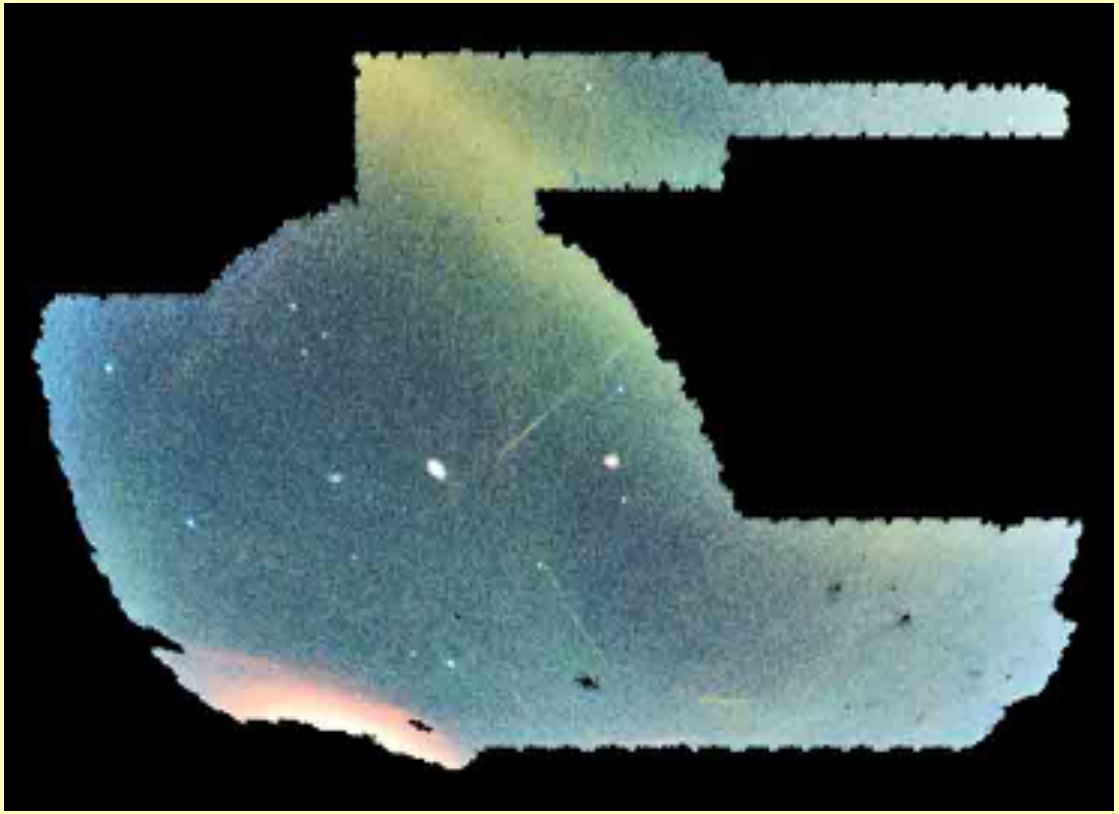
Observing Ofer



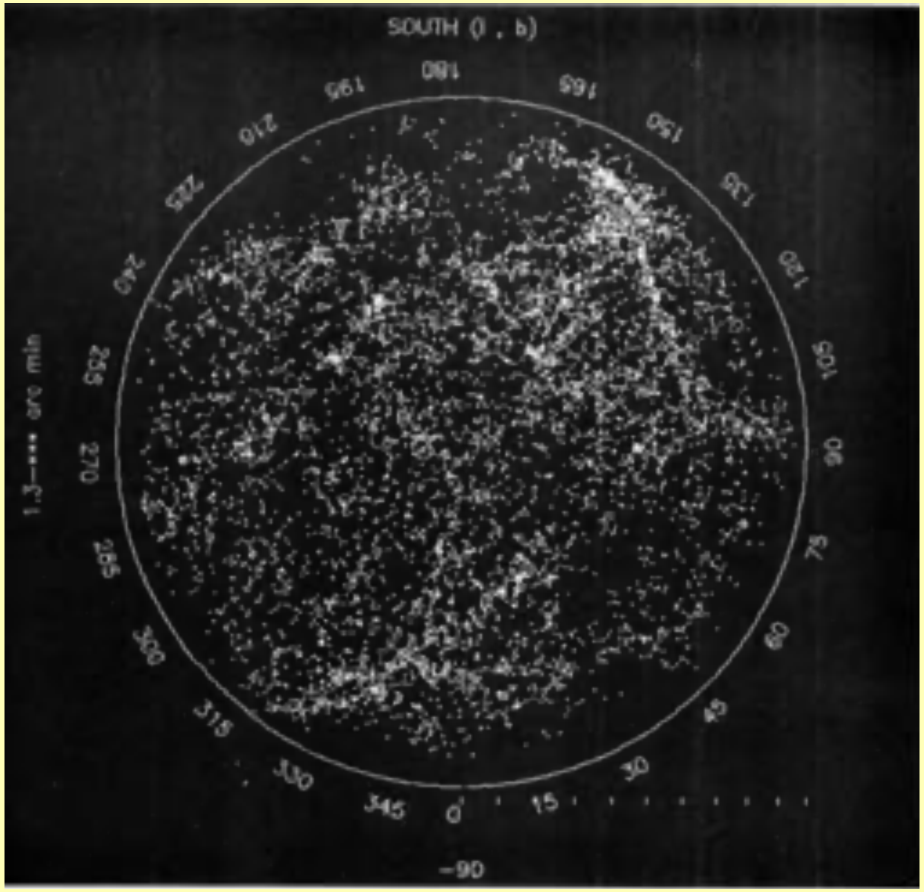
John Peacock **Lahav@60** **8 April 2019**

Outline: 4 decades of Ofer

- 1980s:
  - Dipoles
- 1990s:
  - Λ
  - ANN
- 2000s:
  - Bias and 2dFGRS
- Now:
  - DES and the post-DES statistical outlook

