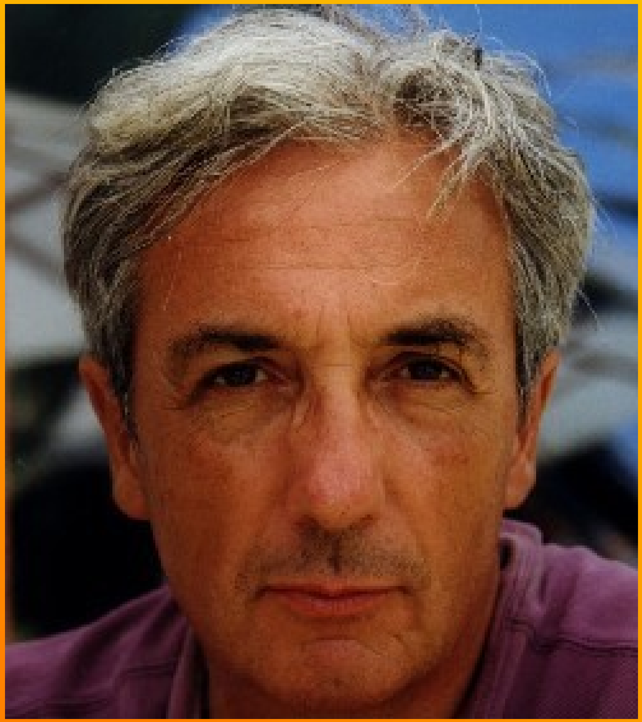
Locomotion in the Zoo

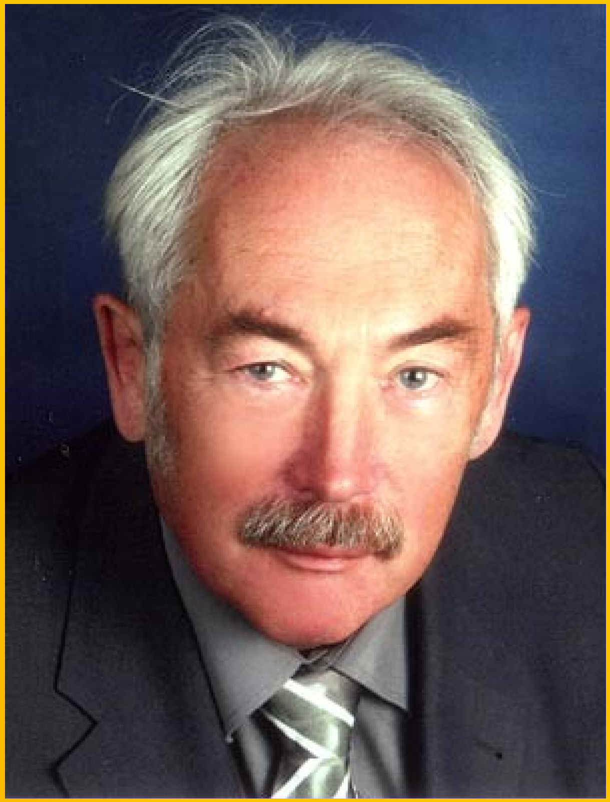
Anže Slosar, BCCP

Introduction

- new fellow at BCCP, the other Oliver
- looking for new contacts / projects
- Will talk about two projects:
  - peculiar velocities of SN (with Kate Land & Chris Gordon)
  - GalaxyZoo project (with Gzoo team, PI Chris Lintott)
  - (sterile neutrinos as a DM candidate next Wed)

Nobel prizes this morning





Albert Fert and Peter Gruenberg for the discovery of Giant Magnetoresistance

Congratulations!

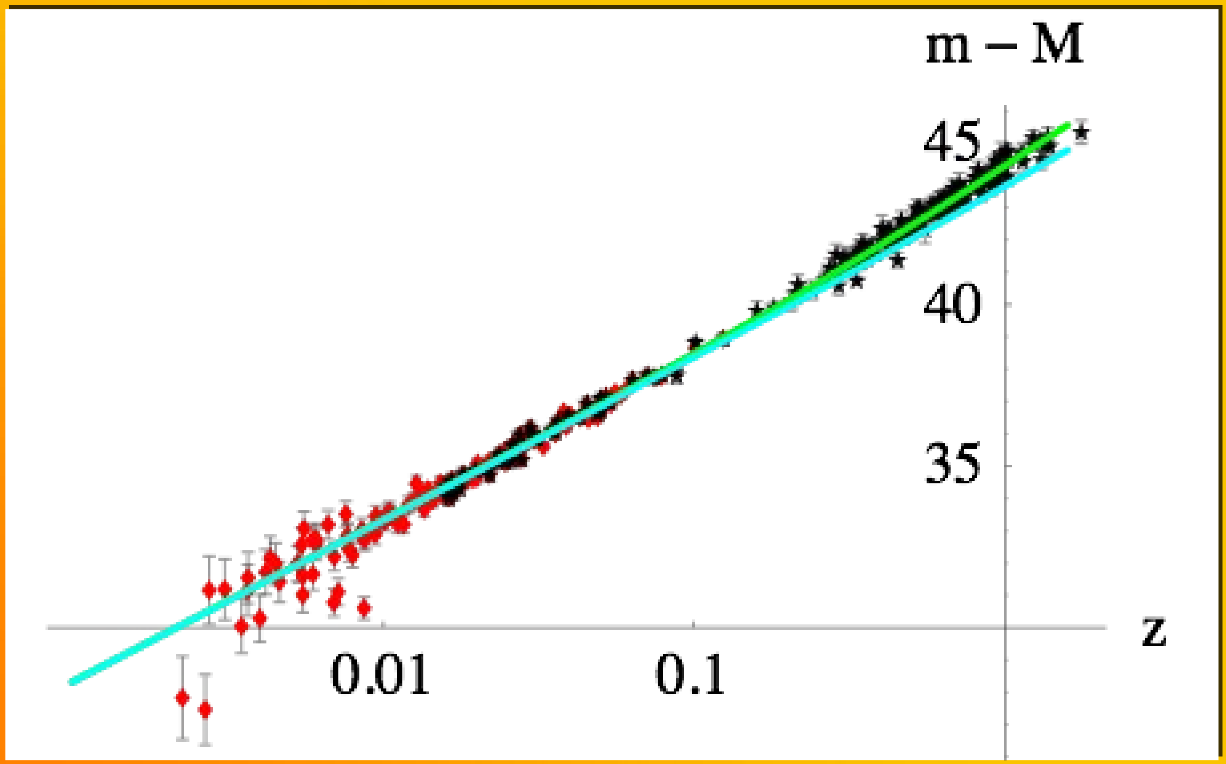
SN Ia recap

- SN go bang when when Chandrasekhar limit is reached.
- expected to work as standard candles
- empirically correct for scatter via rate of decline, colour, etc.

$$F = \frac{L}{4\pi d_L^2}$$

$$d_L = (1+z)\int_0^z \frac{dz'}{H(z')}$$

So, measure Hubble diagram



- measure magnitudes: $m = 5 \log d_L + 25 + M$
- claim the existence of accelerated expansion, etc.

Add velocity perturbations

- Measured redshift changes: $1+z_m=(1+z_i)\left(1+(\vec{v}_e-\vec{v}_o)\cdot\vec{n}\right)$
- hence the "theoretical" distance assuming homogeneous cosmology is given by

$$d_L^{th}=d_{L,i}+\left(d_{L,i}+\frac{(1+z)^2}{H(z)}\right)(\vec{v}_e-\vec{v}_o)\cdot\vec{n}$$

- Measured luminosity changes as

$$d_L^{me}=d_{L,i}\left(1+2(\vec{v}_e-\vec{v}_o)\cdot\vec{n}+\vec{v}_o\cdot\vec{n}\right)$$

(See e.g. Hui & Greene)

and so...

- Expression for luminosity fluctuation is given by

$$\frac{\delta d_L}{d_L} = \frac{d_L^{me} - d_L^{th}}{d_L^{th}} = \vec{n} \cdot \left(\vec{v}_e - \left(\frac{(1+z)^2}{H(z)} \right) \cdot (\vec{v}_e - \vec{v}_o) \right)$$

- We can account for observers velocity from the CMB monopole
- from here one can go and derive local velocity fields and moments

Correlated luminosities

- Correlated velocities lead to correlated luminosities

$$\xi(\mathbf{r_i}, \mathbf{r_j}) = \sin\theta_i \sin\theta_j \xi_\perp(r, z_i, z_j) + \cos\theta_i \cos\theta_j \xi_\parallel(r, z_i, z_j)$$

$$\xi_{\parallel,\perp} = D'(z_i)\, D'(z_j) \int_0^\infty \frac{\mathrm{dk}}{2\pi^2} P(k) K_{\parallel,\perp}(kr)$$

$$K_\parallel(x) = j_0(x) - \frac{2j_1(x)}{x}, \quad K_\perp(x) = j_1(x)/x$$

Likelihood

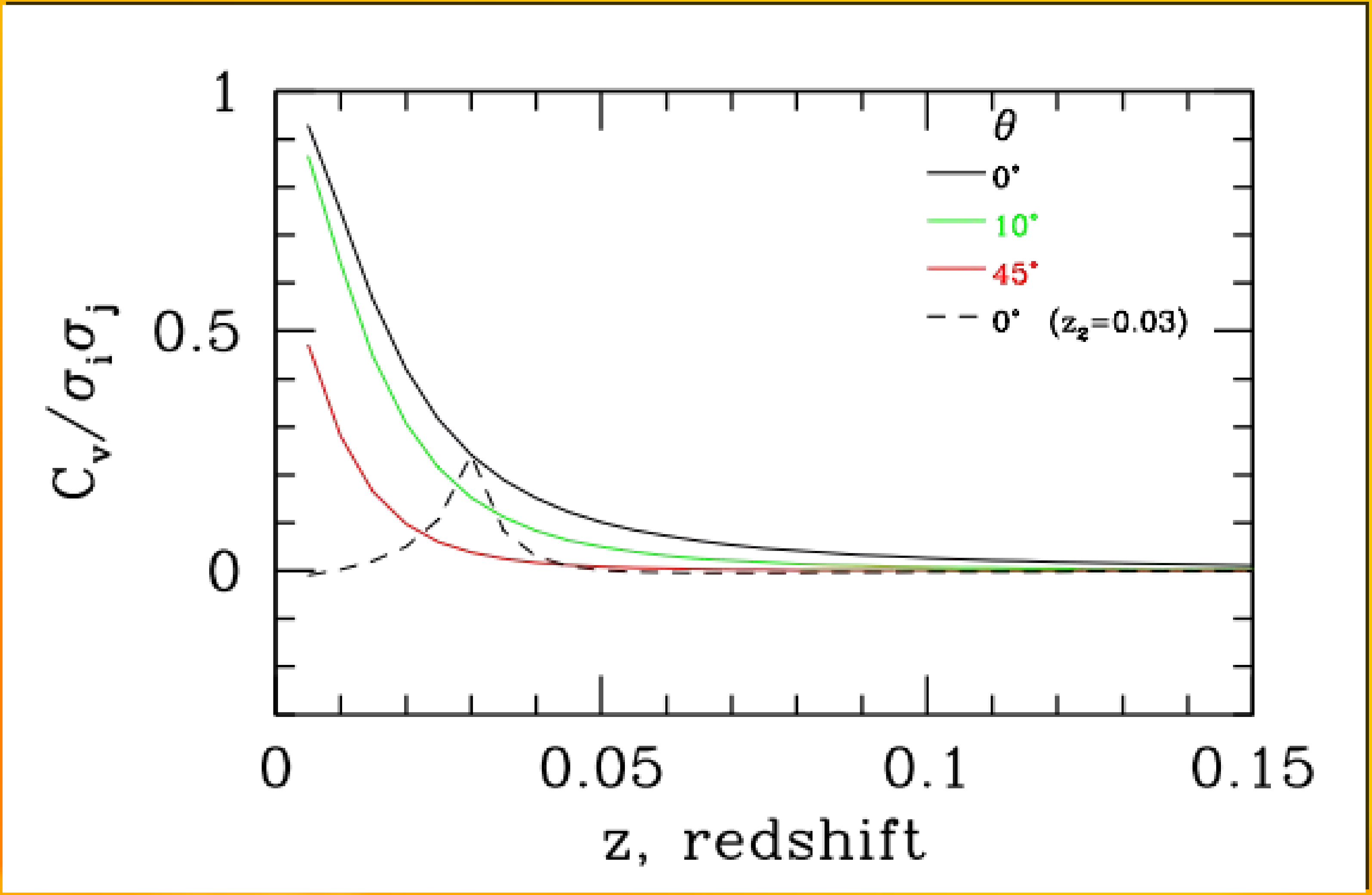
- So, one can write the correlation function for luminosity perturbations

