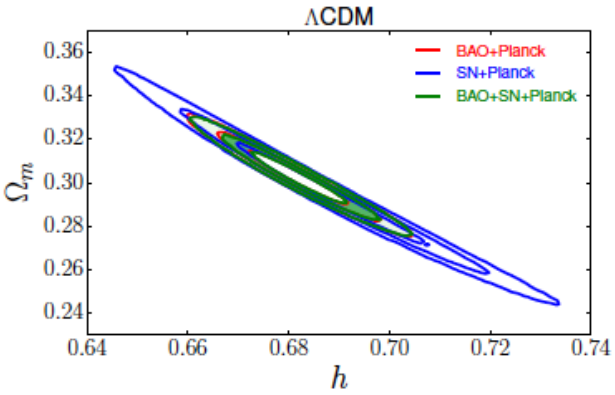
Aubourg et al. 1411.1074 , SDSS

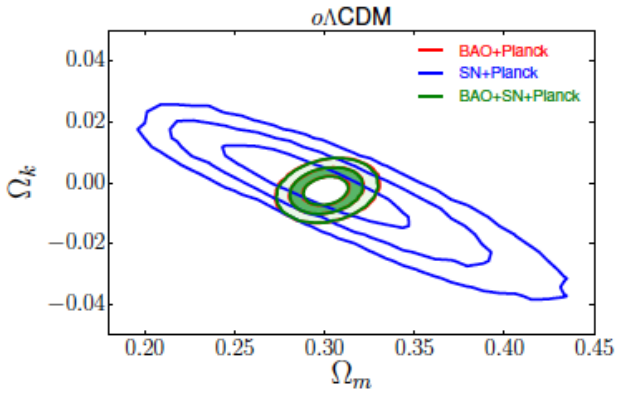


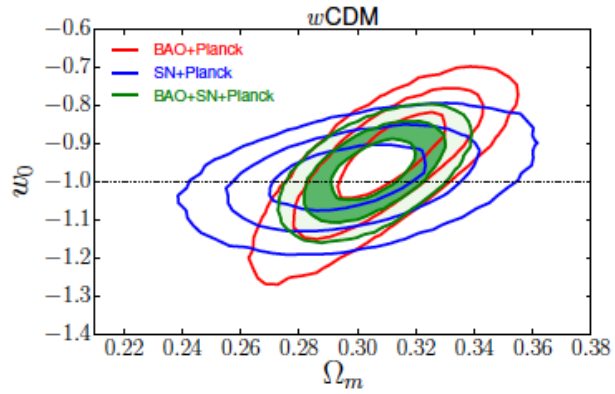
Paper IRFU + IN2P3 lead

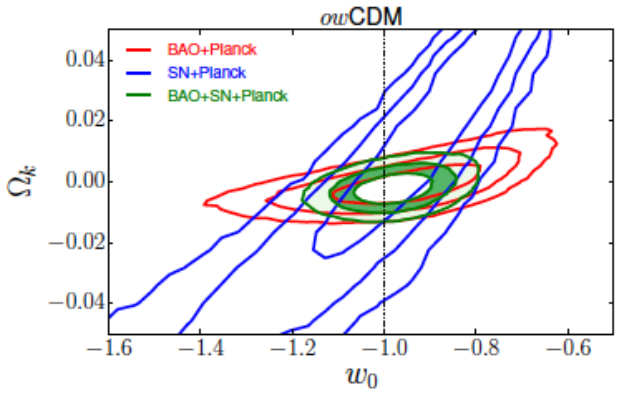
Constraints on cosmological parameters

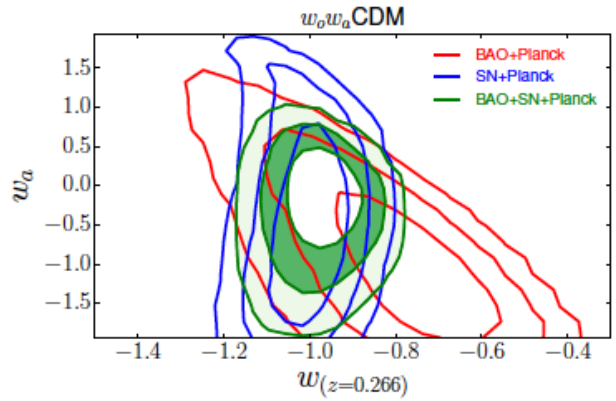
Aubourg et al.
SDSS
1411.1074

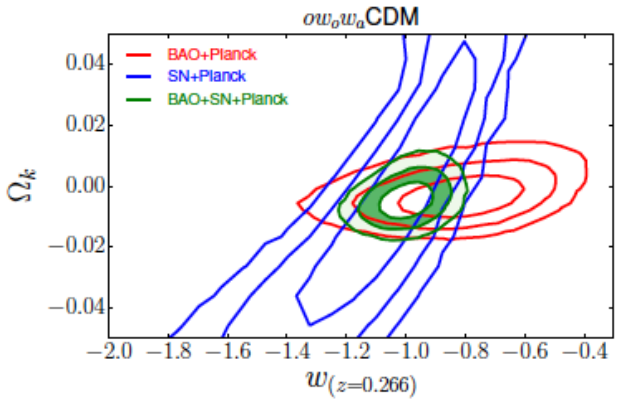






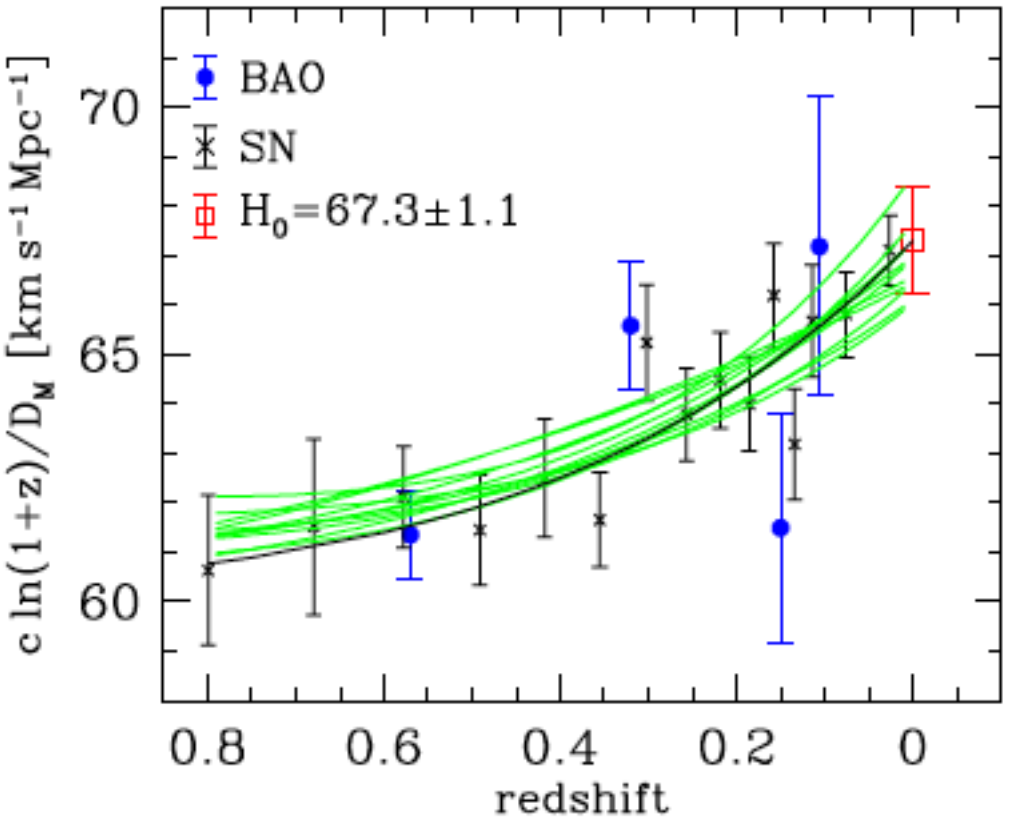






Distance measurements

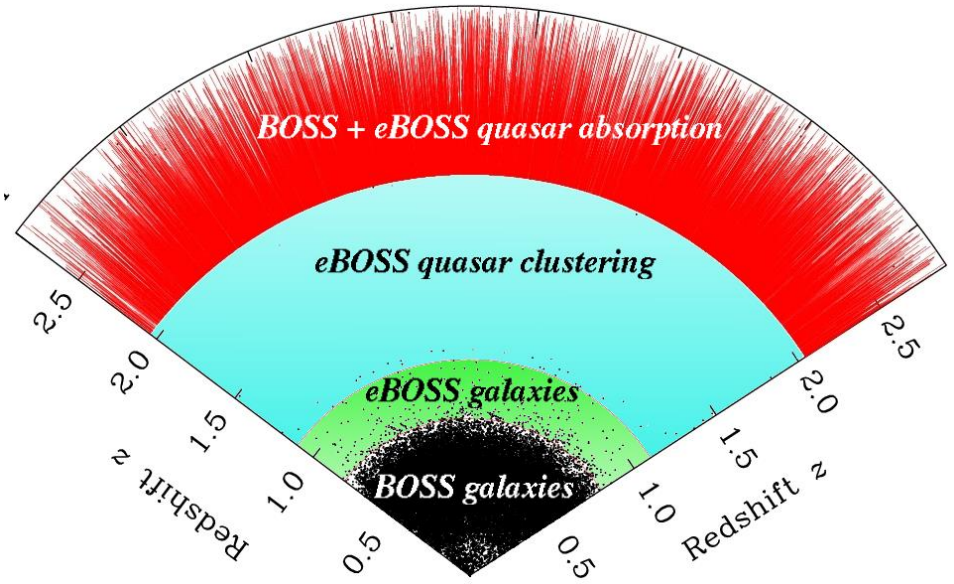
Aubourg et al. ,
SDSS,
1411.1074



- SNIa (luminosity distance /standard candle) are still competitive!
- Need more statistics for BAO (standard ruler), and also for SNIa…

eBOSS started in July 2014

- Transition from deceleration to acceleration ($H(z)$, $D_A(z)$,…)
- Structure growth (test of GR-LCDM)
- Neutrinos
- QSO science
- …



PI: J-P Kneib (French)
Lya: French lead

http://www.sdss3.org/future/eboss.php

eBOSS sino-french projects

People

Tsinghua: C. Tao + Zhao Cheng + Liang Yu + Lin Qiufan+…
NAOC: Zhao Gongbo et al.
CPPM: Pisani, Escoffier, Cousinou, Ealet, Tao,…
APC, Saclay, IAP, Meudon, … +

1) Covariance matrices for LRG, ELG, Lya(?) BAO from mock catalogues calibrated on large N-body simulations
2) Cosmological parameters with all eBOSS probes (LRG, ELG,Lya, voids, RSD,…)
3) Tests of modified gravity better with voids depends on
   - void finder algorithm
   - DM vs galaxy/halo
4) WDM vs CDM better in filaments or voids?
5) AGN Reverberation mapping for luminosity distances at high z?

Status of FCPPL cosmology projects 2015

1) SNFactory: end data taking in 2015, analysis 2016

What next?

a) Exploring collaboration with Chinese SN people: Wang Xiaofeng, Deng Jinsong, ...

b) collaboration on eboss : LIA Origins (+ FCPPL >2016?)

2) QUBIC sino-French-collaboration stopped!