The Good Old Days…

1987: optical dipole



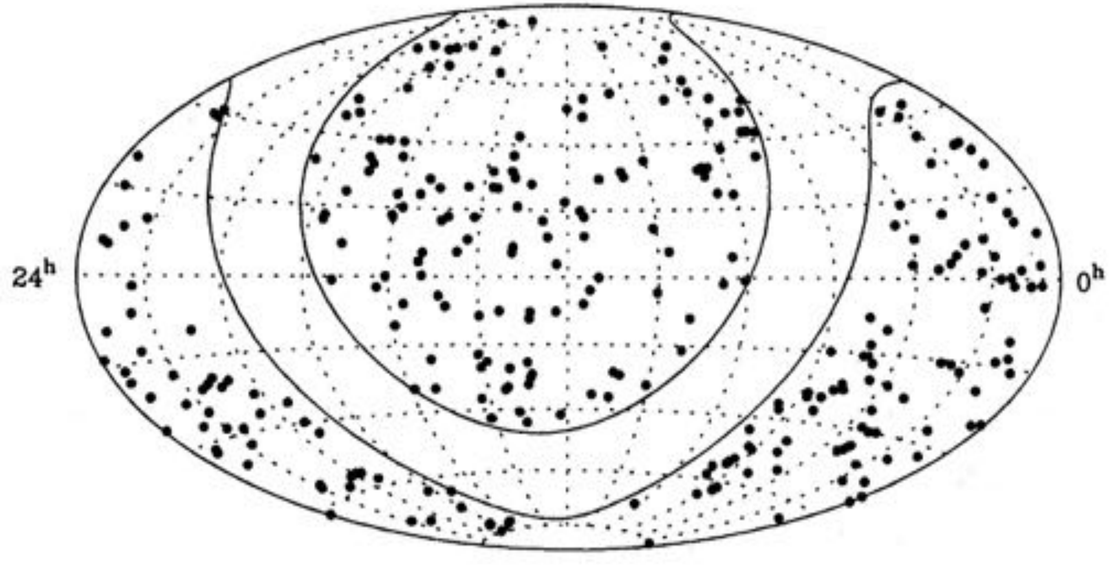
14650 galaxies to z = 0.02 ⇒ Ω = 0.3 from CMB v if b = 1

Mon. Not. R. astr. Soc. (1991) 253, 307–319

The large-scale clustering of radio galaxies

J. A. Peacock[1] and D. Nicholson[2]
[1] Royal Observatory, Blackford Hill, Edinburgh EH9 3HJ
[2] Department of Astronomy, University of Edinburgh, Blackford Hill, Edinburgh EH9 3HJ

Accepted 1991 July 8. Received 1991 June 27; in original form 1991 April 22



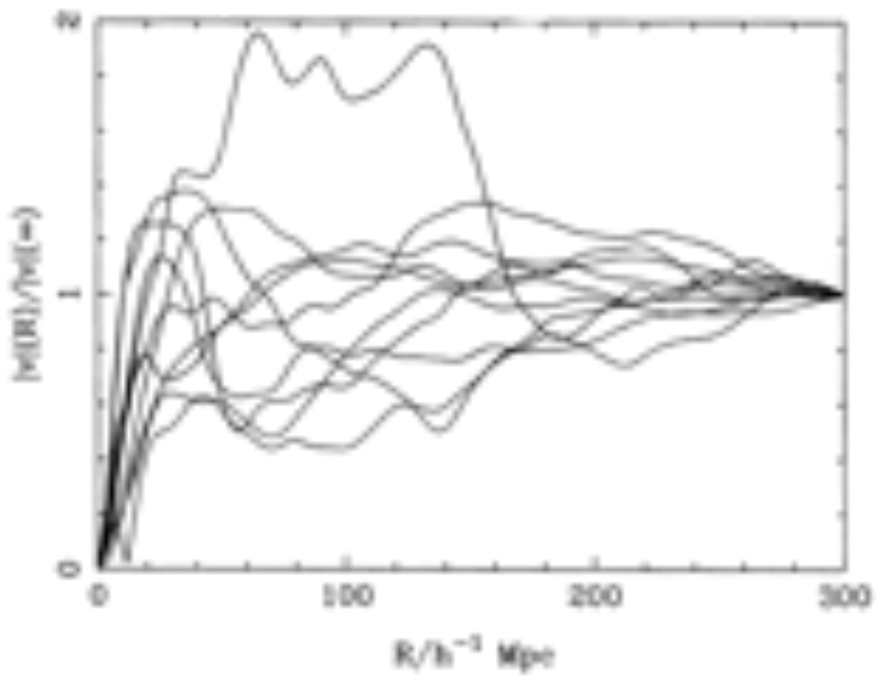
First 3D measurement of large-scale P(k)

Mon. Not. R. astr. Soc. (1992) 258, 581–586

Errors on the measurement of Ω via cosmological dipoles

J. A. Peacock
Royal Observatory, Blackford Hill, Edinburgh EH9 3HJ

Accepted 1992 April 2. Received 1992 March 2



Gravity dipole converges much faster in direction than in magnitude

Λ

Mon. Not. R. astr. Soc. (1991) **251**, 128–136

Dynamical effects of the cosmological constant

Ofer Lahav,[1] Per B. Lilje,[2] Joel R. Primack[3] and Martin J. Rees[1]
[1] *Institute of Astronomy, Madingley Road, Cambridge CB3 0HA*
[2] *NORDITA, Blegdamsvej 17, DK-2100 Copenhagen Ø, Denmark*
[3] *Physics Department, University of California, Santa Cruz, CA 95064, USA*

Accepted 1991 February 21. Received 1991 February 21; in original form 1991 January 21

Peebles $\Omega^{0.6}$ growth rate almost unaffected

Mon. Not. R. Astron. Soc. **282**, 877–888 (1996)

Measuring the cosmological constant with redshift surveys

W. E. Ballinger,[1] J. A. Peacock[2] and A. F. Heavens[1]
[1] *Institute for Astronomy, University of Edinburgh, Blackford Hill, Edinburgh EH9 3HJ*
[2] *Royal Observatory, Blackford Hill, Edinburgh EH9 3HJ*

Accepted 1996 May 15. Received 1996 May 7; in original form 1995 December 28

Plenty of pre-SNe action on Λ, following APM+CMB, despite Bayesian reluctance

ANN: Impressively early advocate

To appear in *Vistas in Astronomy*, special issue on *Artificial Neural Networks in Astronomy*, vol. 38 (3), 1994