$$C_{ij} = \left\langle \left(\frac{\delta d_L}{d_L} \right)_i \left(\frac{\delta d_L}{d_L} \right)_j \right\rangle$$

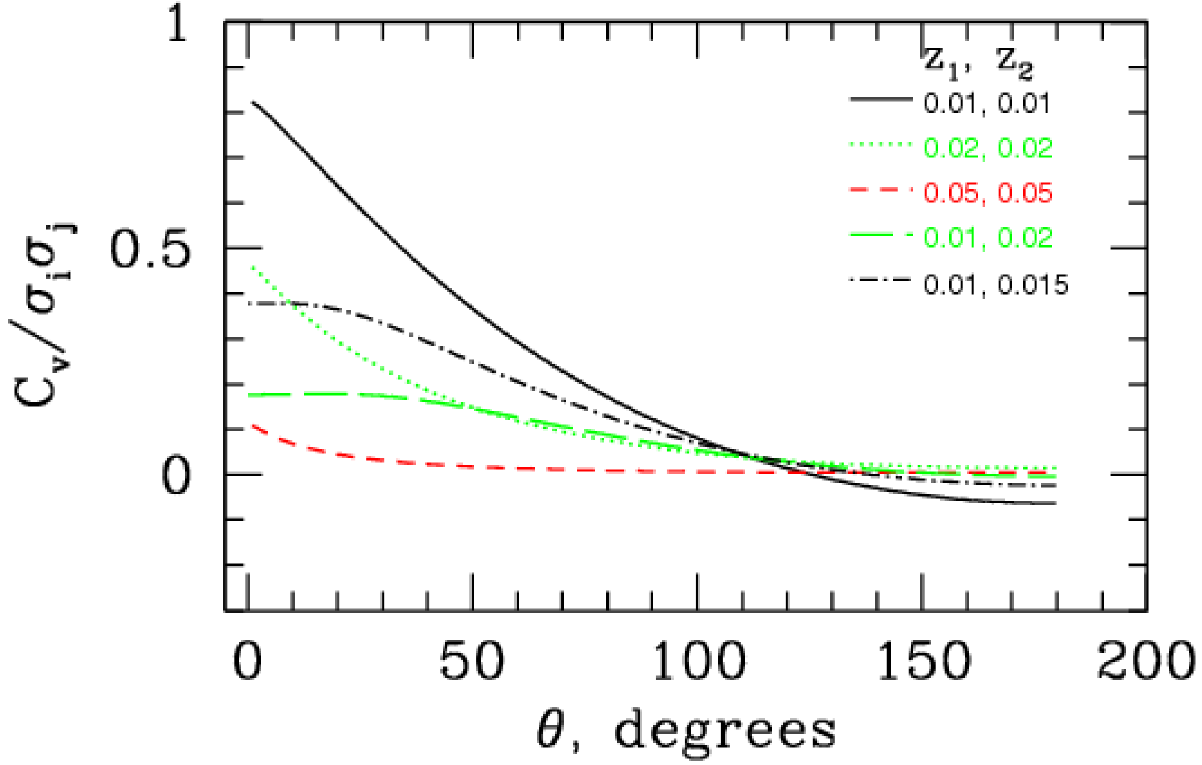
- the exact likelihood is possible with O(100) supernovae:

$$L = \frac{1}{(2\pi)^{(N/2)} |C|} e^{\left(-\boldsymbol{d}^T \boldsymbol{C}^{-1} \boldsymbol{d}\right)}$$

Covariances



Covariances



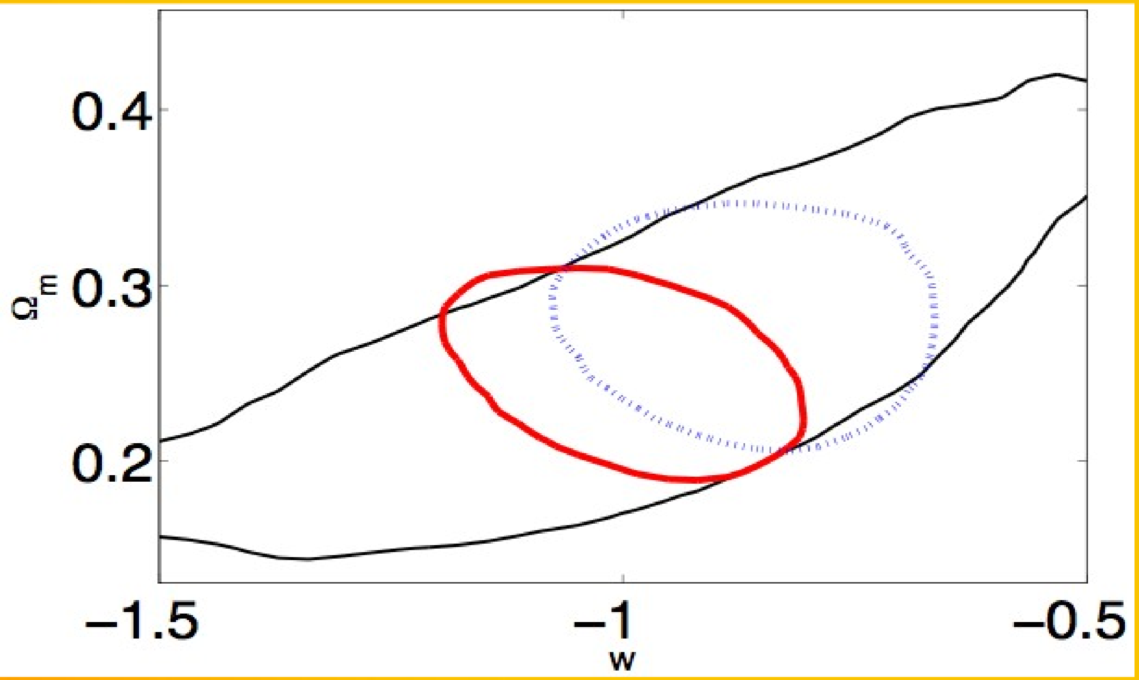
Results:

- Use 133−9=124 nearby ($z<0.12$) SN from Jha et al
- Average separation 100 Mpc/h, mean redshift 0.024
- vary the usual cosmological parameters plus:
  - absolute magnitude offset
  - magnitude scatter
  - velocity scatter
- Add HST + BBN prior to exclude wild models
- In some cases add WMAP or 147 Davis et al SN.

Results:

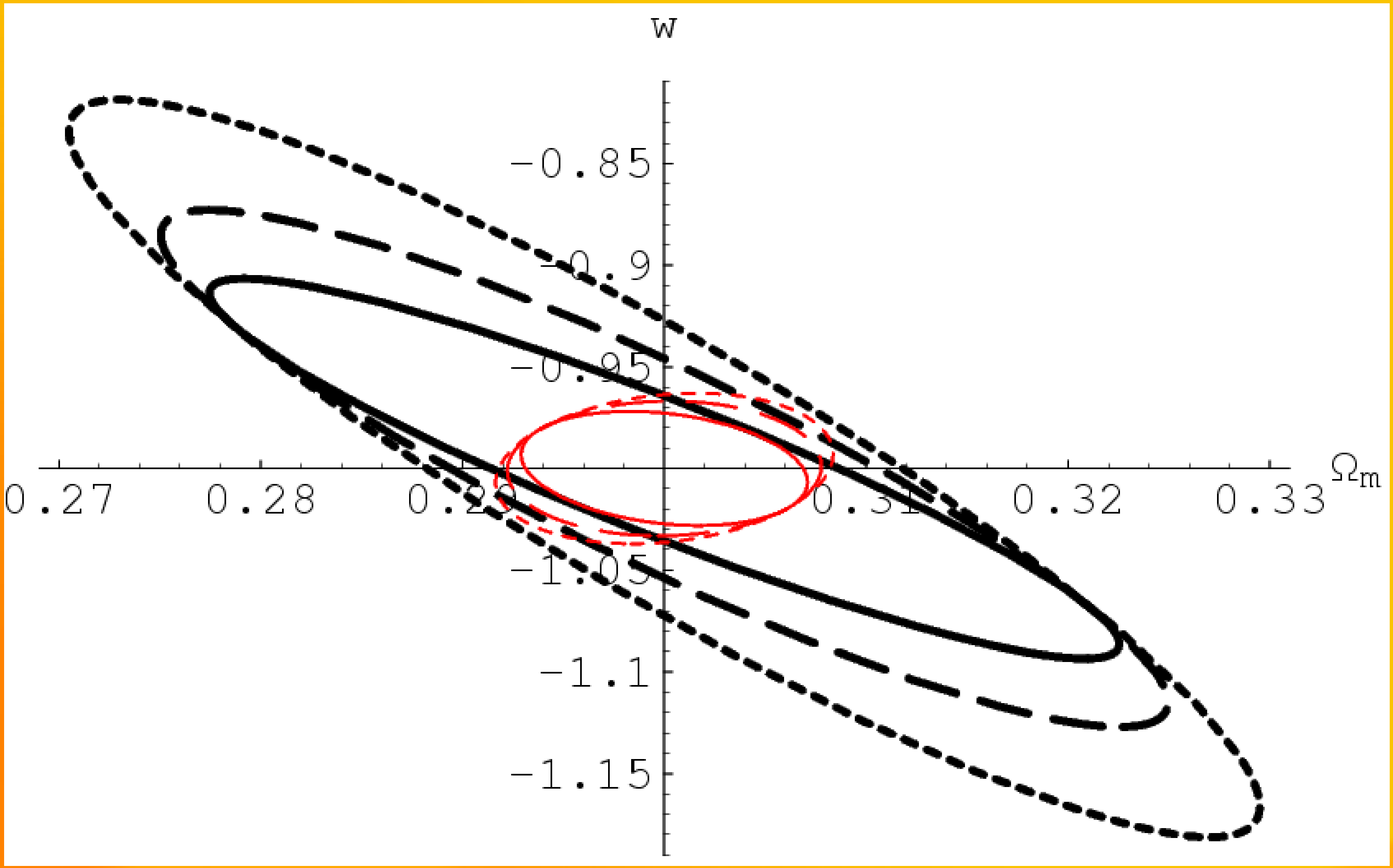
- We get a 3-4 sigma detection of the effect:

$$\sigma_8 = 0.79 \pm 0.22$$



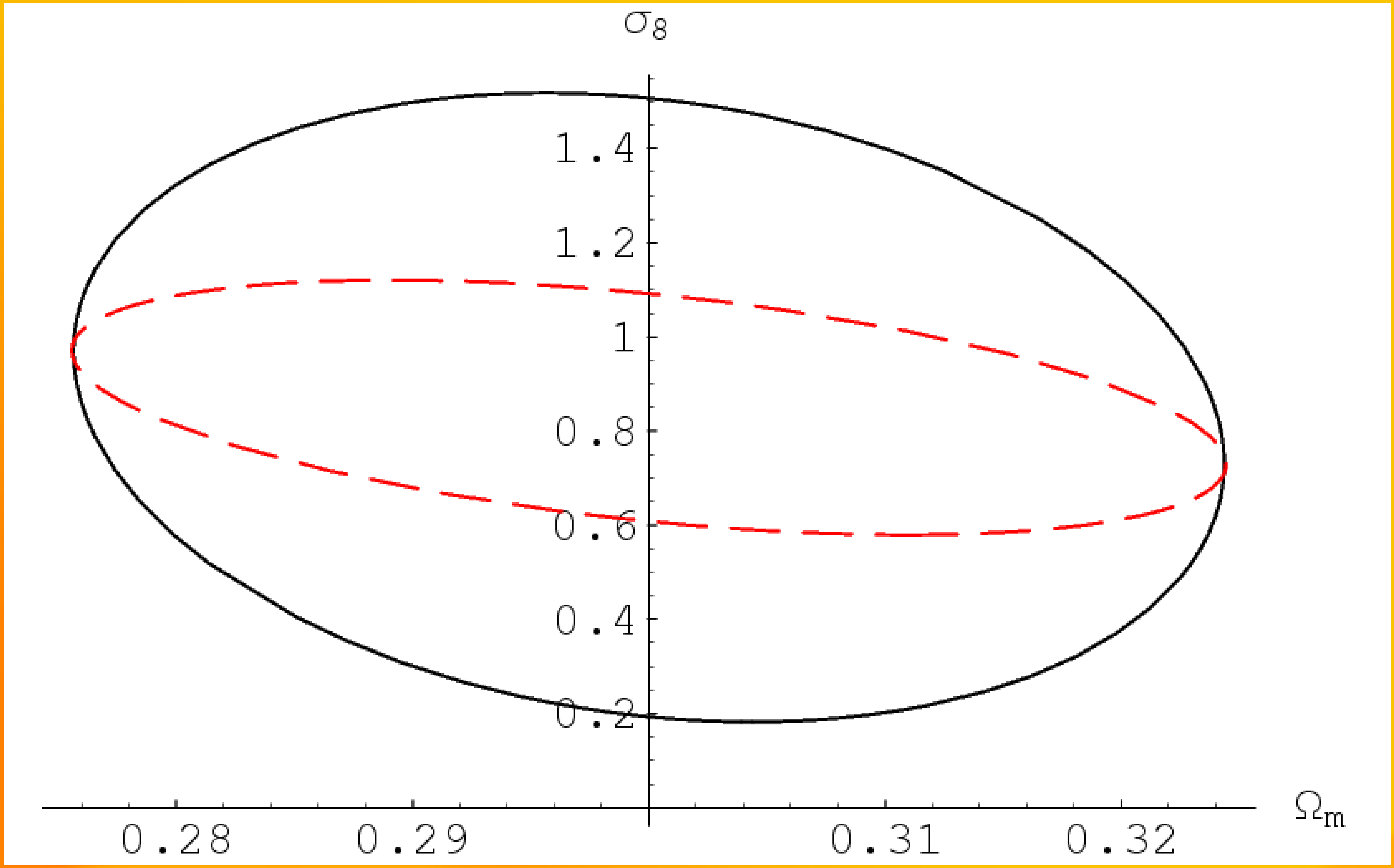
- Covariances act as a source of signal for power spectrum parameters and matter density
- Covariances act as a source of noise for standard background analysis - # of SN effectively reduced

Future: FM analysis



- SN factory: 300 pieces over 10000 sq deg, 0.03<z<0.08
- SNAP: 2000 pieces over 10 sq deg, 0.2<z<1.7

Future: FM analysis

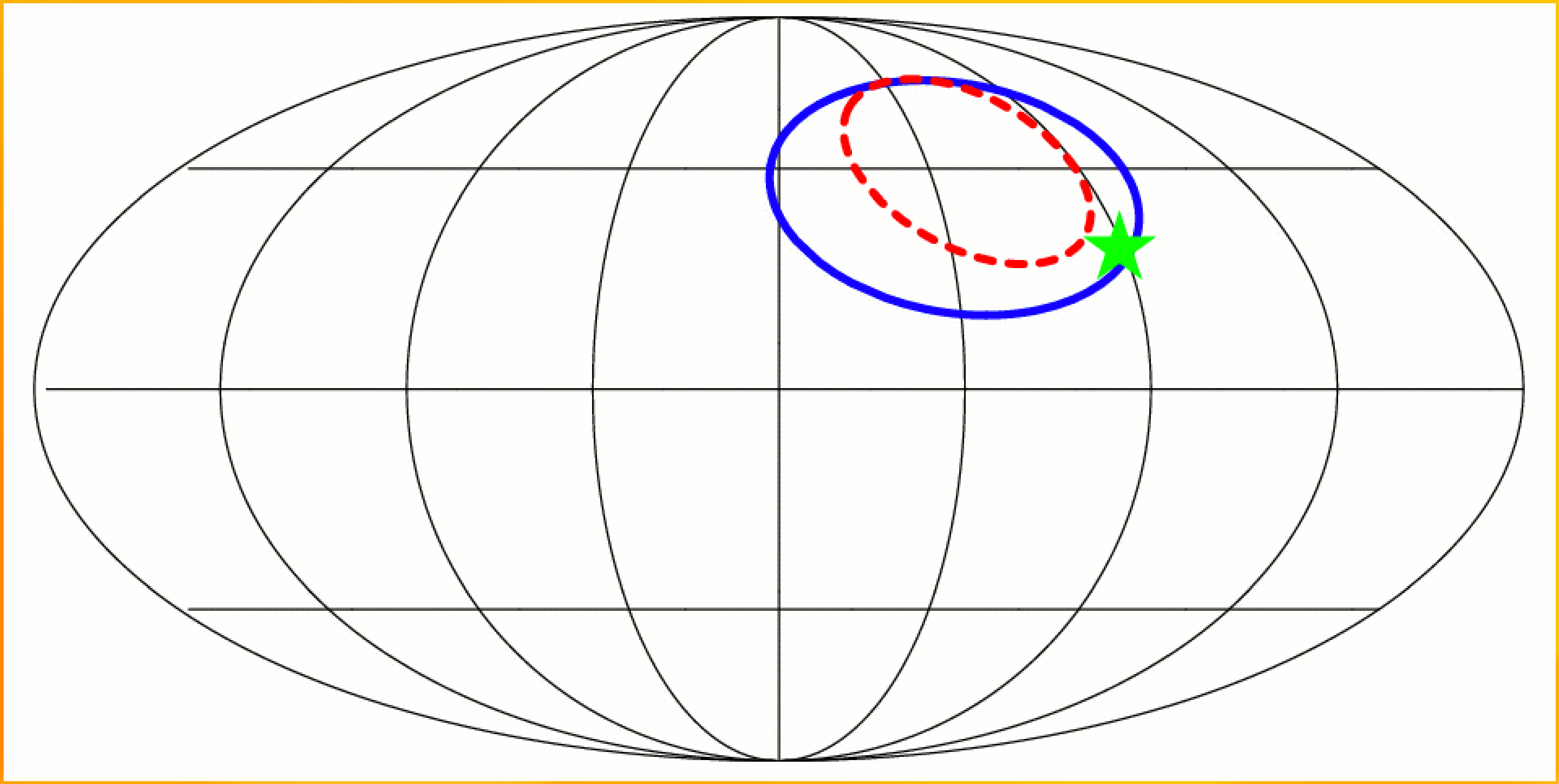


- What the heck: 0.03 – 0.08 vs 0 – 0.08

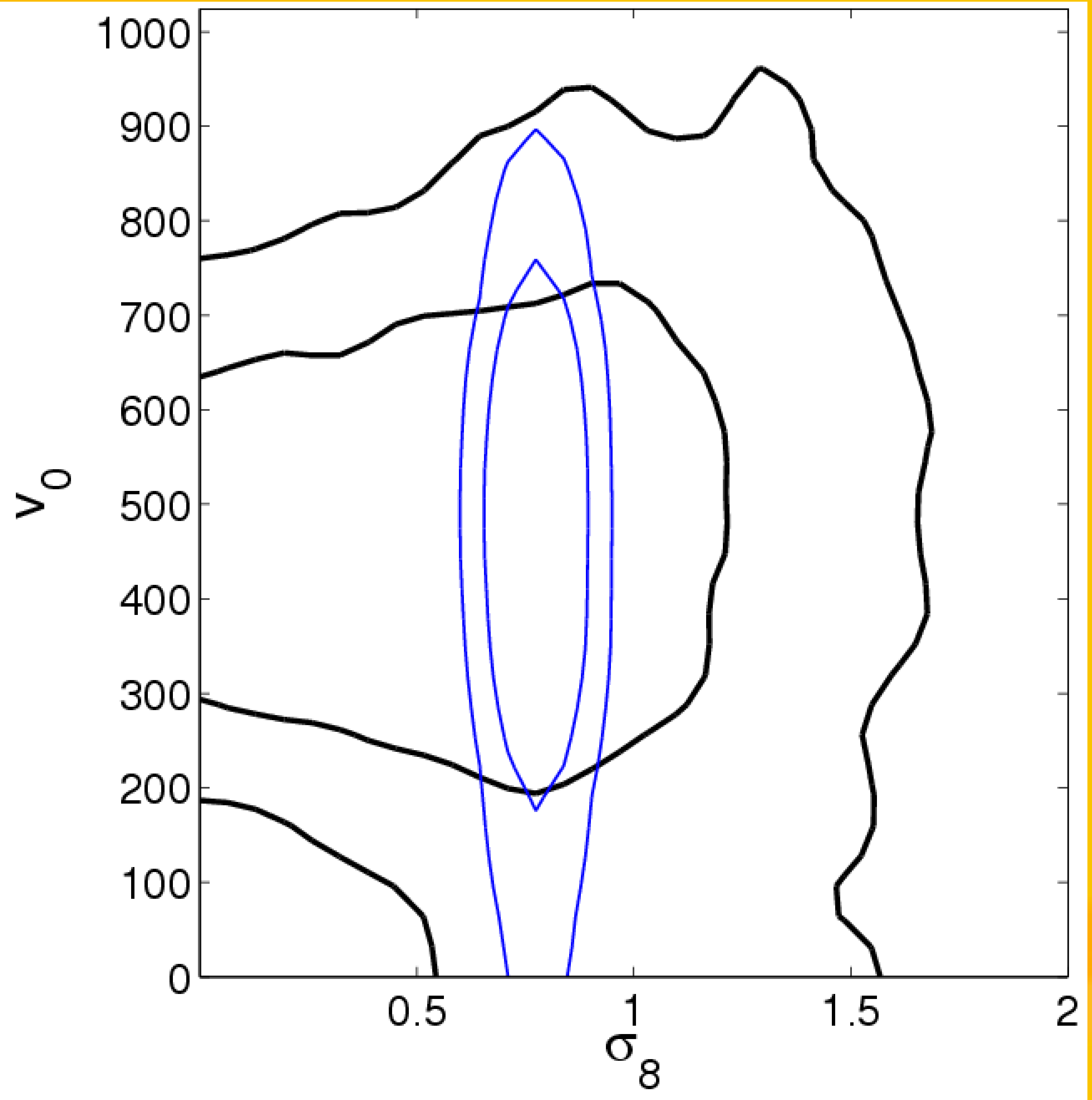
CMB dipole from SN

- CMB Doppler dipole has been seen in SN
- Hand-waving arguments about "high-enough" redshift:
  - our method quantifies these
- Direction and magnitude error-bars necessarily widen
- We fit for CMB dipole taking into account or ignoring correlated velocities.