BICEP2+Planck measure dust ➔ B-Polarization more difficult

Chinese groups are looking at other projects eg, in Ali (Tibet)

3) DM/Underground lab Projects

Important last year SNFactory results

- Active and passive star forming galaxies give Δm=0.1

  M. Rigault et al., 2014, 2015

- SNIa: Hi Si line velocity fraction is environment dependent

  J. Chen et al., 2015 in preparation

Proposed SNIa DESIRE survey with EUCLID

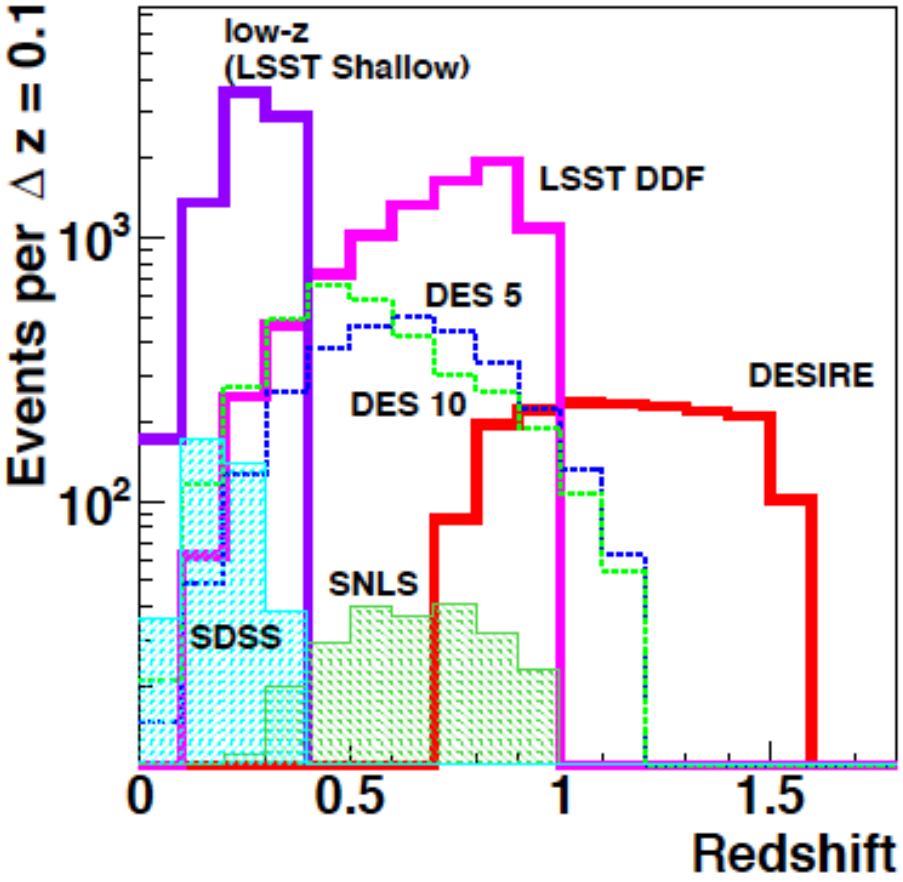


Fig. 12. Redshift distribution of events for various surveys. For th SDSS and SNLS, the distributions sketch the total sample of spectroscopically identified events eventually entering the Hubble diagram. "DES 5" and "DES 10" refer respectively to the "hybrid-5" and "hybrid-10" strategies studied in Bernstein et al. (2012), where the baseline is hybrid-10. "LSST-SHALLOW", "LSST-DDF" and "DESIRE" refer to the three prongs studied in this proposal.

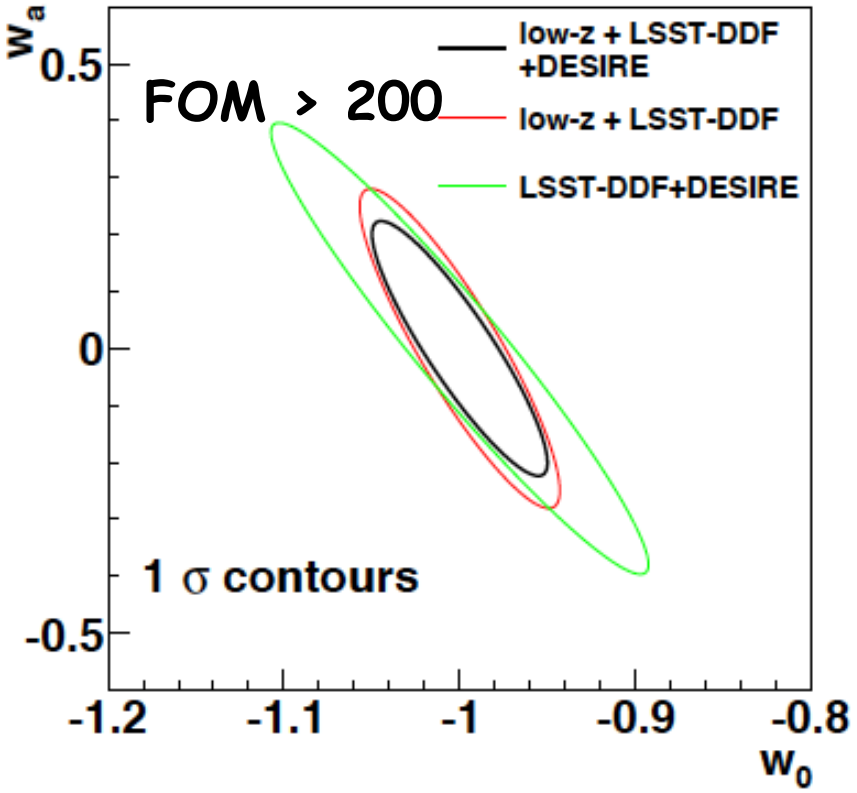


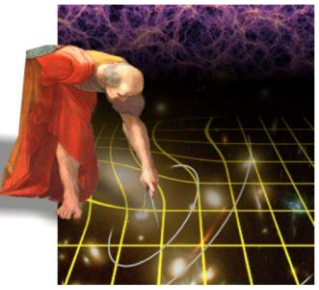
Fig. 9. Confidence contours (at the 1σ level) of the survey combinations listed in Table 5. The assumptions for systematics correspond to the last row of

Table 5. Cosmological performance of the simulated surveys.