ARTIFICIAL NEURAL NETWORKS AS NON-LINEAR EXTENSIONS OF STATISTICAL METHODS IN ASTRONOMY

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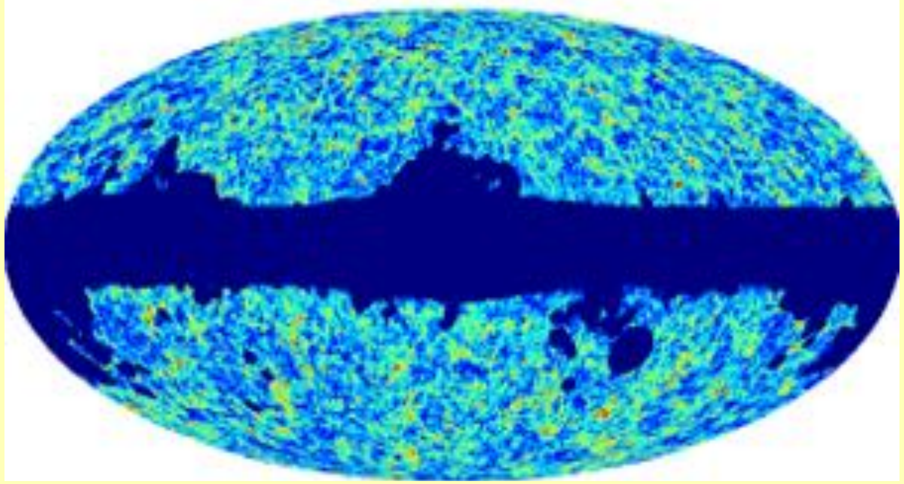
THE ASTROPHYSICAL JOURNAL SUPPLEMENT SERIES, 225:5 (24pp), 2016 July
doi:10.3847/0067-0049/225/1/5

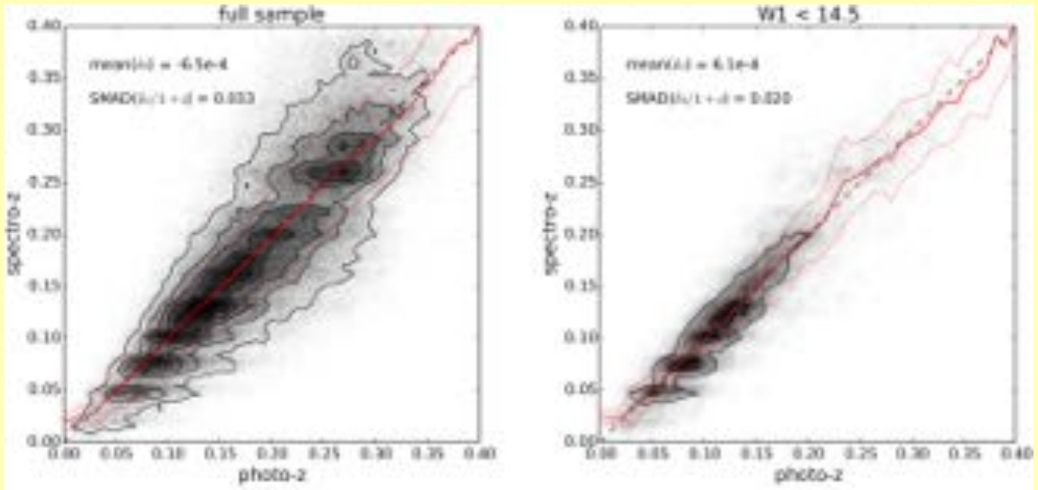
CrossMark

WISE × SuperCOSMOS PHOTOMETRIC REDSHIFT CATALOG: 20 MILLION GALAXIES OVER 3π STERADIANS

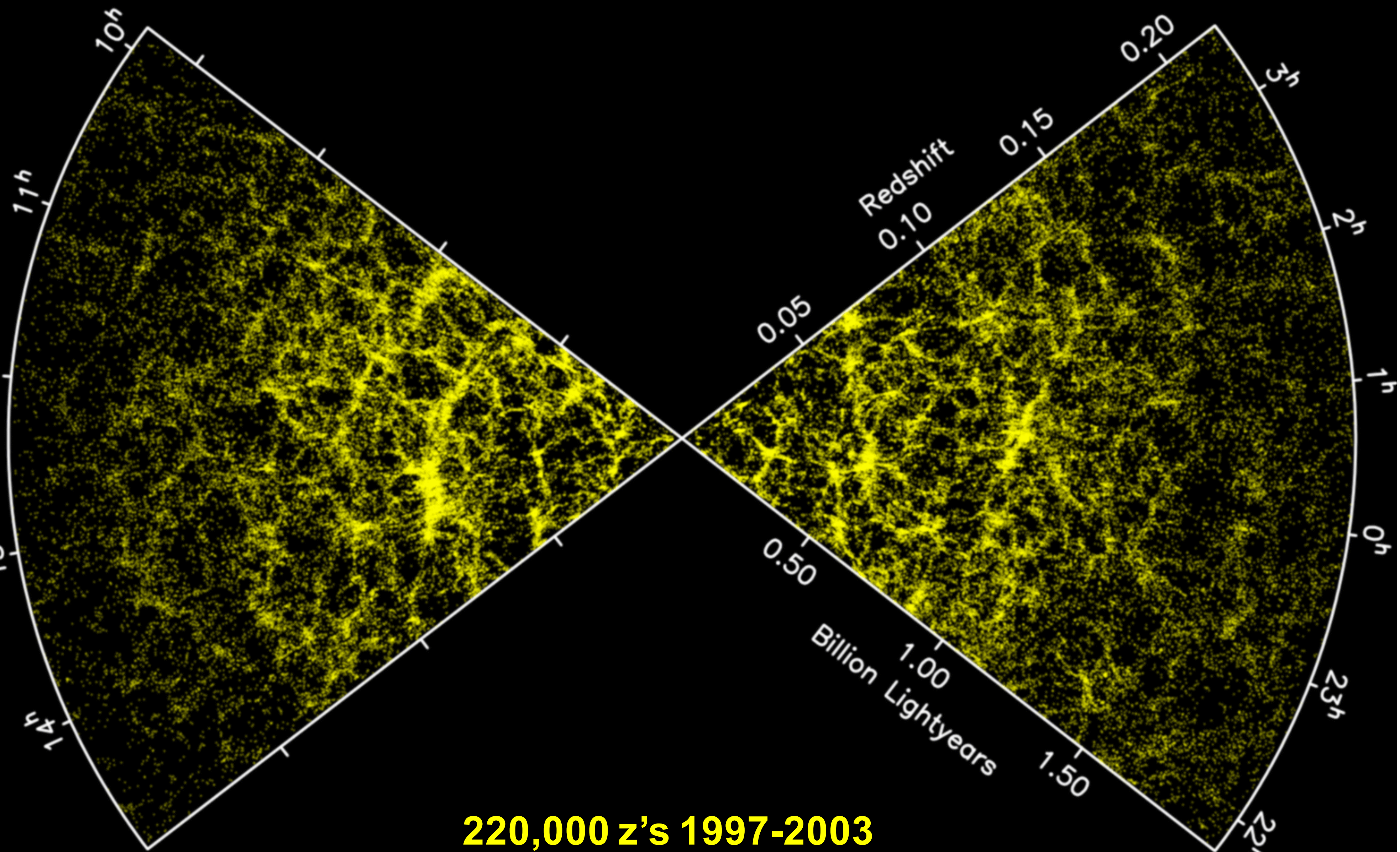
MACIEJ BILICKI[1,2,3], JOHN A. PEACOCK[4], THOMAS H. JARRETT[1], MICHELLE E. CLUVER[5], NATASHA MADDOX[6], MICHAEL J. I. BROWN[7], EDWARD N. TAYLOR[8], NIGEL C. HAMBLY[4], ALEKSANDRA SOLARZ[3,9], BENNE W. HOLWERDA[2], IVAN BALDRY[10], JON LOVEDAY[11], AMANDA MOFFETT[12], ANDREW M. HOPKINS[13], SIMON P. DRIVER[12,14], MEHMET ALPASLAN[15], AND JOSS BLAND-HAWTHORN[16]