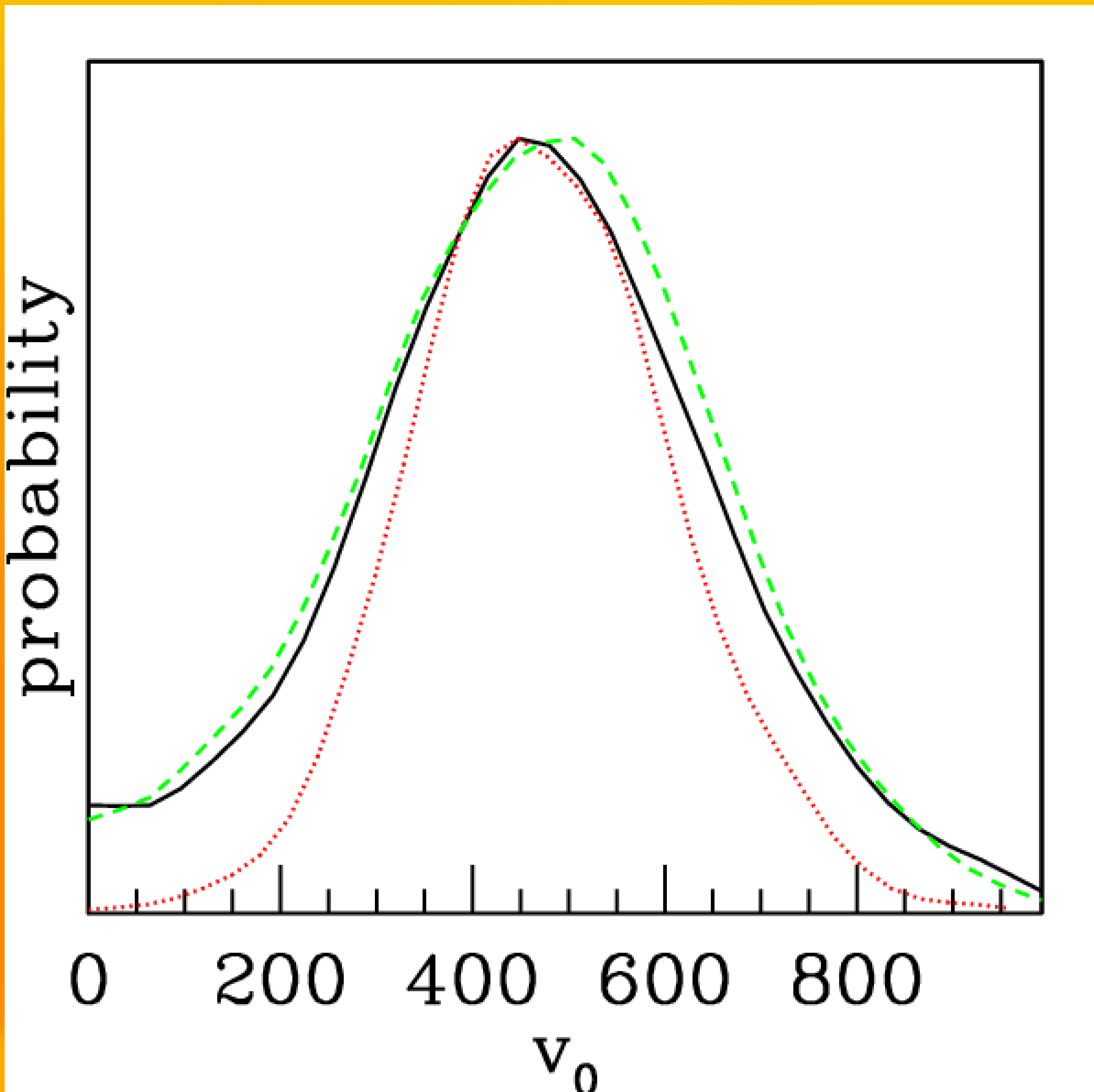
CMB dipole - results



CMB dipole - results



CMB dipole - results



Bottom line:

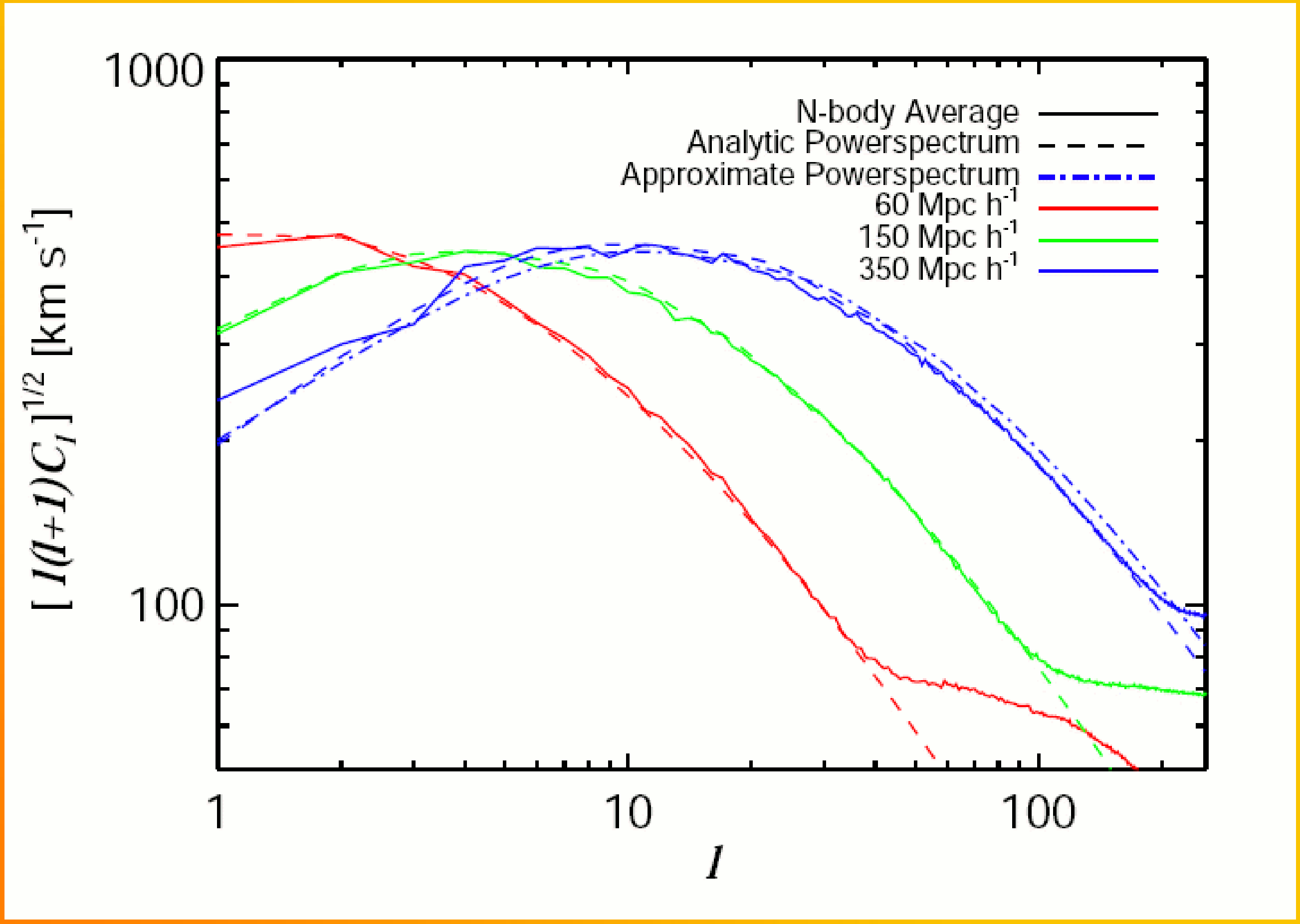
- detection of our dipole motion to below 3 sigma
- performing fisher matrix indicates that this will never get much better.

Distance fluctuations in general

$$
\begin{aligned}
\tilde{d}_L(z_S,\mathbf{n}) &= (1+z_S)(\eta_O-\eta_S)\Bigg\{1-\frac{1}{(\eta_O-\eta_S)\mathcal{H}_S}\mathbf{v}_O\cdot\mathbf{n}-\left(1-\frac{1}{(\eta_O-\eta_S)\mathcal{H}_S}\right)\mathbf{v}_S\cdot\mathbf{n} \\
&\quad -\left(2-\frac{1}{(\eta_O-\eta_S)\mathcal{H}_S}\right)\Psi_S+\left(1-\frac{1}{(\eta_O-\eta_S)\mathcal{H}_S}\right)\Psi_O \\
&\quad +\frac{2}{(\eta_O-\eta_S)}\int_{\eta_S}^{\eta_O}d\eta\Psi+\frac{2}{(\eta_O-\eta_S)\mathcal{H}_S}\int_{\eta_S}^{\eta_O}d\eta\dot{\Psi}-2\int_{\eta_S}^{\eta_O}d\eta\frac{(\eta-\eta_S)}{(\eta_O-\eta_S)}\dot{\Psi}+\int_{\eta_S}^{\eta_O}d\eta\frac{(\eta-\eta_S)(\eta_O-\eta)}{(\eta_O-\eta_S)}\ddot{\Psi} \\
&\quad -\int_{\eta_S}^{\eta_O}d\eta\frac{(\eta-\eta_S)(\eta_O-\eta)}{(\eta_O-\eta_S)}\nabla^2\Psi\Bigg\}\,. \qquad (59)
\end{aligned}
$$

- from Bonvin et al., also Sasaki, Pyne & Birkinshaw, Hui & Greene
- Valid as long as **metric** perturbations small (always)
- Lensing dominates at high redshift
- Angular diameter distance does exactly the same!!