	$\sigma(w_a)$	z_p	$\sigma(w_p)$	FoM
low-z + LSST-DDF + DESIRE	0.22	0.25	0.022	203.2
low-z + LSST-DDF	0.28	0.22	0.026	137.1
LSST-DDF + DESIRE	0.40	0.35	0.031	81.4

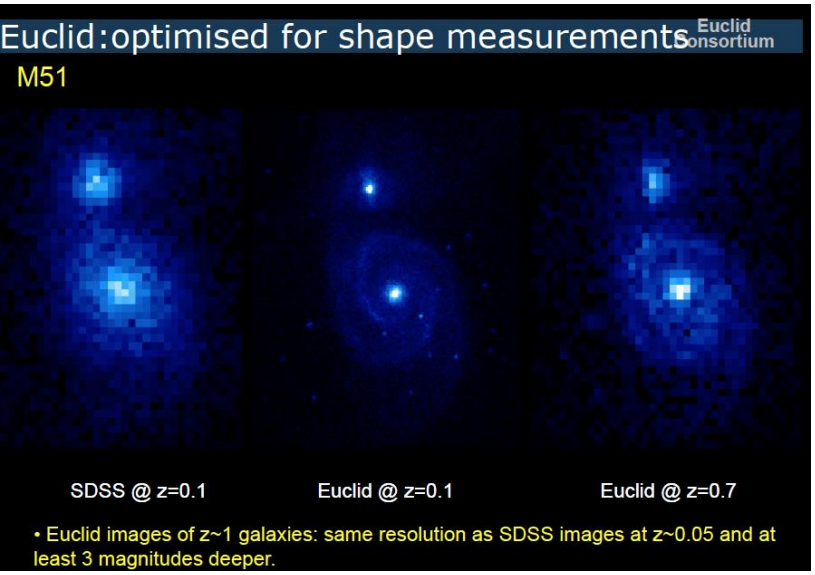
Notes. The FoMs assume a 1-D geometrical *Planck* prior and flatness. z_p is the redshift at which the equation of state uncertainty reaches its minimum $\sigma(w_p)$. The FoM is defined as $[Det(Cov(w_0, w_a))]^{-1/2} = [\sigma(w_a)\sigma(w_p)]^{-1}$ and accounts for systematic uncertainties. The contributions of the main systematics are detailed in Table 6.

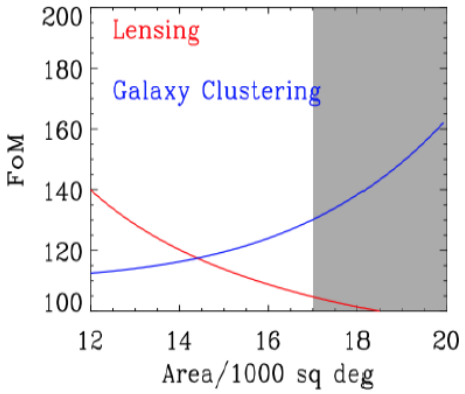
Astier et al. arXiv:1409.8562

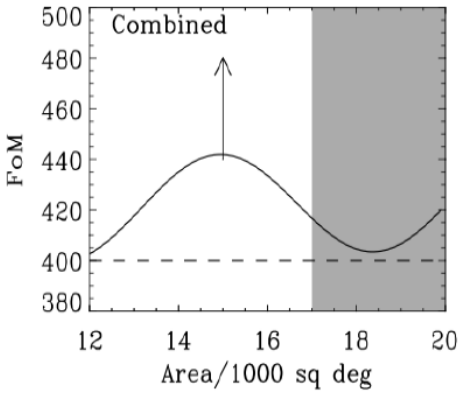


The European EUCLID space project

http://www.euclid-ec.org





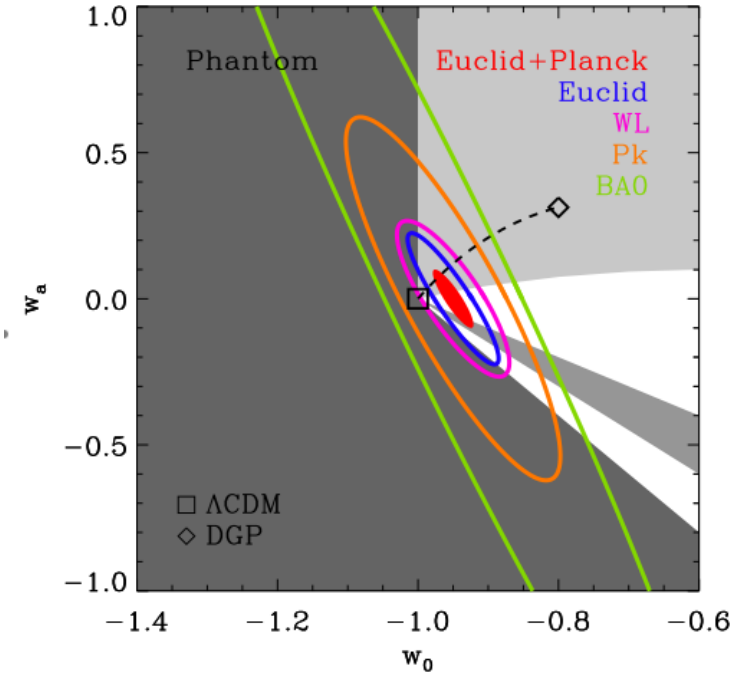


- With 15,000 deg^2 for for GC and WL: optimisation for a fixed time survey.
- Allows Euclid to do WL and GC simultaneously on the same area.

Will provide best constraints on DE parameters with multi-probe combination + studies of DM

Euclid - impact on Cosmology

	Δw_p	ΔW_a	$\Delta\Omega_m$	$\Delta\Omega_\Lambda$	$\Delta\Omega_b$	$\Delta\sigma_8$	Δn_s	Δh	DE FoM
Current+WMAP	0.13	-	0.01	0.015	0.0015	0.026	0.013	0.013	~10
Planck	-	-	0.008	-	0.0007	0.05	0.005	0.007	-
Weak Lensing	0.03	0.17	0.006	0.04	0.012	0.013	0.02	0.1	180
Imaging Probes	0.018	0.15	0.004	0.02	0.007	0.0009	0.014	0.07	400
Euclid	0.016	0.13	0.003	0.012	0.005	0.003	0.006	0.020	500
Euclid +Planck	0.01	0.066	0.0008	0.003	0.0004	0.0015	0.003	0.002	1500
Factor Gain	13	>15	13	5	4	17	4	7	150



Euclid Imaging will challenge all sectors of the cosmological model:

- Dark Energy: w_p and w_a with an error of 2% and 13% respectively (no prior)
- Dark Matter: test of CDM paradigm, precision of 0.04eV on sum of neutrino masses (with Planck)
- Initial Conditions: constrain shape of primordial power spectrum, primordial non-gaussianity
- Gravity: test GR by reaching a precision of 2% on the growth exponent γ ($d\ln\delta_m/d\ln a \propto \Omega_m^{\gamma}$)