$0.2 < z < 0.3$





2dFGRS



220,000 z's 1997-2003

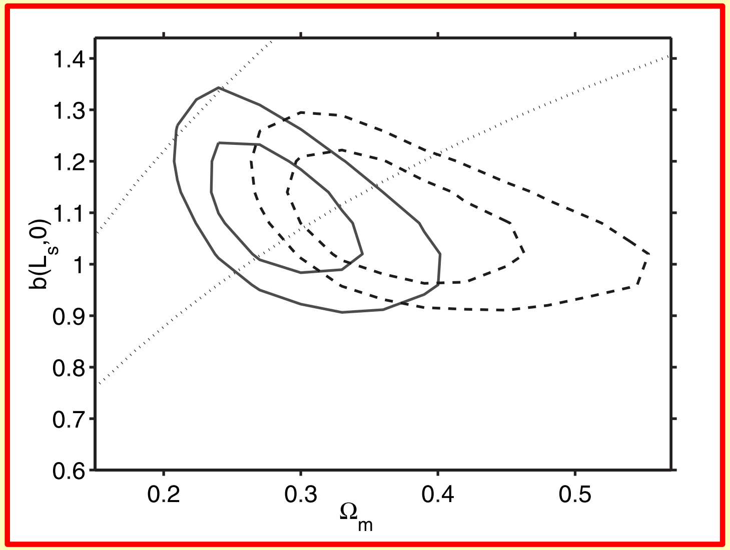
2003: 2dFGRS / 2 – OL

Galaxy bias in 2dFGRS

Mon. Not. R. Astron. Soc. **333,** 961–968 (2002)

The 2dF Galaxy Redshift Survey: the amplitudes of fluctuations in the 2dFGRS and the CMB, and implications for galaxy biasing

Ofer Lahav,[1★] Sarah L. Bridle,[1] Will J. Percival,[2] John A. Peacock,[2] George Efstathiou,[1] Carlton M. Baugh,[3] Joss Bland-Hawthorn,[4] Terry Bridges,[4] Russell Cannon,[4] Shaun Cole,[3] Matthew Colless,[5] Chris Collins,[6] Warrick Couch,[7] Gavin Dalton,[8] Roberto De Propris,[7] Simon P. Driver,[9] Richard S. Ellis,[10] Carlos S. Frenk,[3] Karl Glazebrook,[11] Carole Jackson,[5] Ian Lewis,[8] Stuart Lumsden,[12] Steve Maddox,[13] Darren S. Madgwick,[1] Stephen Moody,[1] Peder Norberg,[3] Bruce A. Peterson,[5] Will Sutherland[2] and Keith Taylor[10]

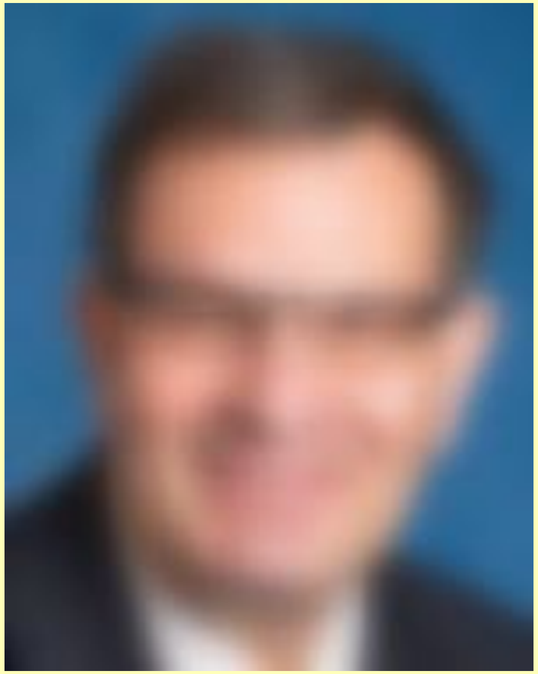


2dFGRS P(k) shape favours low Ω_m. Plus pre-WMAP CMB amplitude shows 2dFGRS bias close to 1

– consistent with RSD and bispectrum results

Peak-background split and biased mass functions

=



+

Shifted collapse threshold: $\delta_c \rightarrow \delta_c - \varepsilon$(large-scale)

$n(m) \rightarrow n(m) + (dn/d\nu)(d\nu/d\varepsilon)\,\varepsilon = n(m)\,[1+b\,\varepsilon]$