Multipole expansion



- from Hannestad et al.
- Dipole traces H(z) (another Bonvin paper)

Conclusions so far

- SN luminosity fluctuations will be very important in the next few years:
  - need to be taken into account when anchoring low-z Hubble diagram
  - potentially a source of systematic
  - non-linearities need to be understood better
- Already with the present data one can make a very decent detection of the effect

GALAXY ZOO - Introduction

- Crazy paper by Longo

Does the Universe Have a Handedness?

Michael J. Longo
University of Michigan, Ann Arbor, MI 48109-1120

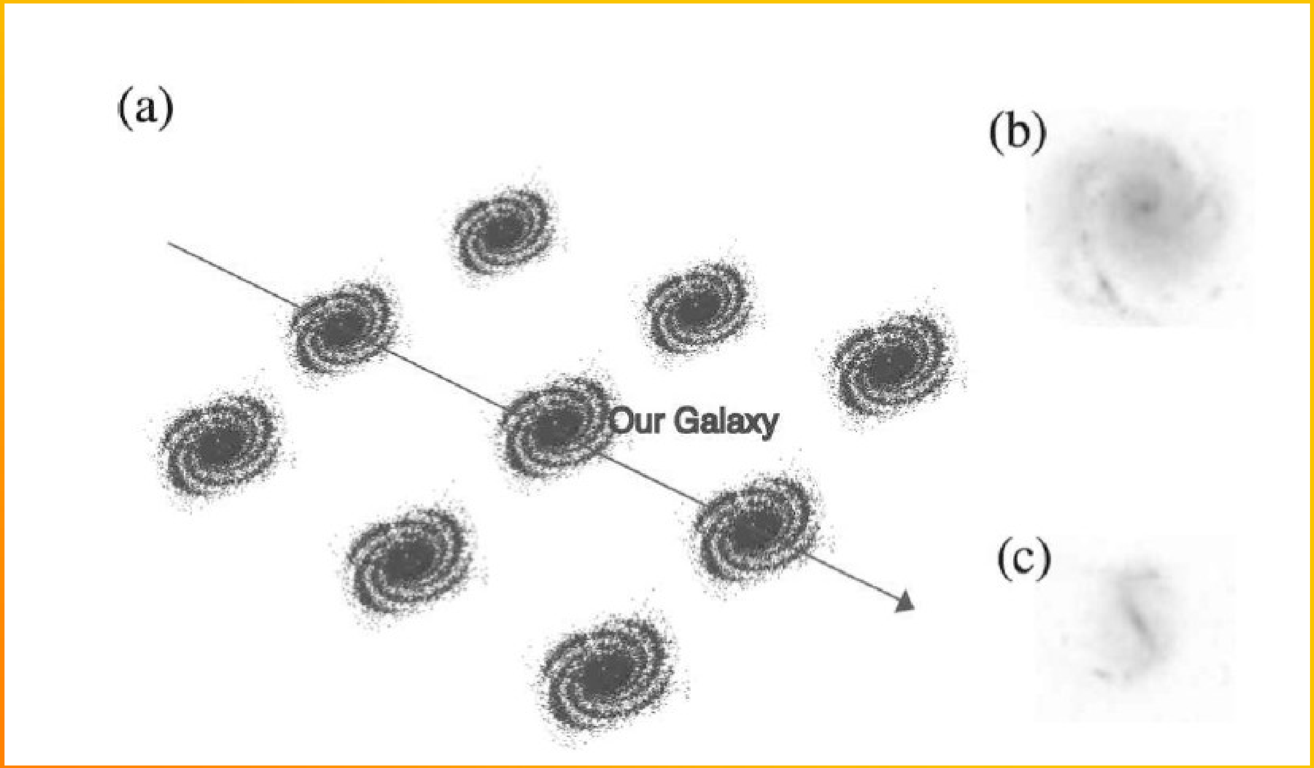
In this article I study the distribution of spiral galaxies in the Sloan Digital Sky Survey (SDSS) to investigate whether the universe has an overall handedness. A preference for spiral galaxies in one sector of the sky to be left-handed or right-handed spirals would indicate a preferred handedness. The SDSS data show a strong signal for such an asymmetry with a probability of occurring by chance ~3.0 x 10^{-4}. The asymmetry axis is at (RA,δ) ~(202°,25°) with an uncertainty ~15°. The axis appears to be correlated with that of the quadrupole and octopole moments in the WMAP microwave sky survey, an unlikely alignment that has been dubbed "the axis of evil". Our Galaxy is aligned with its spin axis within 8.4° of this spiral axis.

Subject headings: cosmological parameters---galaxies: general---galaxies: spiral---large-scale structure of the universe

1. INTRODUCTION

Symmetry has a strong appeal to the human psyche. Nature, however, exhibits some surprising asymmetries. On the smallest scales, an asymmetry (parity violation) was found in the angular distribution of electrons in the beta decay of spin oriented ^{60}Co, confirming the proposal by Lee and Yang (1956) that parity was violated in weak decays. On the molecular scale, there

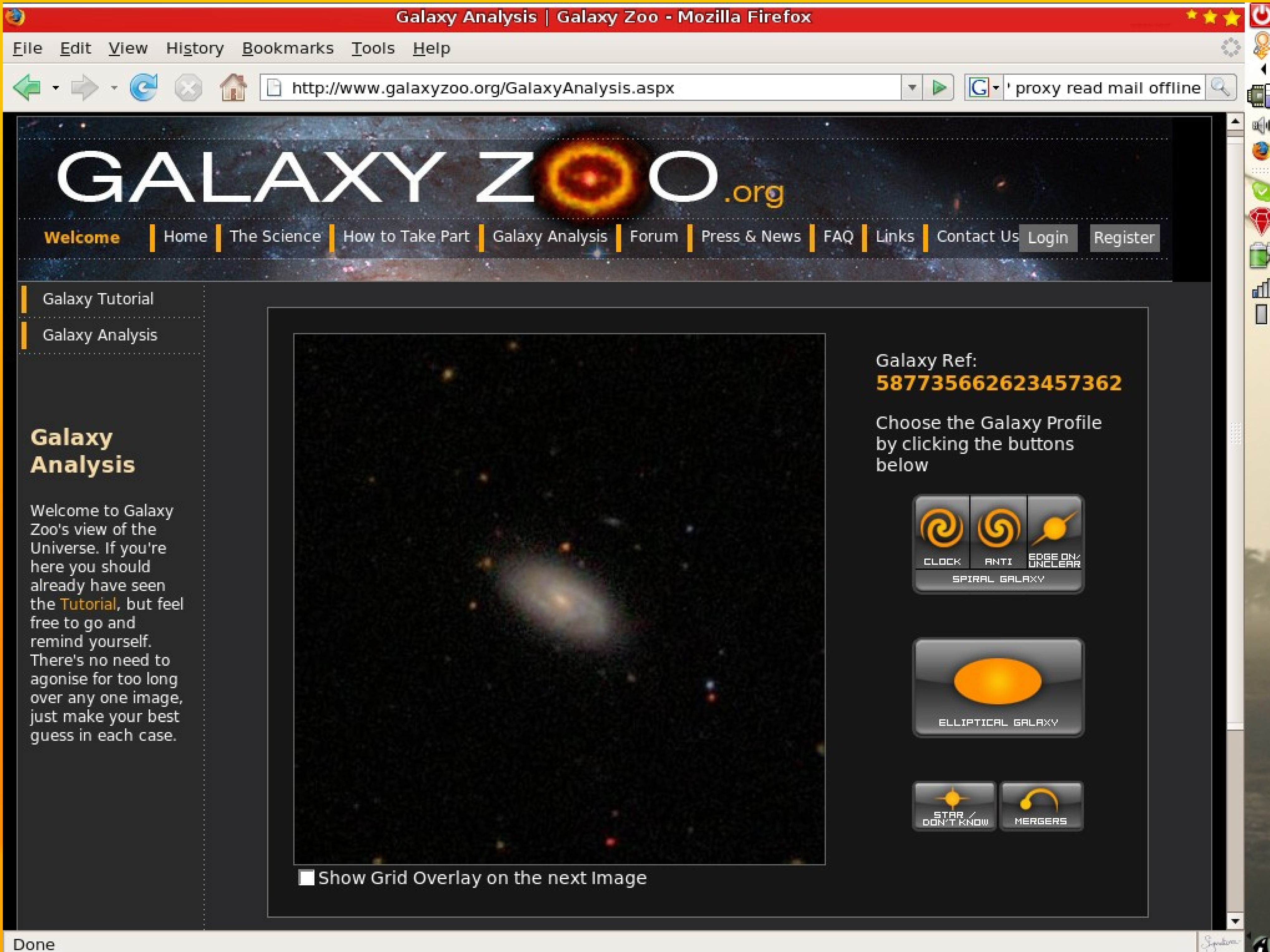
GALAXY ZOO - Introduction



- Must be wrong: would have been seen by now.
- Nothing obviously wrong with the paper: potentially interesting secondary effects?

GALAXY ZOO

- Classify "one million" (870 thousand actually) SDSS galaxies visually
- anyone can participate after passing a short tutorial
- Approved by SDSS; team includes members from Oxford, Portsmouth, John Hopkins and now Berkeley
- Project composed of website and a forum
- Programming donated by Dan Andrescu, web-design by Fingerprint Digital Media
- Extra servers donate by JHU