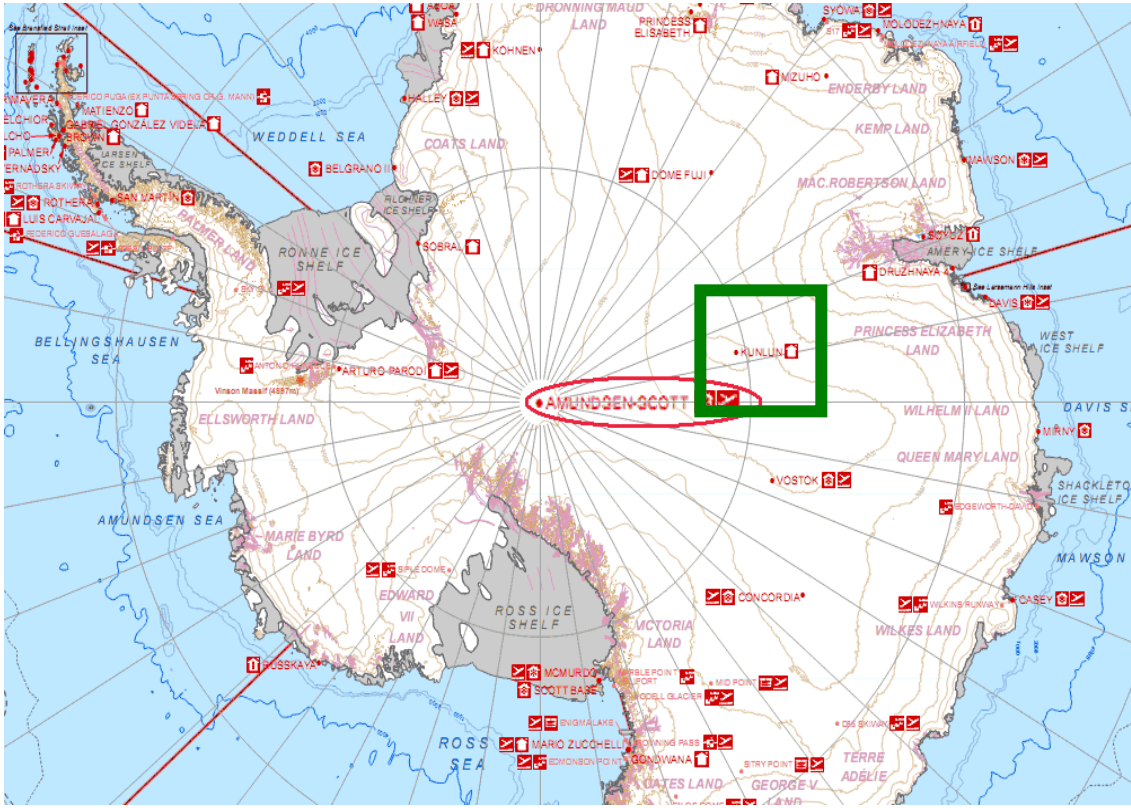
$\rightarrow$ Uncover new physics and Map LSS at 0<z<2: Low redshift counterpart to CMB surveys

SNIa cosmology Future

- Nearby SN now
  - Different classes of SNIa, average magnitude may depend on environment, redshift …
  - May have impact on precision cosmological parameter determination
  - Precision aim for 1% : calibration issues
- Waiting for SNI thousand SNIa scale **space programs** (**EUCLID** in Europe, WFIRST in US, 2m in China?)
- And/Or … **Chinese Antarctica Dome A** project?

South Pole Dome A Kunlun Telescope will answer fundamental questions about the structure of the Universe.