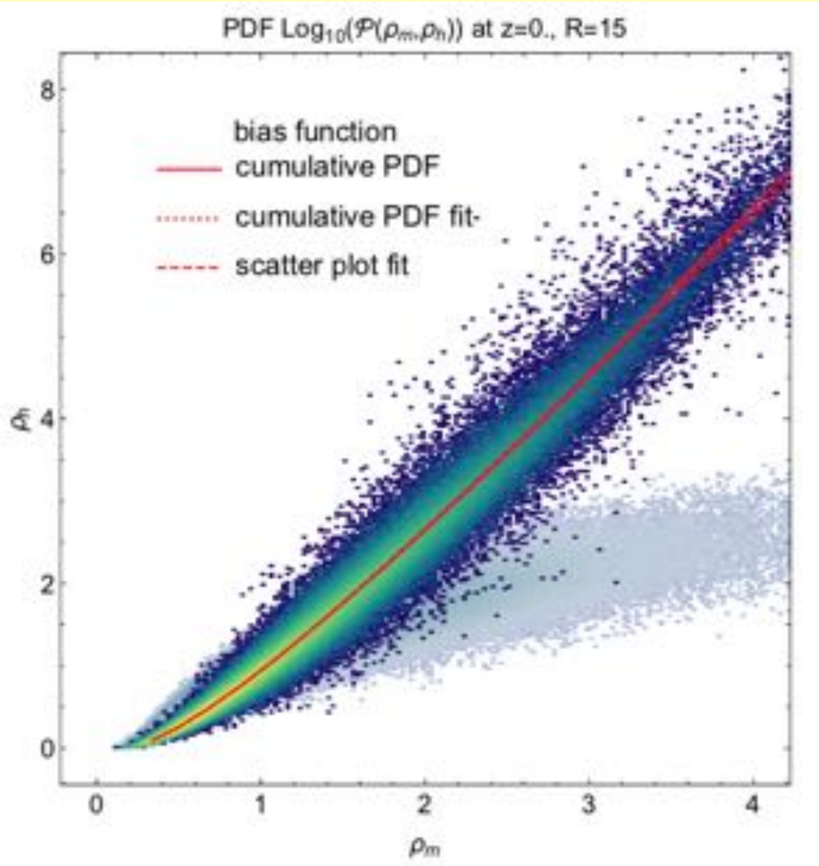
Bias parameter b(M) depends on halo mass function (Sheth & Tormen 1999)

Bias is nonlinear and stochastic

THE ASTROPHYSICAL JOURNAL, 520:24–34, 1999 July 20

STOCHASTIC NONLINEAR GALAXY BIASING

AVISHAI DEKEL[1] AND OFER LAHAV[1,2]
Received 1998 June 15; accepted 1999 March 1



Nonlinear response of halo abundance to DM fluctuation is at the heart of the 2000 halo model

Uhlemann et al. 1705.08901

DES

From: lahav@star.ucl.ac.uk Thu Aug 12 2004
Delivered-To: jap@roe.ac.uk

Dear Alan, Andy, John,

From your previous messages I gather we all agree that we should not miss the DES opportunity, and that we should act quickly before Fermilab contacts other potential partners. Therefore it would be sensible to submit a SoI by the end of the month (for the 21 Sep meeting of the PPARC Science committee). The idea is to ask for approx 1M Pounds towards 'in kind' contribution via UCL instrumentation, which will allow us participation in the science. It would be great if you join me on this, perhaps also with Cambridge (and other UK departments?)

Best regards,

Ofer

Errors on errors

Mon. Not. R. Astron. Soc. **315**, L45–L49 (2000)

Bayesian 'hyper-parameters' approach to joint estimation: the Hubble constant from CMB measurements

O. Lahav,[1,2★] S. L. Bridle,[3] M. P. Hobson,[3] A. N. Lasenby[3] and L. Sodré, Jr[4]
[1]*Institute of Astronomy, Madingley Road, Cambridge CB3 0HA*
[2]*Racah Institute of Physics, The Hebrew University, Jerusalem 91904, Israel*
[3]*Astrophysics Group, Cavendish Laboratory, Madingley Road, Cambridge CB3 0HE*
[4]*Departamento de Astronomia, Instituto Astronomico e Geofisico da USP, Av Miguel Stefano 4200, 04301-904 São Paulo, Brazil*

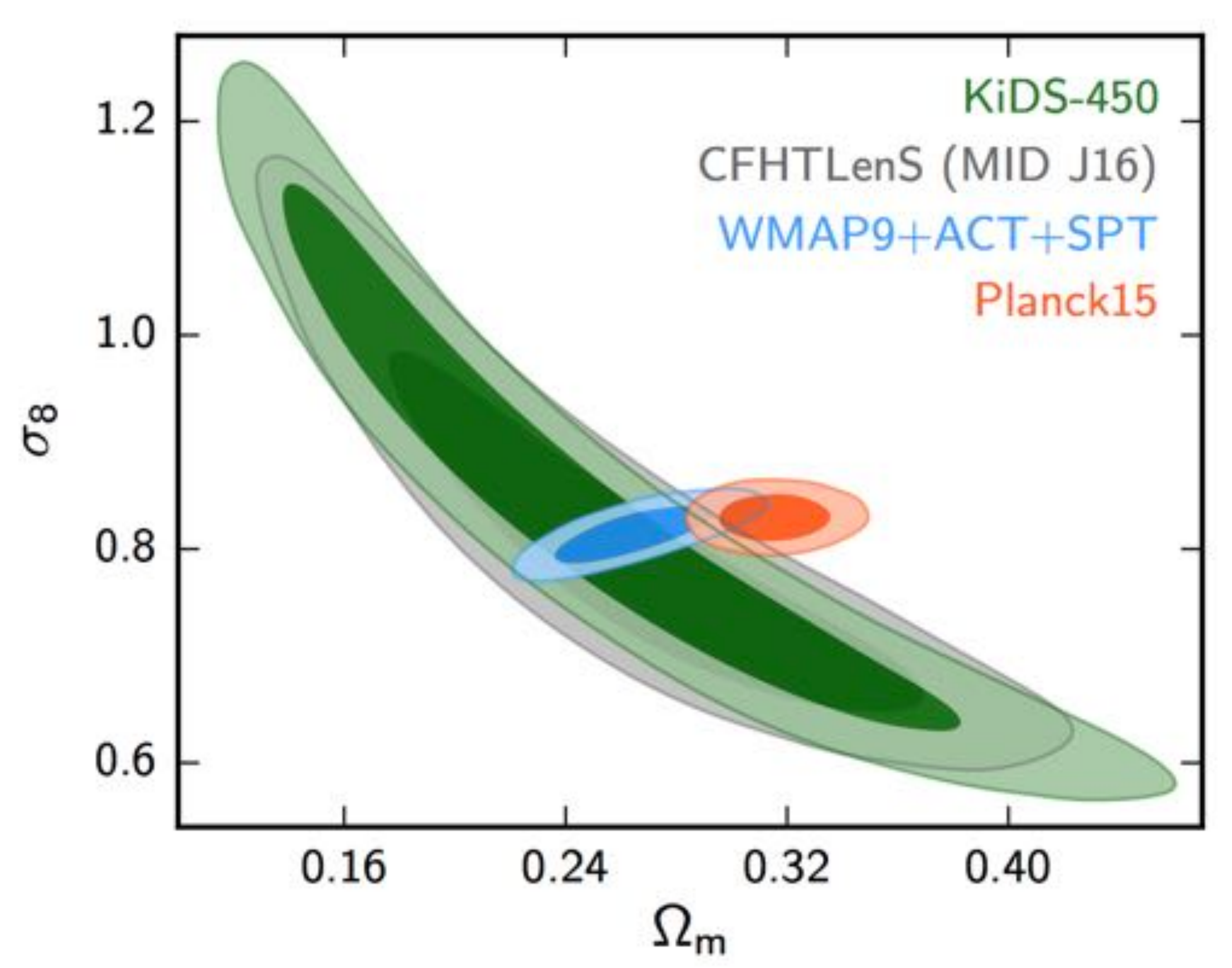
Accepted 2000 April 28. Received 2000 April 14; in original form 1999 December 8