Galaxy Analysis | Galaxy Zoo - Mozilla Firefox
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http://www.galaxyzoo.org/GalaxyAnalysis.aspx
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Welcome
Home
The Science
How to Take Part
Galaxy Analysis
Forum
Press & News
FAQ
Links
Contact Us
Login
Register
Galaxy Tutorial
Galaxy Analysis
Galaxy Analysis
Welcome to Galaxy Zoo's view of the Universe. If you're here you should already have seen the Tutorial, but feel free to go and remind yourself. There's no need to agonise for too long over any one image, just make your best guess in each case.
Show Grid Overlay on the next Image
Galaxy Ref:
587735662623457362
Choose the Galaxy Profile by clicking the buttons below
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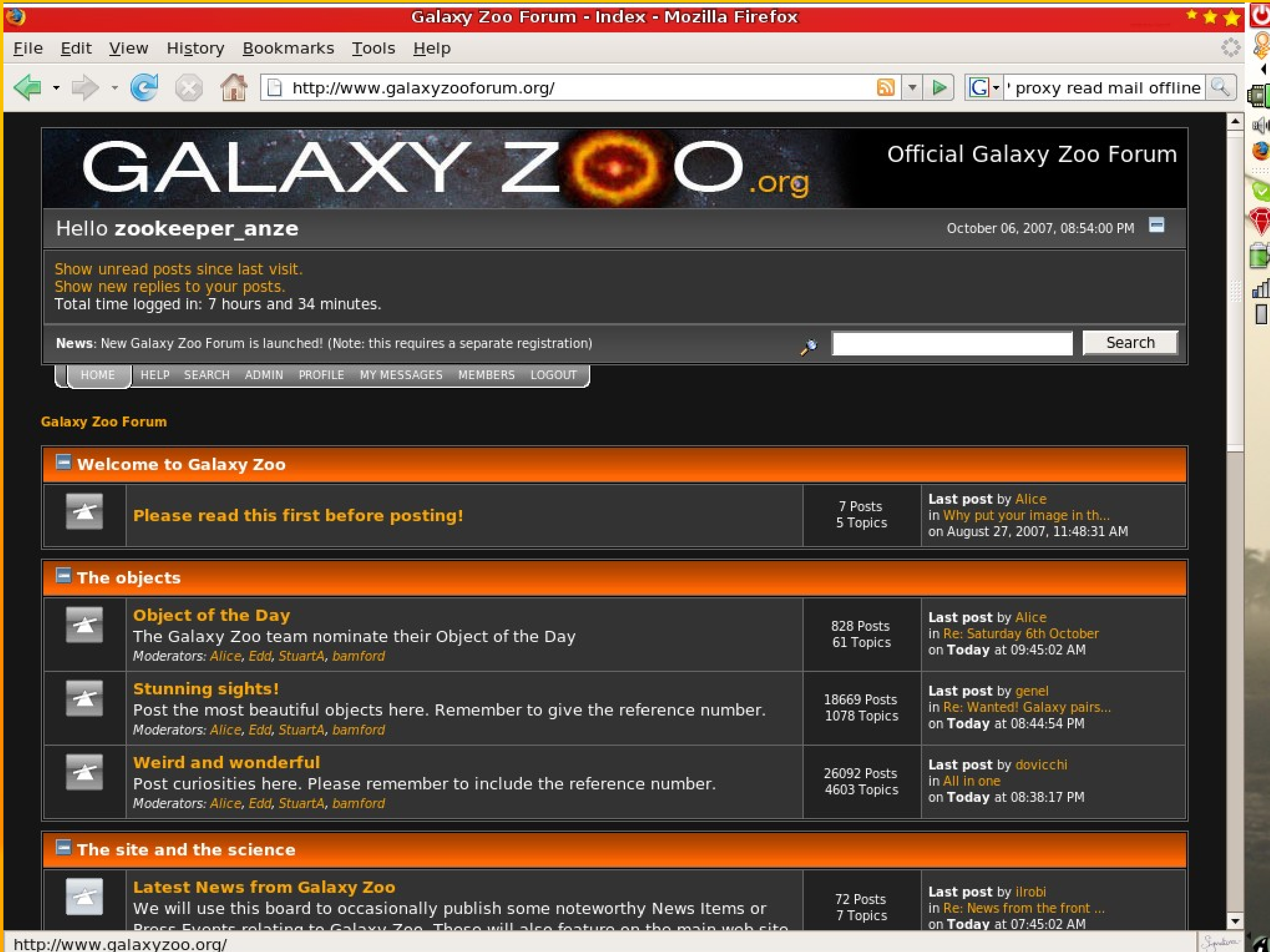
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GALAXY ZOO .org
Official Galaxy Zoo Forum
Hello zookeeper_anze
October 06, 2007, 08:54:00 PM
Show unread posts since last visit.
Show new replies to your posts.
Total time logged in: 7 hours and 34 minutes.
News: New Galaxy Zoo Forum is launched! (Note: this requires a separate registration)
Search
HOME HELP SEARCH ADMIN PROFILE MY MESSAGES MEMBERS LOGOUT
Galaxy Zoo Forum
Welcome to Galaxy Zoo
Please read this first before posting!
7 Posts 5 Topics
Last post by Alice in Why put your image in th... on August 27, 2007, 11:48:31 AM
The objects
Object of the Day
The Galaxy Zoo team nominate their Object of the Day
Moderators: Alice, Edd, StuartA, bamford
828 Posts 61 Topics
Last post by Alice in Re: Saturday 6th October on Today at 09:45:02 AM
Stunning sights!
Post the most beautiful objects here. Remember to give the reference number.
Moderators: Alice, Edd, StuartA, bamford
18669 Posts 1078 Topics
Last post by genel in Re: Wanted! Galaxy pairs... on Today at 08:44:54 PM
Weird and wonderful
Post curiosities here. Please remember to include the reference number.
Moderators: Alice, Edd, StuartA, bamford
26092 Posts 4603 Topics
Last post by dovicchi in All in one on Today at 08:38:17 PM
The site and the science
Latest News from Galaxy Zoo
We will use this board to occasionally publish some noteworthy News Items or
72 Posts 7 Topics
Last post by ilrobi in Re: News from the front ... on Today at 07:45:02 AM
http://www.galaxyzoo.org/

Interestin g objects

Interestin g objects

THE ASTROPHYSICAL JOURNAL, 662: L51–L54, 2007 June 20

THE 8 O'CLOCK ARC: A SERENDIPITOUS DISCOVERY OF A STRONGLY LENSED LYMAN BR
THE SDSS DR4 IMAGING DATA

SAHAR S. ALLAM,[1,2] DOUGLAS L. TUCKER,[1] HUAN LIN,[1] H. THOMAS DIEHL,[1] JAMES ANN
ELIZABETH J. BUCKLEY-GEER,[1] AND JOSHUA A. FRIEMAN[1,3]
Received 2006 November 3; accepted 2007 May 7; published 2007 May 31

ABSTRACT

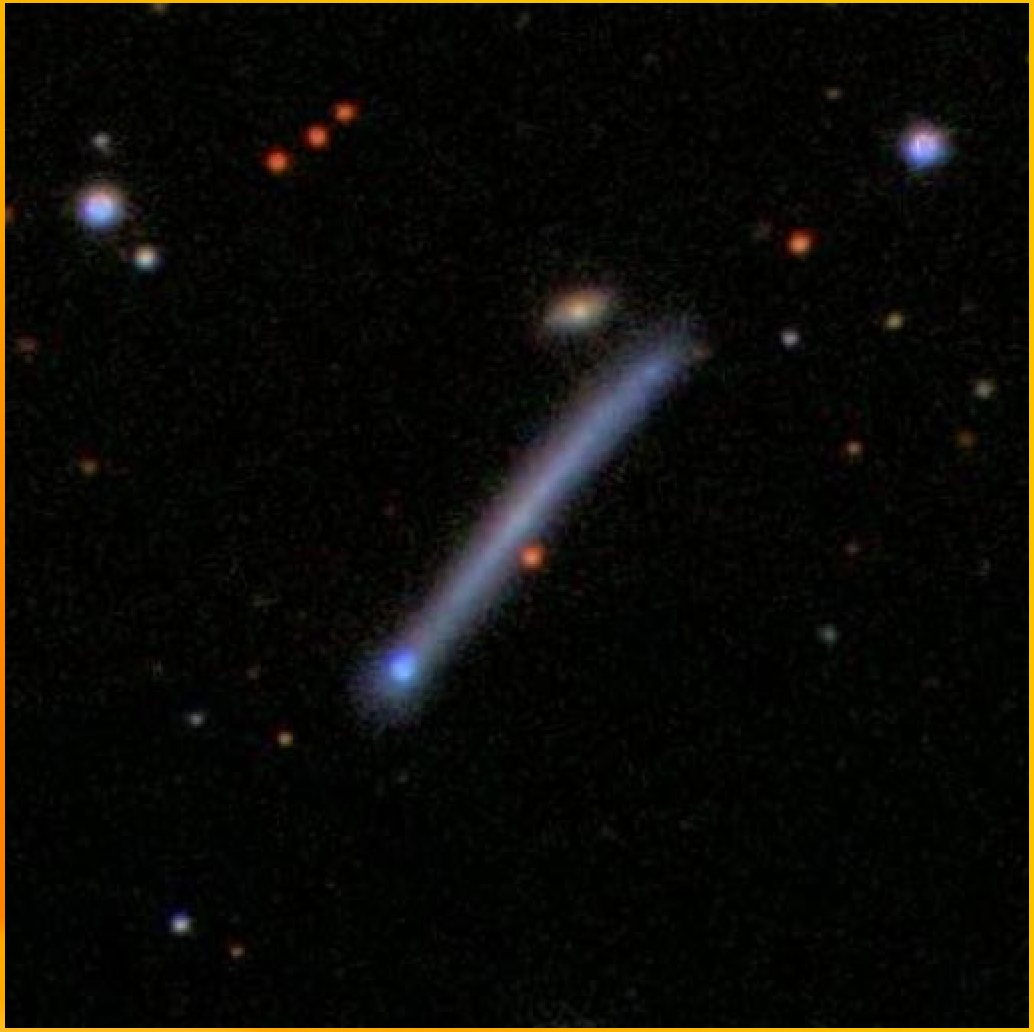
We report on the serendipitous discovery of the brightest Lyman break galaxy (LBG) curren
galaxy at $z = 2.73$ that is being strongly lensed by the $z = 0.38$ luminous red galaxy (
J002240.91+143110.4. The arc of this gravitational lens system, which we have dubbed the "8 o'c
to its time of discovery, was initially identified in the imaging data of the Sloan Digital Sky Survey
4; followup observations on the Astrophysical Research Consortium (ARC) 3.5 m telescope at A
Observatory confirmed the lensing nature of this system and led to the identification of the arc's spe
of an LBG. The arc has a spectrum and a redshift remarkably similar to those of the previous reco
brightest LBG (MS 1512−cB58, also known as cB58), but, with an estimated total magnitude o
(20.0, 19.2, 19.0) and surface brightness of $(\mu_g, \mu_r, \mu_i) = (23.3, 22.5, 22.3)$ mag arcsec^{-2}, the 8 o
thrice as bright. The 8 o'clock arc, which consists of three lensed images of the LBG, is 162° (9.6″)
a length-to-width ratio of 6 : 1. A fourth image of the LBG—a counterimage—can also be identifie
3.5 m *g*-band images. A simple lens model for the system assuming a singular isothermal ellipsoid yiel
radius of $\theta_{\rm Ein} = 3.32'' \pm 0.16''$, a total mass for the lensing LRG (within the 12.1 ± 0.6 h^{-1} kpc en

Interesting objects

Interesting objects

Interestin g objects

Interesting objects



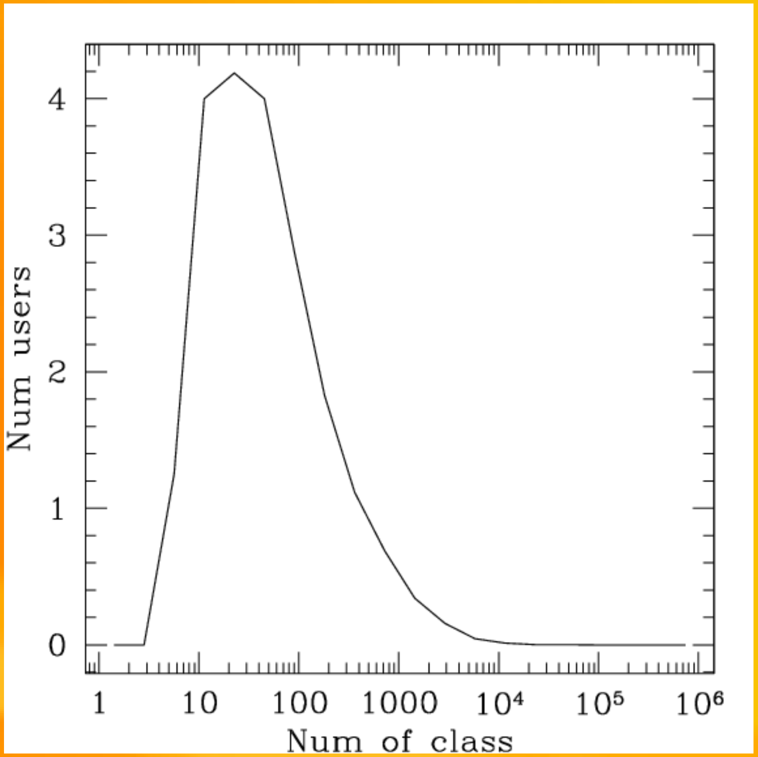
Back-lit galaxies:

- Bill Keel (Alabama) is interested in "back-lit" galaxies to study dust-content and distribution
- 10 years ago Ray White and Chris Conselice found <20 usable pairs
- Recently he found spiral/elliptical pairs by clever filtering of SDSS redshift data
- The he asked people on GZ forum:

"I've kept track of the promising ones seen on galaxuzooforum so far and have almost 180. I knew intellectually that the number of superposed pairs was a strong function of survey depth, but this is breathtaking."

