Title: Discussion
Date: Aug 12, 2015  03:30 PM
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Abstract:
REFLECTIONS ON COSMIC FLOWS AND OTHER NOVELTIES

Mike Hudson
U. Waterloo
"I think you should be more explicit here in step two."
• What is most exciting thing in cosmology now and in the near future?

• If you had a billion dollars, what would you do with it?
• What is most exciting thing in cosmology now and in the near future?

• If you had a billion dollars, what would you do with it?

• What keeps you up at night?
• What is most exciting thing in cosmology now and in the near future?
• If you had a billion dollars, what would you do with it?
• What keeps you up at night?
• Be provocative

Make my day ....
THEMES OF THE MEETING
Death of the auto correlation
CROSS-CORRELATIONS

- Density
  - Galaxies/halos
  - 21 cm
  - Ly alpha (flux decrement)
  - (Projected) DM (WL kappa)

- Velocity
  - Galaxies
  - Electrons
  - Ly alpha gas

- CMB Temperature
CROSS-CORRELATIONS

- Density
  - Galaxies/halos
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- Velocity
  - Galaxies
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  - Ly alpha gas

- CMB Temperature
THEMES OF THE MEETING

- Neutrinos
- kSZ
- The gaseous Universe
  - IGM and Ly alpha
  - Reionization epoch
- Theory of power spectra and extensions to the non-linear regimes
NEUTRINOS

• The good:
  • They should be there!
  • We can measure their mass, and in principle separate this from primordial power spectrum ...
KINETIC SUNYAEV-ZELDOVICH

- The good:
  - Measure velocities, on large scales
  - Missing baryons!
KINETIC SUNYAEV-ZELDOVICH

- The good:
  - Measure velocities, on large scales
  - Missing baryons!
- The bad
  - Small signal, hard to separate from primary CMB “noise”
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- The good:
  - Measure velocities, on large scales
  - Missing baryons!
- The bad
  - Small signal, hard to separate from primary CMB "noise"
- The ugly
  - Do we understand the profile of electrons around halos?
DIDN’T HEAR MUCH ABOUT..
DIDN’T HEAR MUCH ABOUT..

- Non-Gaussianity (except Sarah Shandera)
- ISW
  - Maximum possible is 8 sigma (Crittenden?)
  - What happened to the factor of 2 (Ho et al 2008)?
DIDN'T HEAR MUCH ABOUT..

- Non-Gaussianity (except Sarah Shandera)
- ISW
  - Maximum possible is 8 sigma (Crittenden?)
  - What happened to the factor of 2 (Ho et al 2008)?
- Substructure / missing satellites / WDM
DIDN’T HEAR MUCH ABOUT..

• Other Anomalies ....

  • CMB “Axis of Evil”

  • Cold spot(s) and super“voids”

“I’m not an Anomaly Denier”

- Dick Bond
DIDN’T HEAR MUCH ABOUT..

- Other Anomalies …
- CMB “Axis of Evil”
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“I’m not an Anomaly Denier”

- Dick Bond
JELLY BEANS CAUSE ACNE!
SCIENTISTS! INVESTIGATE!

WE FOUND NO LINK BETWEEN JELLY BEANS AND ACNE (P > 0.05).

WE FOUND NO LINK BETWEEN PURPLE JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN BROWN JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN PINK JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN BLUE JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN TEAL JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN SALMON JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN RED JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN TURQUOISE JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN MAGENTA JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN YELLOW JELLY BEANS AND ACNE (P > 0.05).

THAT SETTLES THAT.
I HEAR IT'S ONLY A certain color THAT CAUSES IT.
SCIENTISTS!

BUT WE'RE PLAYING MINECRAFT!
COSMIC FLOWS: THE GOOD

- Measure growth factor $f$ and the matter power spectrum on very large ($\sim\text{Gpc}$) scales in the low $z$ Universe

- You mean “redshift space distortions?”
PREDICTING PECULIAR VELOCITIES FROM THE DENSITY FIELD

\[ v(r) = \frac{f H_0}{4\pi} \int d^3r' \delta_m(r') \frac{(r' - r)}{|r' - r|^3} \]

Tully-Fisher, Fundamental Plane, SNe

Redshift survey (all sky)
PREDICTING PECULIAR VELOCITIES FROM THE DENSITY FIELD

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Tully-Fisher, Fundamental Plane, SNe

Redshift survey (all sky)
$f \sigma_8$ from different probes

Carrick et al. 15
$f\sigma_8$ from different probes

Carrick et al. 15

Peculiar velocities
~6000

RSD (~2012)
800,000 z
PROBING LARGEST SCALES

$$\sigma_V^2 = \frac{\Omega_m^{1.1}}{2\pi^2} \int_0^\infty dk \mathcal{W}_{ab}^2(k) P(k)$$

Figure 26. The $P(k)$ measurements for the Northern (NGC; open red triangles) and Southern Galactic Cap samples (SGC; open blue squares), with the mean of the respective mock samples displayed with a solid line. The difference between the two lines illustrates the effect of the different windows of the NGC and SGC on the expected $P(k)$.

Ross et al 12, BOSS DR9

credit: H. Feldman
• Measurement of Johnson et al. (2014): consistency with standard model with particular sensitivity to large scales

![Graph showing data points and trend lines for different velocities.]

- Taipan survey velocity sample will be 20 times larger!!

slide credit: Chris Blake
THE BAD AND THE UGLY

• Systematics are very difficult:
  • 1% errors at z ~ 0.1 : 300 km/s > signal
  • e.g. SDSS photometry only good to ~0.01 mag

Needs large well-controlled data sample
PROJECTS DISCUSSED

- BOSS
- CHIME
- ...
COSMOLOGY PROJECTS

Euclid Telescope
Gravitational Lensing,
Large-scale structure
1 billion euros 2020
COSMOLOGY PROJECTS

Gravitational Lensing, LSS
$700 M, 2020
COSMOLOGY PROJECTS

Gravitational Lensing,
Large-scale structure
$2 billion 2025?
COSMOLOGY PROJECTS

Gravitational Lensing, LSS
$700 M, 2020
Is Cosmology Dead?
THE BAD: VANILLA $\Lambda$CDM

- Flat
- CDM
  - neutrinos
- DE with $w = -1$
- Power-law primordial fluctuations
THE GOOD: CCCDM

• Curvature

• CDM with lower mass (WDM) or self-interaction

• DE that evolves

• Primordial features or unusual B-modes

• … deviations from GR
Stargazing Party: Watch the Perseids with us!

Wednesday, August 12, 2015 - 7:30 PM to 10:30 PM EDT

Join Faculty of Science and Royal Astronomical Society of Canada astronomers to learn more about the Perseids meteor shower, and see how many meteors you can spot!