- Scale covariances independently for each dataset

$$L(a) \propto \prod_i \alpha_i^{n_i/2} \exp[-\alpha_i \chi_i^2/2]$$
$$\propto \prod_i \alpha_i^{n_i/2} \exp[-\alpha_i \chi_{i,\min}^2(a_i)/2]\, p_i[\alpha_i^{1/2}(a - a_i)]$$

- Get p(a) by marginalising over all α's independently

Small errors breed 'tensions'



Evidence for Modified Gravity?
− or just systematics?

1606.05338

Bayes doesn't like new physics

Will we believe any 'detections' of new physics?

P(model | data) ~ L(data | model) P(model)

- Moderate prior belief in simplest neutrino hierarchy
- Strong prior belief in unevolving Λ
- Even stronger prior belief in Einstein gravity

Already plenty of 'detections' that are ignored: e.g. Λ in 1990s; Bean 2009 GR disproof; 2014 Beutler et al. massive neutrino detection.

General prior: new physics is rare; human error is common

Tensions: two distinct issues

(1) Are several datasets consistent or inconsistent?

− Various tests exist:
  − Joint χ^2 vs χ^2 for subsets
  − Bayesian evidence ratio (Marshall++2011; DES)
  − Index of Inconsistency (Lin & Ishak 2017)

(2) How do we combine datasets?

− Standard answers for consistent data:
  − Multiply likelihoods; reciprocal variance weights
− But what about inconsistent data?
  − And is consistent = perfect the right assumption?
– Some possible answers in Bernal & JP 1803.04470

The wisdom of Donald Rumsfeld (2002)

“There are known knowns. There are things we know that we know. There are known unknowns. That is to say, there are things that we now know we don't know. But there are also unknown unknowns. There are things we do not know we don't know”

Shift systematics

$$L(a) \propto \prod_i \alpha_i^{n_i/2} \exp[-\alpha_i \chi_i^2/2] \; p_i[\alpha_i^{1/2}(a - a_i + \Delta_i)]$$

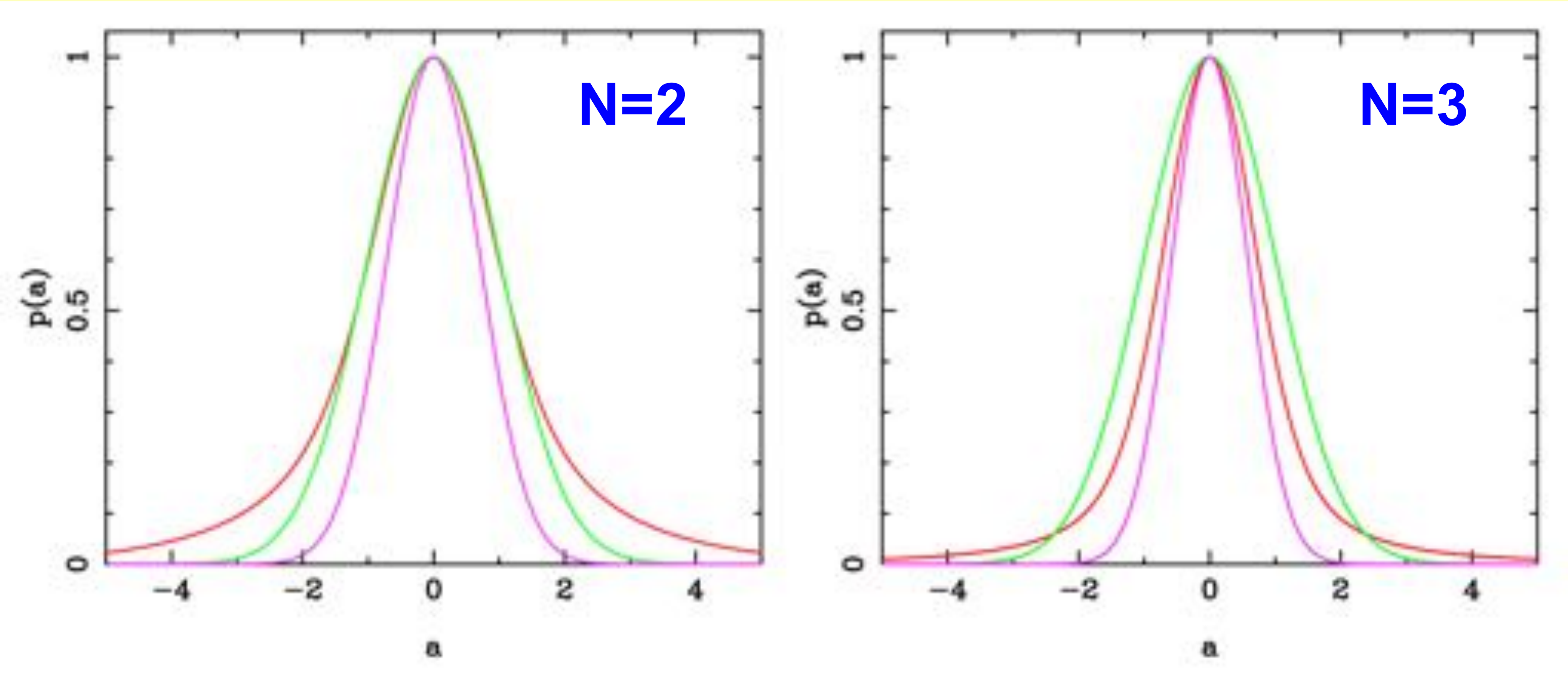
- May still rescale χ^2 if too high (fails null tests)
  - but normally a small correction