Data reduction:

- The last snapshot of the data has
  - 30 million datapoints from 75 thousand users
  - around 30 datapoints per galaxy, queuing system insures sub-poisson distribution of datapoints



Top users absolute maniacs:

User Name	Classifications
Joseph K. H. Cheng	340308
CARL R.E. MILLS	330715
Hennex	264820
ALAN MASON	224654
ntel25	200800
dougre	158723
JEFF LAUER	137956
didi0815	135200
gianserse	127220
Magic	113664
ElisabethB	111295
clarea13	104610

Top users total bonkers:

"Whenever I picked up spectacular objects I first wrote down the Ref. manually in a journal I am keeping for my original records which contains date, time & brief descriptions of the image. Then for the really good ones I downloaded the page right away. For the less gorgeous ones I went back to do the downloading when I am not so busy."

ANIMALS OF THE ZOO (2), THE EXOTIC ENTITIES:

ANIMAL NO. (9) BLUE BIRD (PARROT ?) WITH BACK ON US	588017723865825315
ANIMAL NO. (10) KANGAROO - HEAD TO RIGHT / TAIL TO LEFT	588016525560315967
ANIMAL NO. (11) PLATYPUS - HEAD TO LEFT	587739631167668399
ANIMAL NO. (12) STANDING SQUIRREL	588007004169830476
ANIMAL NO. (13) BEAGLE WITH TAIL POINTING UPWARDS	587739811564093632
ANIMAL NO. (14) SWIMMING PENGUIN - HEAD TO RIGHT	587730841521487998

Data reduction:

Various methods of data reduction:

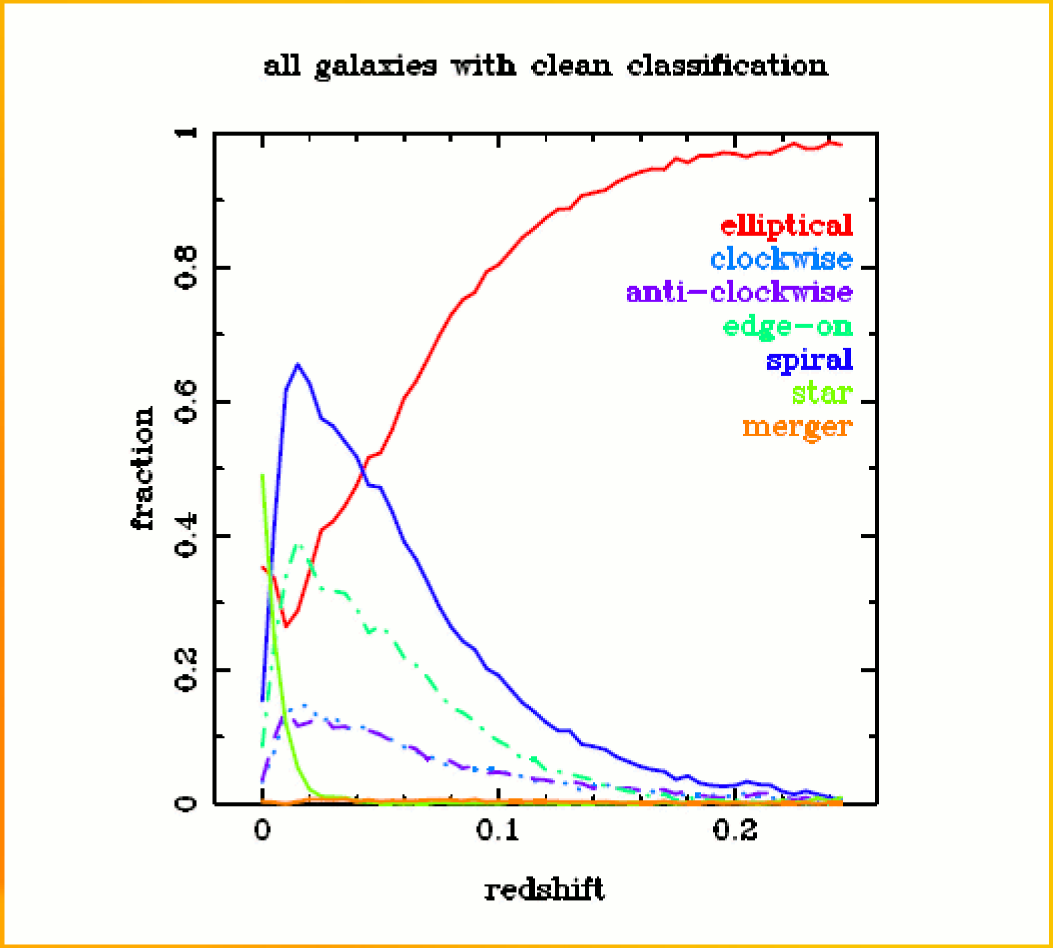
- **Anarchic:** treat all users equally
- **Democratic:** iteratively reweight users
  - start with unit weights for all users
  - get first inference about galaxy-types
  - reweight users according to how they agree with estimates
  - repeat until converged (3–4 iterations)
- **Aristocratic:** same as Democratic but add superusers from GE community
- **Fascist:** you can be your own superuser

Data reduction:

Results:

- 36% is classified (>10 votes and >80% agreement)
- 55% is good (votes not Poisson limited, but no clear agreement)
- 9% need more data

Biases:


all galaxies with clean classification
elliptical
clockwise
anti-clockwise
edge-on
spiral
star
merger
fraction
redshift
0
0.1
0.2
0
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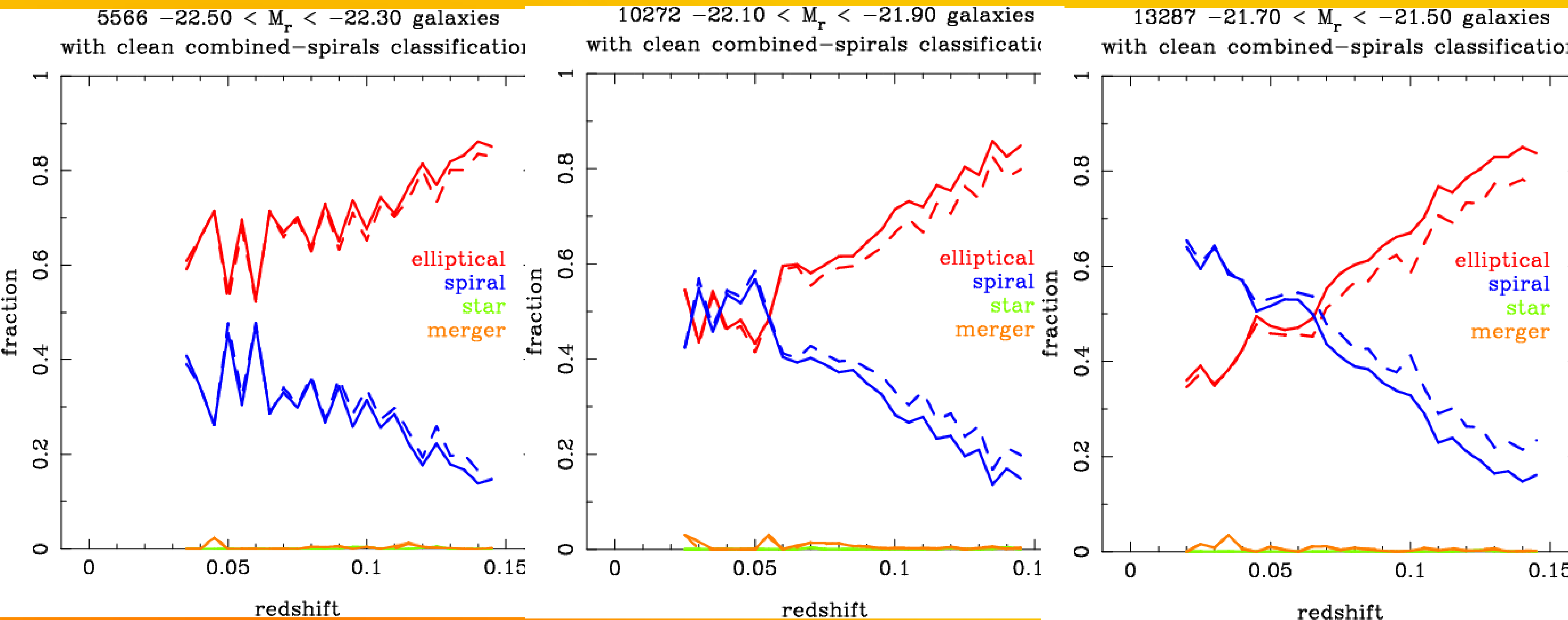
0.6
0.8
1

Biases:



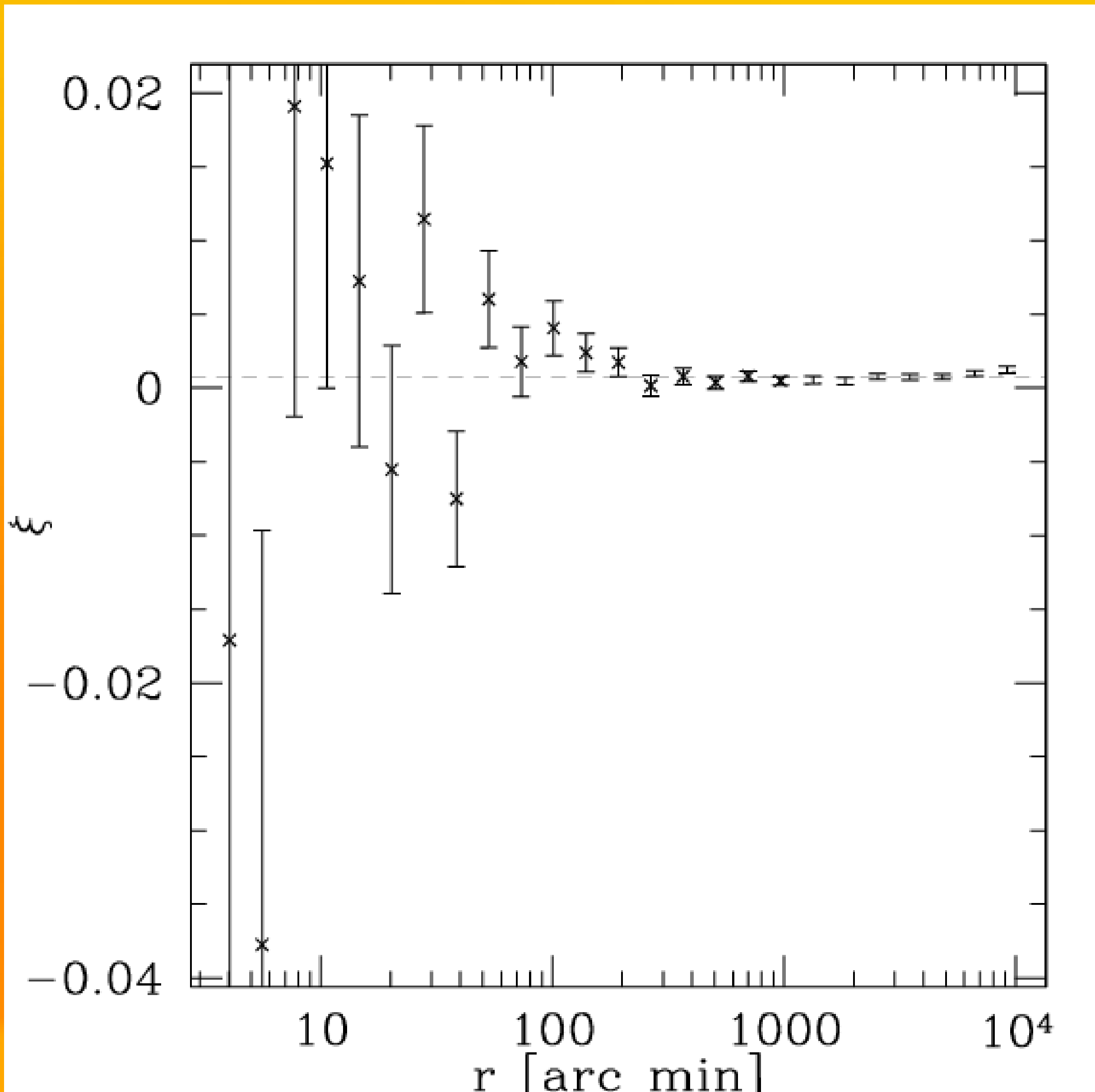
- "If one million French believe in something, it doesn't make it true..."
- Comparison with Fukugita et al quite promising, but S0 and Sa are counted as elliptical in our sample.

Axis in the Universe?

Immediately clear that something is going on:

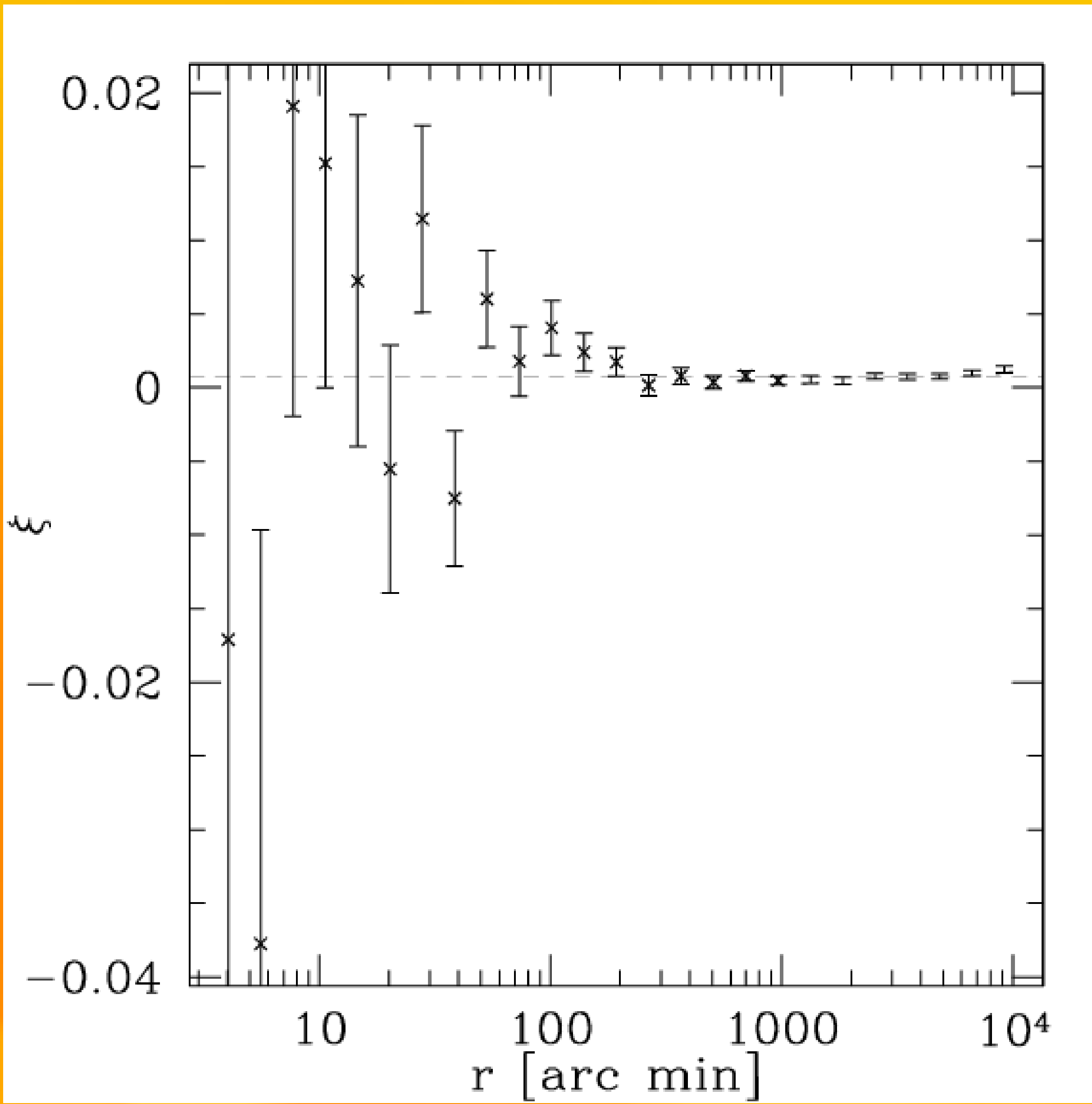
- Raw data show 1.88 million clockwise vs 1.72 million anti-clockwise clicks, 9% or 100 sigma difference
- Anecdotal evidence that this is a known effect in physiology
- Processed data show about 5% excess
- Longo's data also show a 8% excess
- For shared data Longo and we agree at 99.9% level.
- "monopole" + asymmetric window function gives you a "dipole"
- Feeding mirrored images to quantify effect

Correlation function



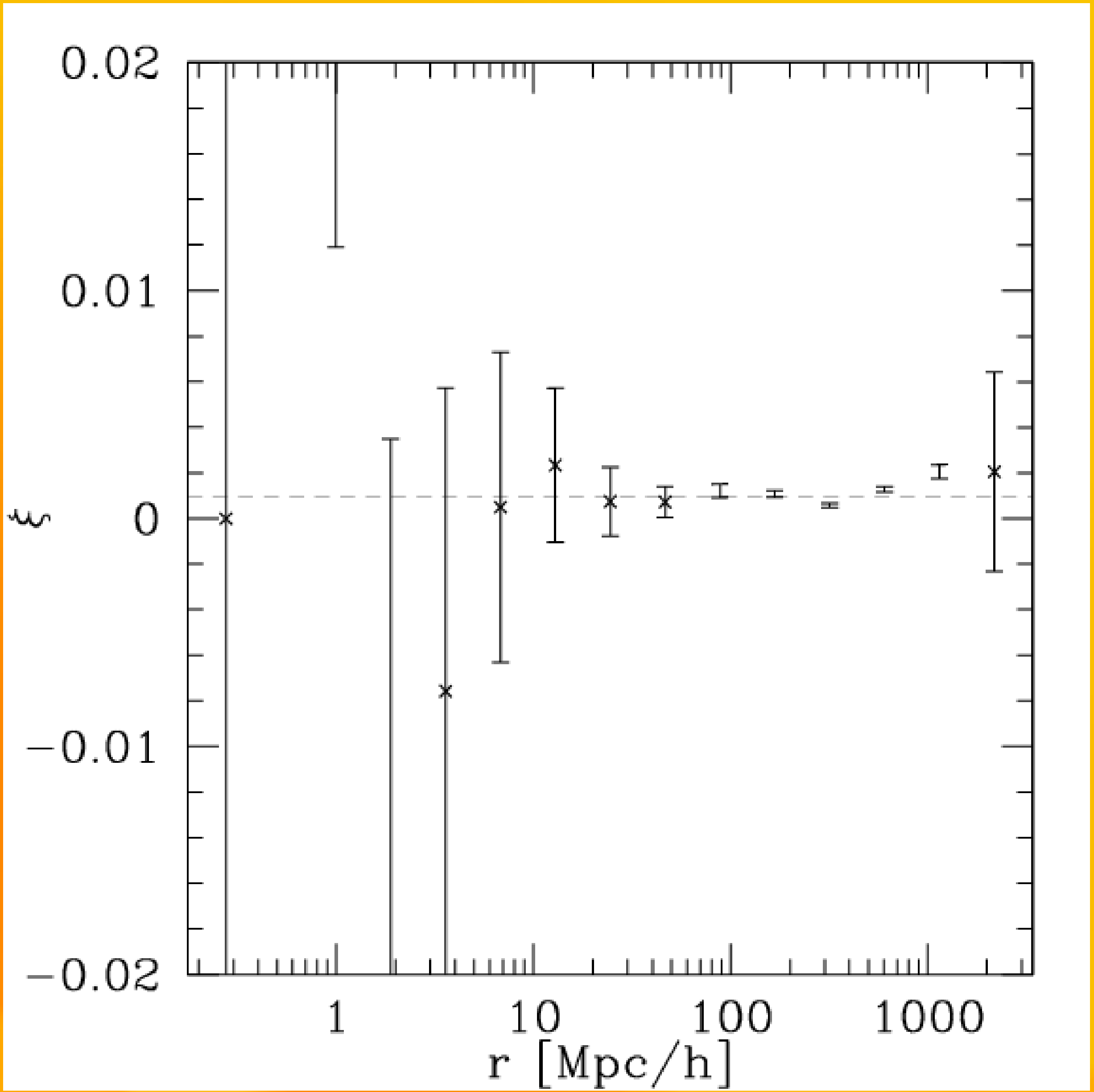
- Correlation function consistent with monopole term only.
- The correlation function of sign of radial component of AM vector
- Around 4% have wrong sign, 20 deg DM/baryons misaligment

Correlation function



- Confirms results of Sugai & Iye, 1995
- Consistent with tidal torque theory (e.g. Barnes & Efstathiou 1986)

Real-space correlation



- Confirms results of Sugai & Iye, 1995
- Consistent with tidal torque theory (e.g. Barnes & Efstathiou 1986)

Conclusions

- GZOO an exciting project:
  - it usefulness remains to be seen, but looks promising
  - first papers soon
  - V2: full Hubble fork
  - V3: natural classifications based on FoF