Wang Lifan

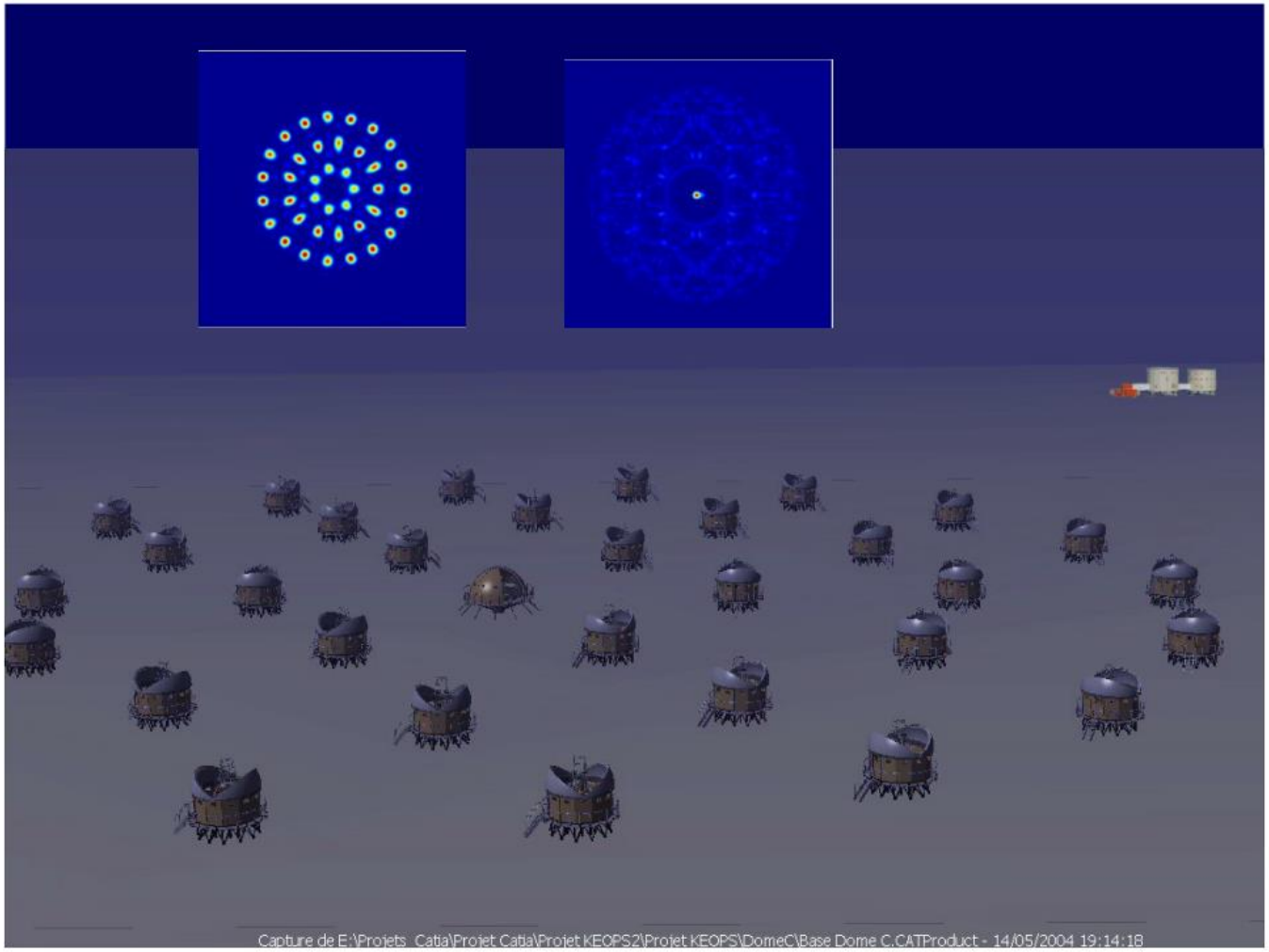


Advantage: great seeing!

Expect: 0.3 arc sec, eg space

Sino- US-Australian + French(?) project

Antarctica
for future science that is not realistic in space?



Dome-A status January 2015 traverse

- CSTAR re-installed
- AST3-1 re-vived
- AST3-2 installed
- SNIa and exo-planet surveys started last week!

➔**Problem: Worse than space conditions without the accompanying funding!**

➔ **Solutions:**

- Winter-over capability (depends on PRIC: When?)
- Dome C (French- Italian station) which has 16 people winter-over capability

Underground lab/DM projects

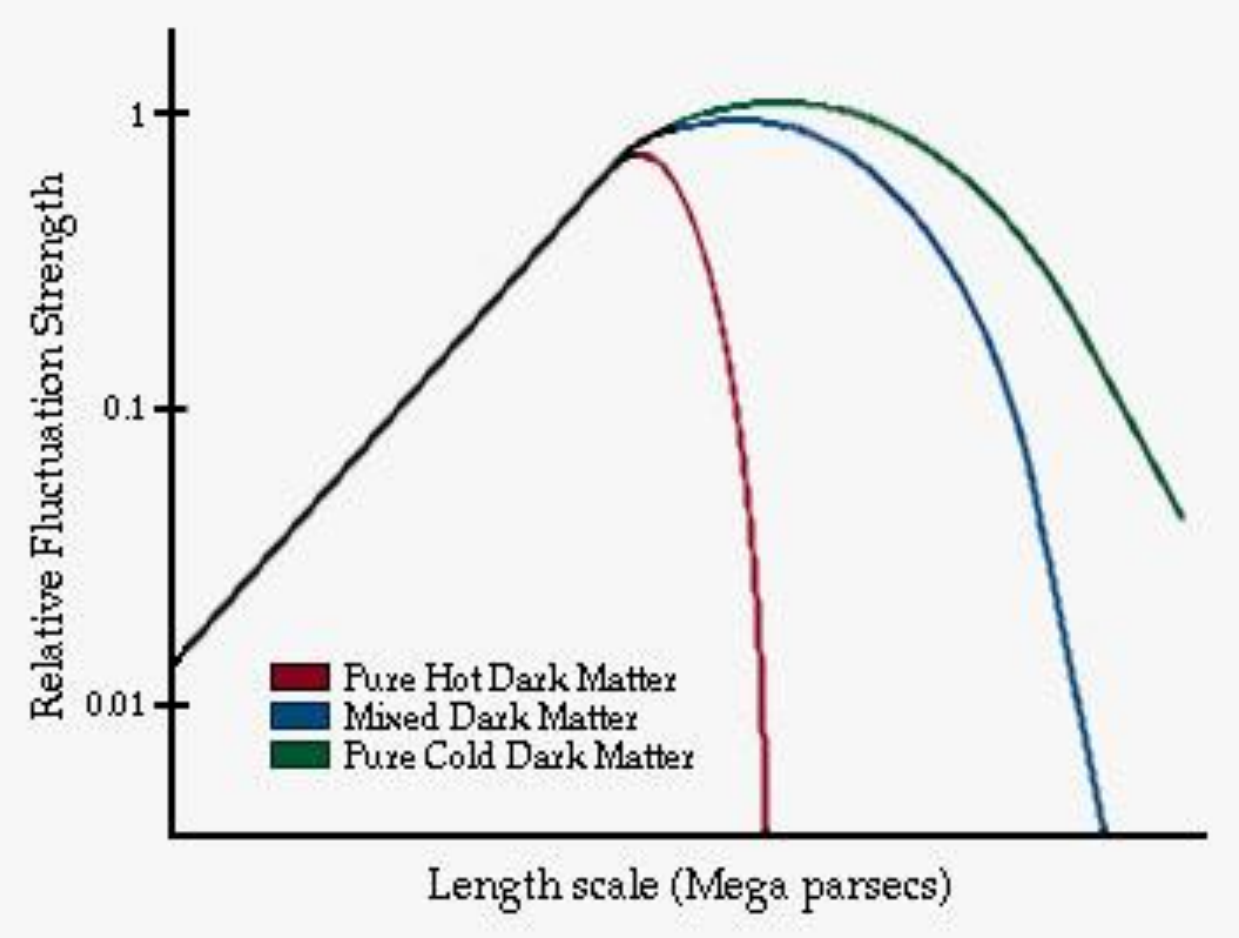
- Results from Chinese groups in Jinping CJPL:

CDEX (Li Jing) + PandaX (Ni Kaixuan)

Impressive speed < 5 years
in reaching top international levels !

- Collaboration with LSM and CPPM on low background techniques (Li Jing)

Nature of DM: WDM or CDM?