- Assume all experiments equally likely to have systematics that mimic parameter shifts

- Assume shifts are drawn from a Gaussian prior
  - Need to marginalise over shifts − AND over unknown width of prior (or covariance, in n-D parameter space)

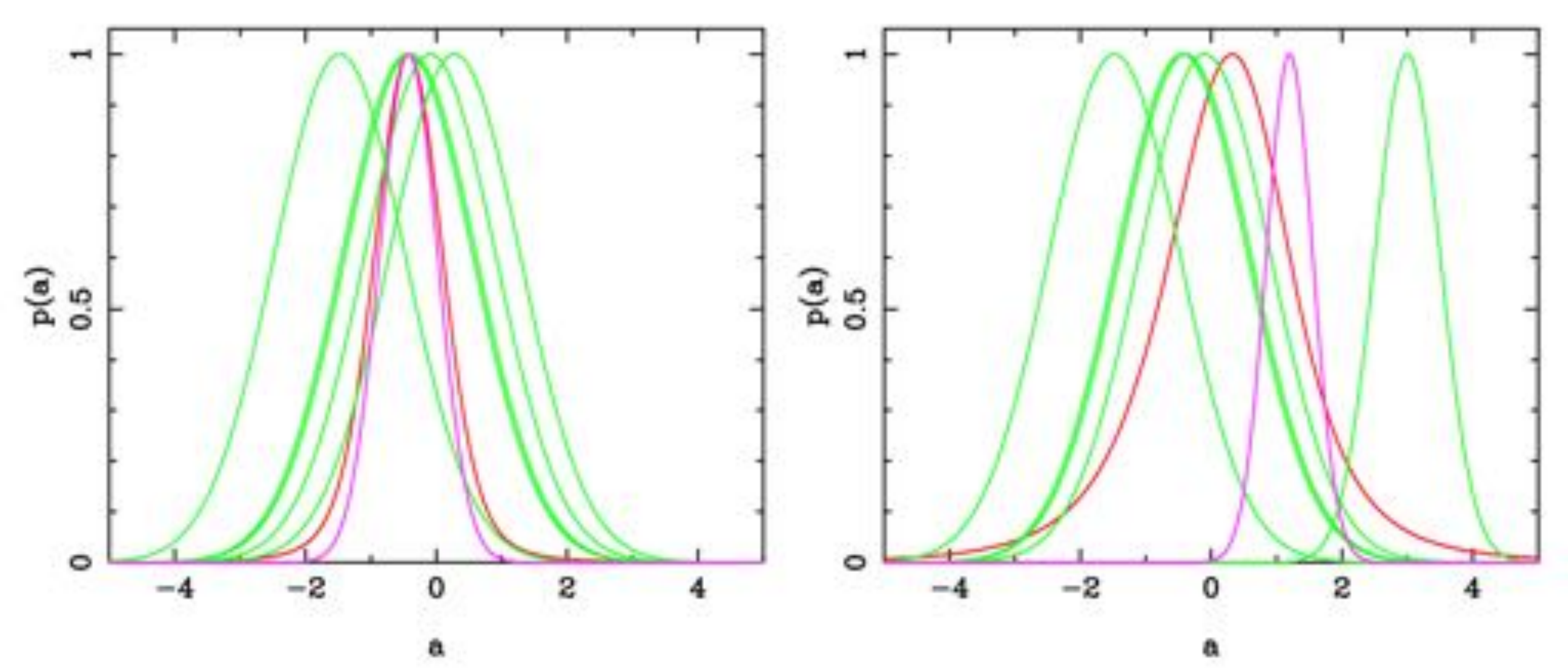
Some consequences

- One measurement tells you nothing
- Two consistent measurements doesn't give any improvement in error − just limits size of systematics
- Possibility of large systematics leads to large tails on posteriors: Prob ~ $(\Delta\,\mathrm{par})^{1-N}$ for N datasets



