Cosmic Microwave Background

1 Introduction

2 CMB

1. Very successful to date
2. Only a small part of the information in the CMB has been captured. E.g. WMAP has measured $\sim l_{\rm max}^2 \simeq 500^2$ modes with S/N > 1. Modes for which simple predictions can be compared with data go out to $l_{\rm max} \simeq 2000$. So we've discovered less than a tenth of what's encoded in the CMB.
3. Planck will get much of the rest in the T-spectrum
4. Polarization: Almost all information in the polarization field has yet to be mined. This is not just doubling the information in T. There are two completely new areas: B-modes and lensing. For B-modes, you get nothing from T. For lensing, you get much better measurements of projected potential using polarization than using T alone.

3 Origin of the Universe

1. Explain inflation
2. Evidence to date can be explained only by inflation or something more revolutionary
3. Primordial gravity waves
4. They produce B-modes
5. Measurement/upper limit on B-modes tells us about physics at GUT-scale
6. Non-gaussianity/running also depend on GUT-scale physics. CMBPol will tighten these as well

4 Other Fundamental Physics

1. Neutrino mass: measures sum of neutrino masses via their effect on projected gravitational potential. Complementary to particle physics experiments which measure mass differences. Oscillation experiments provides two targets: inverted hierarchy predicts $\sum m_\nu > 0.1$ eV; normal hierarchy predicts $\sum m_\nu = 0.05$ eV. Lensed Polarization limits will certainly reach the first target and possibly the second
2. Dark Energy: projected potential sensitive to early dark energy

5 Astrophysics

1. Reionization
2. Magnetic Fields