Present astrophysical constraints favor non-hot DM

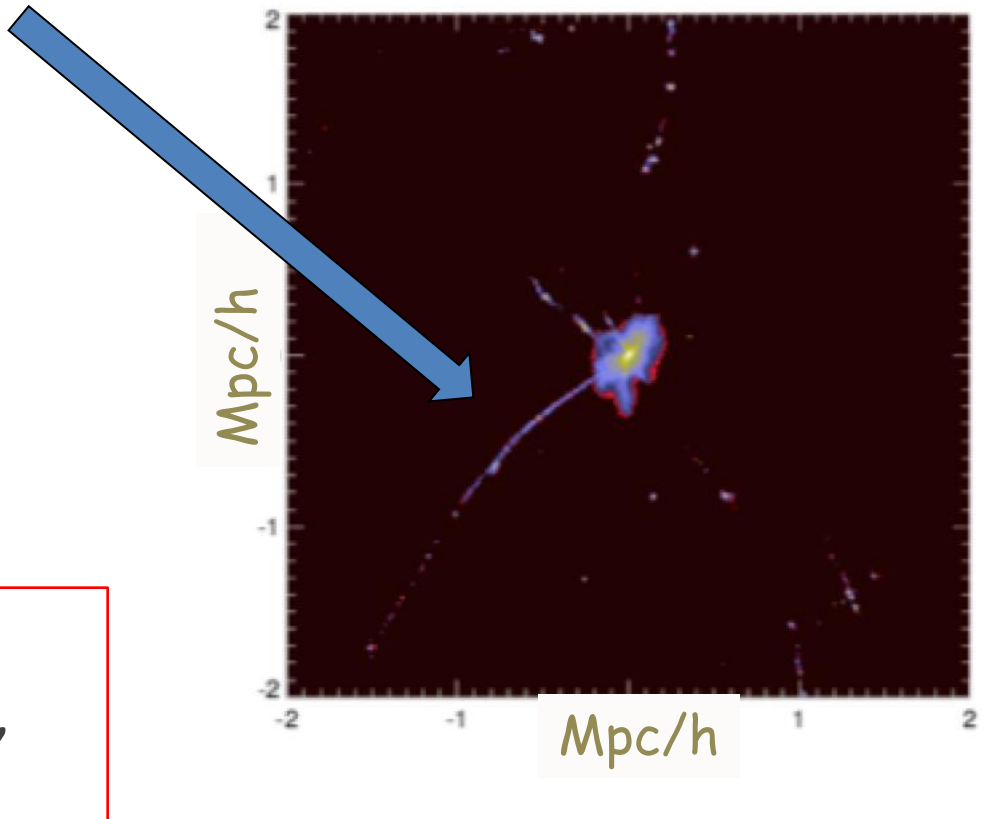
WDM hydrodynamic simulation with gaz flow

Gao, Sino-French LIA Origins Workshop DM, October 2014

Observations of a stringy appearance of high z galaxies will rule out CDM

This star formation model
Is NOT included in any current galaxy formation models.

Many arguments against WDM should be revised. (Reionisation, Lya PS, satellites abundance …)



GAMA find “tendrils” in voids !