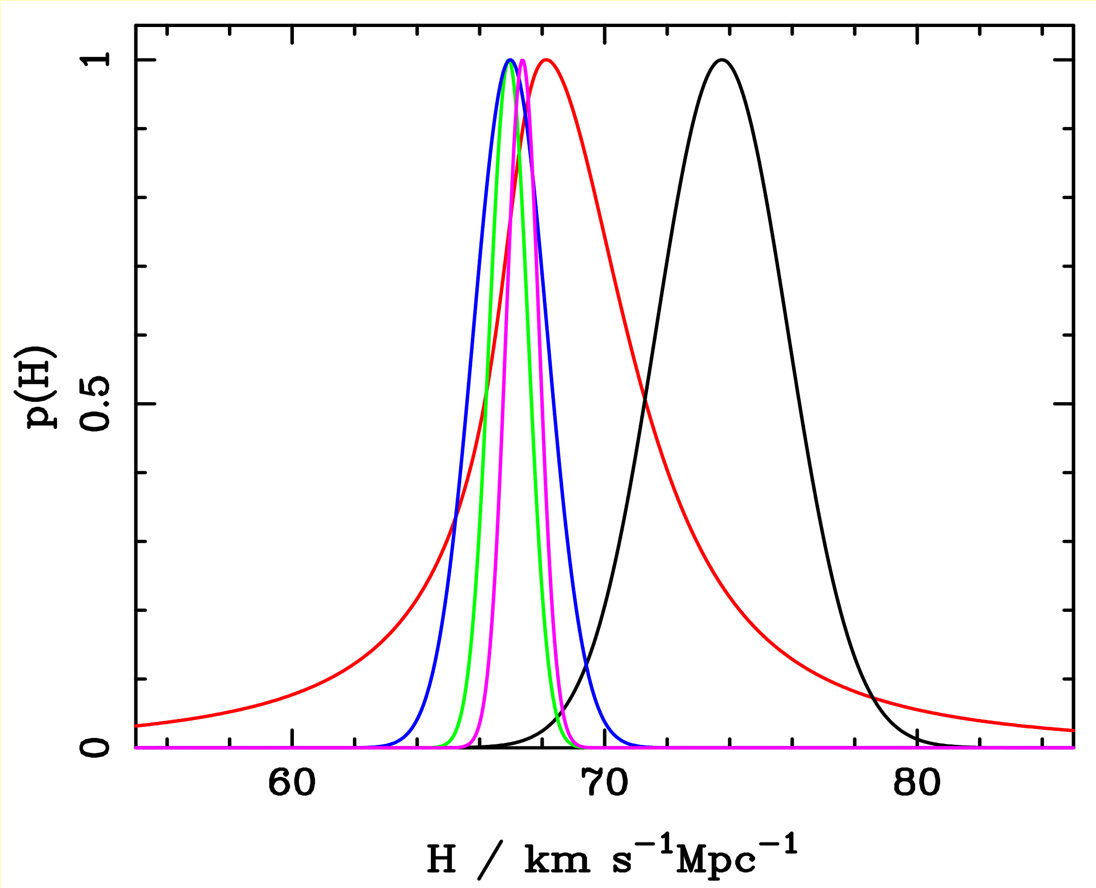
Consistent vs inconsistent

- One bad experiment damages everything
- Sufficient data can identify outliers automatically, even though prior is that all might be affected



Simple application to H_0

- 73.75 ± 2.11 (Riess et al. Cepheids++); 66.93 ± 0.62 (Planck CMB); 66.98 ±1.18 (Addison et al. BAO+BBN).

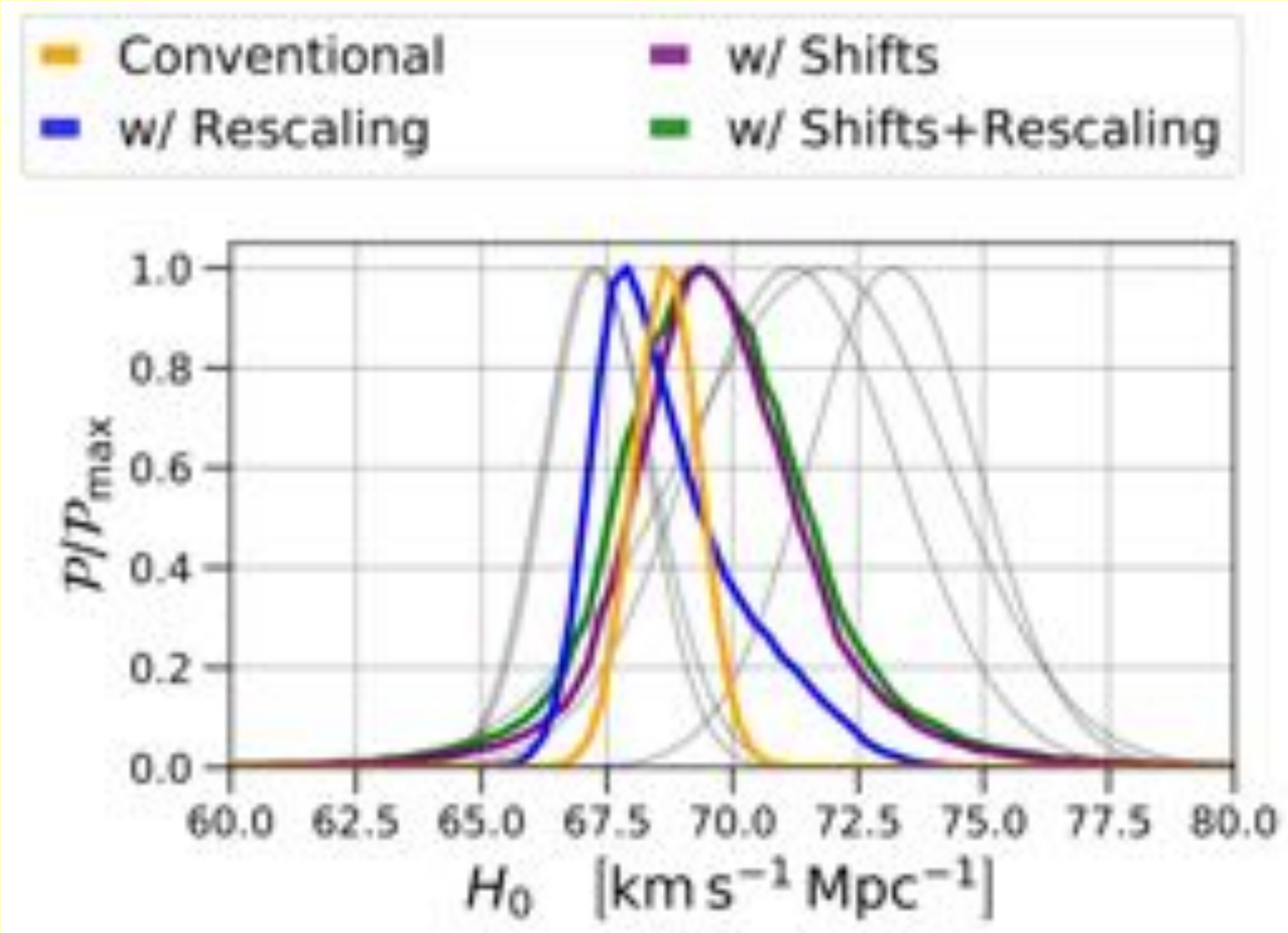


68% confidence: 65.2 – 73.2; 95% confidence: 57.0 – 84.2 !

Need more data to remove tails – value in modest accuracy experiments

Application to H_0 – more

- + DES; H0LICOW



68% confidence: 68.0 – 71.5; 95% confidence: 65.6 – 74.3

Conclusions

- Ofer has been ahead of the game in cosmology on many occasions:
  - Λ
  - ANN
  - The opportunity of DES
  - Systematics

Happy Birthday, Ofer