Physics from Combined Cosmological Probes

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1 Physics and Probes

1.1 Dark Energy

- Expect deceleration
- Add in dark energy or modify gravity Brax, [CK09]
- Typical scale is 10^{-33} eV
- Measure w, w' [ABC$^+$06] Zuntz
- Measure growth of structure: $\Psi/\Phi, G_{\rm eff}$ Brax
- Supernovae (Distances)
- BAO (Distances)
- LSS (separate from BAO because it requires much more sophisticated modeling); also includes Redshift Space Distortions Sheth and Musso
- Clusters (Distances and Growth)
- Weak Lensing Rassat (Distances and Growth)

1.2 Inflation

- Earlier epoch of acceleration, proof from coherent series of peaks and troughs
- Flatness is big success
- Scalar and tensor perturbations related to $V(\phi)$ Creminelli
- Scalar well-characterized (Melchiorri): nearly Gaussian, adiabatic, deviation from scale-invariance, no evidence yet for running
- Tensors: fundamental limit of $r \sim 0.1$ from temperature
- B-modes: detected! determine scale of inflation, need to disentangle from dust and lensing

1.3 Neutrinos

- 3 SM generations, weakly interacting → relic abundance today of $115cm^{-3}$ for each generation
- Could be *sterile* neutrinos, ν_R that are light (heavy sterols form the basis of the see-saw mechanism)
- Energy density early on (when they're still relativistic) is 68% of CMB
- Energy density of SM neutrinos today is $\Omega_\nu h^2 = 0.01(\sum m_\nu / 1eV)$
- Impact on LSS: $\sum m_\nu$ → Suppression of power. Guaranteed detection because oscillation experiments ensure that $\sum m_\nu > 0.05$ eV. Current constraints (Melchiorri) are about a factor of 5 above this
- Impact on CMB: mostly very light (< eV) steriles that are produced in the early universe (Melchiorri); do not impact keV neutrinos that might be DM

2 2D Correlations

2.1 Limber Approximation

2.2 Large Scale Structure and Lensing

Overview with focus on what can be learned about dark energy: [RAB+15]

2.2.1 Overlap in Window Function

2.2.2 Galaxy-Galaxy Lensing and Large Scale Clustering

One idea for extracting information about clustering as a function of redshift: [YS12]

2.2.3 Magnification

Detection paper using galaxy magnitudes: [MSFR10]

3 Cluster Masses

3.1 Thermal Sunyaev-Zel'dovich Effect

Recent results from the South Pole Telescope: [Collaboration13]

3.2 Richness

Most up-to-date richness estimator: [RRBM14]

3.3 Weak Lensing

Recent results from the Dark Energy Survey: [Collaboration14]

3.4 CMB Cluster Lensing

Initial paper: [SZ00]

4 CMB Lensing

Very clear review including polarization: [HCL10]

4.1 Quadratic Estimator

Initial paper: [Hu01]

4.2 Cross-correlations with LSS

4.3 Lensed B-modes

4.4 De-Lensing

References

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