Arxiv 1401.4064

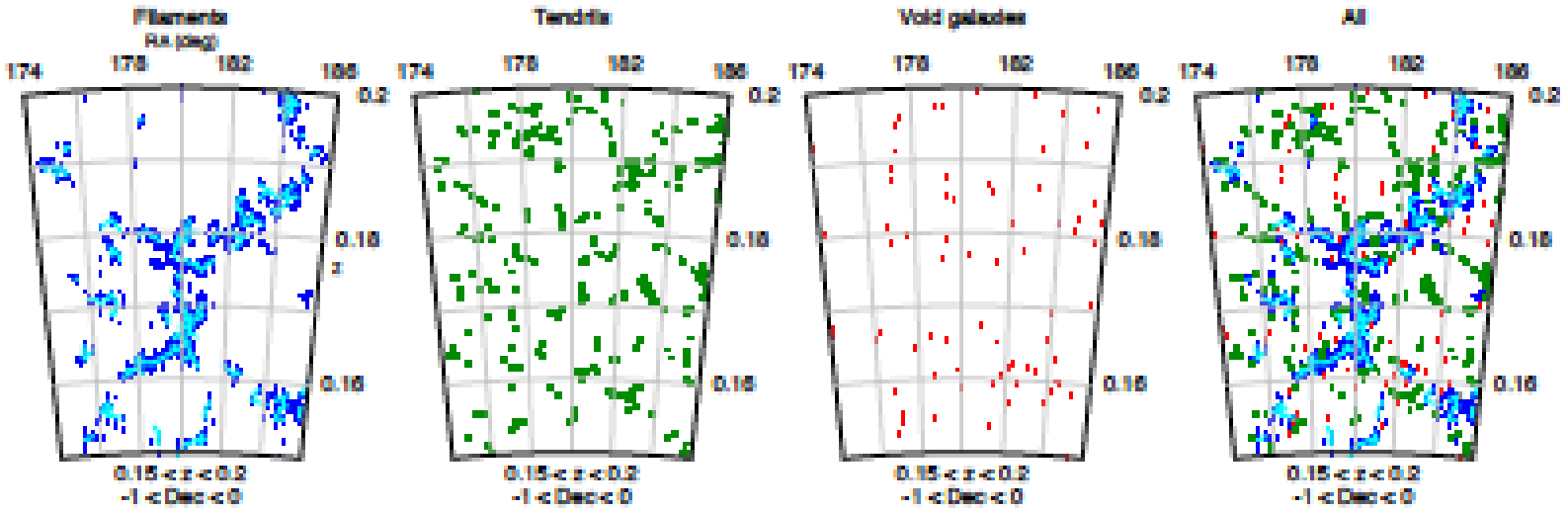
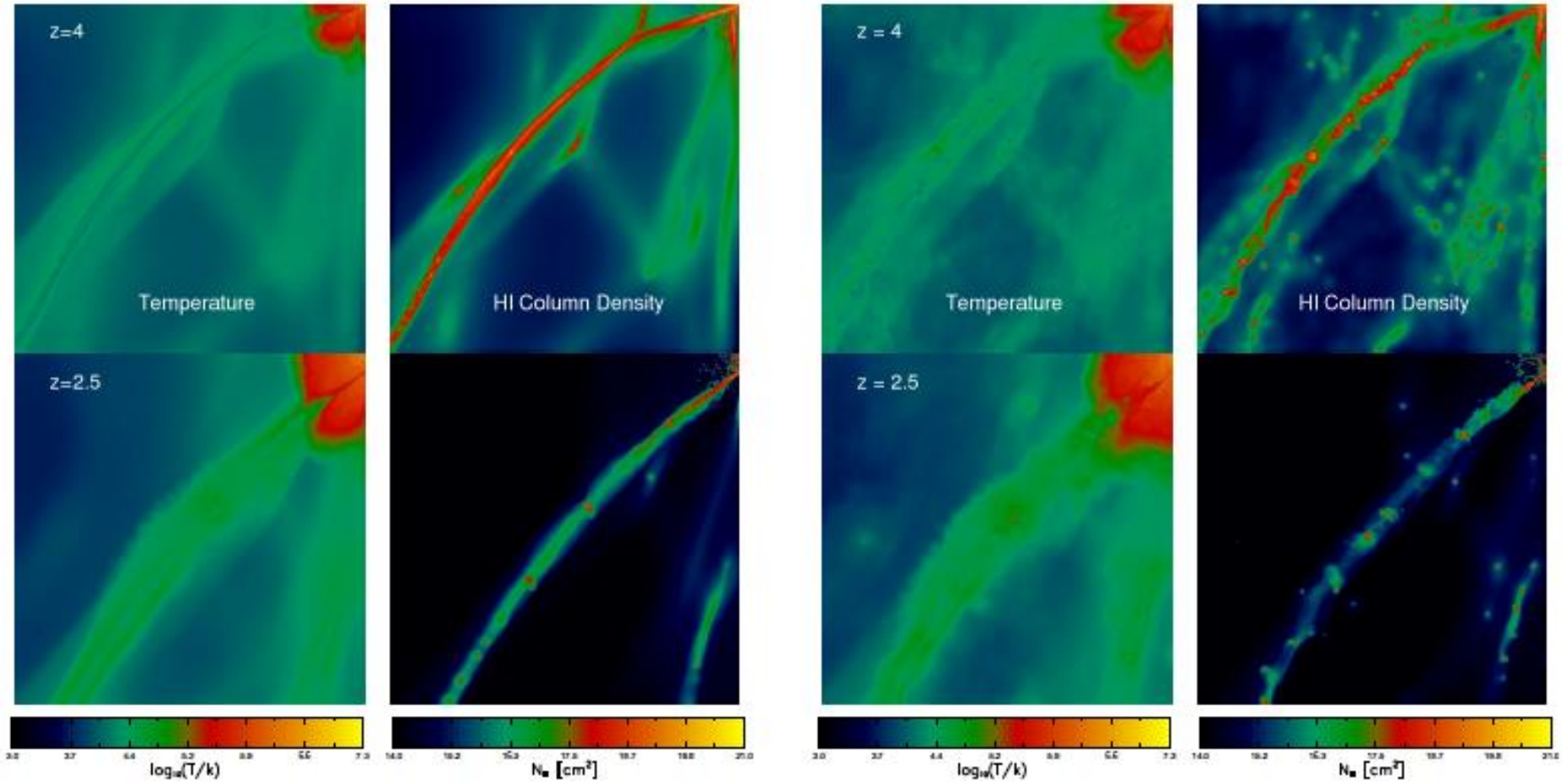


Figure 1. A section of the G12 field with different galaxy populations shown in each panel. From left to right the populations shown are galaxies in filaments with the filament minimal spanning tree (blue and cyan respectively); galaxies in tendrils (green); galaxies in voids (red); and all three populations in their respective colours.

Thin filaments found !

WDM/CDM hydrodynamic simulations star formation

Gao, theuns, Springel 2014



NB: Box size: 1.5 Mpc/h

Warm or CDM?

- More work is necessary!

  Need Baryons simulations

  but CDM is still alive!

Underground lab/DM projects

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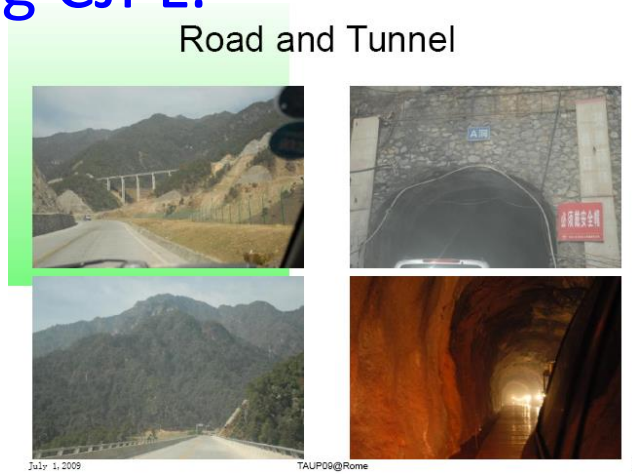

Impressive speed < 5 years
in reaching top international levels !

- Collaboration with LSM and CPPM on low background techniques (Li Jing)

- Future
  - NEWS Sphere DM detector (Ioanis Giomataris)
  - MIMAC Directional DM TPC (Daniel Santos)

- Double beta project (Karl Giboni, SJTU)

International cosmology projects

With Chinese participation

- SDSS
- DESI (ex BigBoss)
- HETDEX
- MSE
- ALMA

- SKA : approved in China by MOST a week ago
- LSST
- TMT
- PFS (?)
- …

Main Chinese-led cosmology projects

- Optical Astronomy
  - LAMOST: not extra-galactic performance
  - Dome A Antarctica
  - 2m space station

- Radio- astronomy
  - 21CMA
  - FAST
  - Tianlan (HSHS) 21cm : NAOC + **LAL** + US + Canada

- X- and gamma- ray astronomy
  - HXMT first Tsinghua-IHEP led to be launched in 2016?

  cf Zhang ShuangNan's talk Friday morning

- **DAMPE : Space DM project** **(next talks)**