

COSMOLOGY IN SOUTH AFRICA: PAST AND PRESENT

George Ellis

History Meeting 2018

SAA0

- Cosmology has changed over the past 50 years from a mainly theoretical subject based in general relativity studies, to a data-rich subject due to many new kinds of telescopes and observational techniques, with a corresponding change in emphasis in research.
 - This talk will outline effects of those changes in the South African context
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EARLY YEARS

- Lemaitre visited Cape Town in 1952 (British Association Mtg)
- Thackeray at SAAO: Distance scale (1953) □ Feast
- Rund (Durban) □ Lovelock, Wainwright, Matravers
- Ellis (UCT) □ Maartens, Nel, Madsen, Bassett
- Hellaby, Dunsby
- Many visitors and collaborations, workshops

COSMOLOGY THEN (1961)

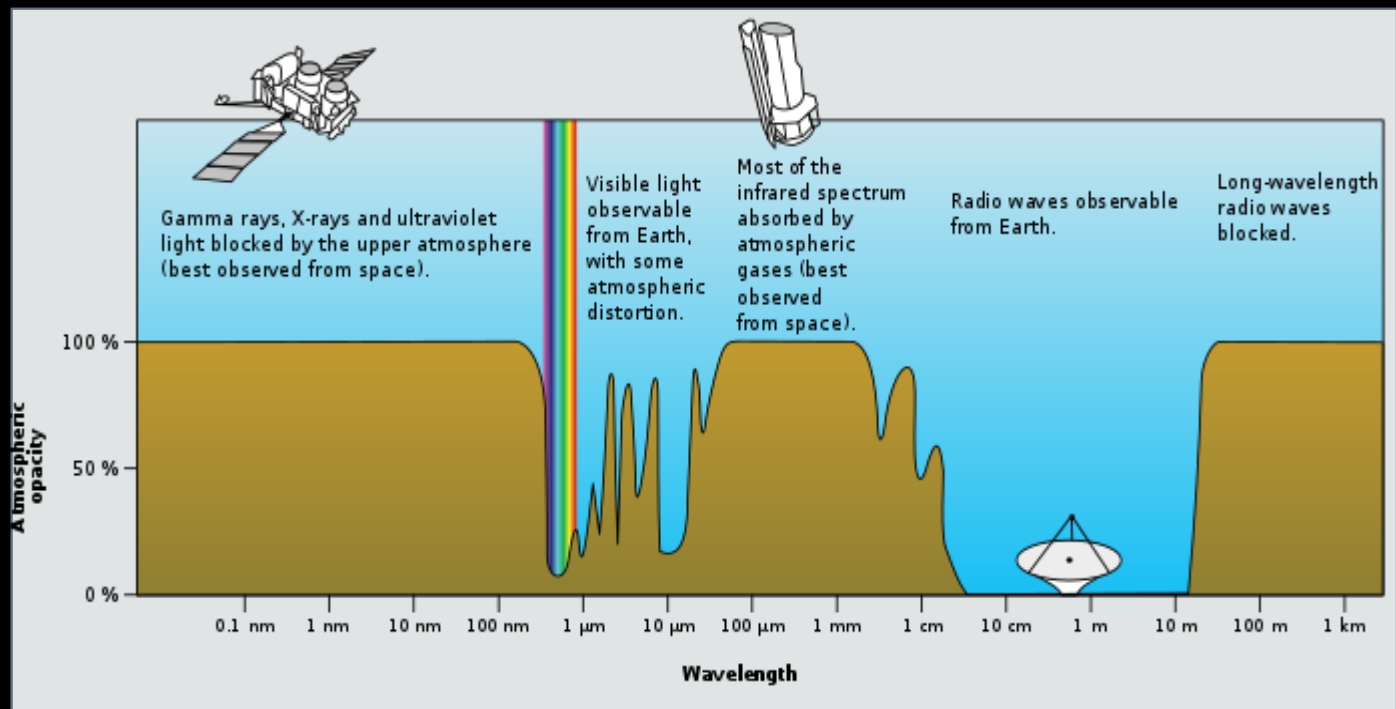
- Optical: Mount Palomar 200" Hale telescope, Largest redshift: 0.42 (Baum)
- Radio sources and source counts: 76-meter Lovell Telescope at Jodrell Bank Observatory,
Cambridge Interferometer
- Cosmology: "just two numbers" (Sandage): H_0 , q_0
 - N.B. included cosmological constant
- Hubble trouble: age of the universe
- Horizons just clarified (Rindler)
- FLRW taken for granted
- ? Start to the universe? Predictions due to symmetry?
- Regarded as philosophy by hard core physicists

ISSUES

- Observational cosmology program: light cone possibilities
- Anisotropic cosmologies: Bianchi models
 - Workshop, book: Dynamical Systems in Cosmology (Wainwright)
- Small universe? See right round?
- Inhomogeneous cosmologies
 - Do we in fact need dark energy?
- Emergent Universe (no singularity)
- 1+3 covariant perturbation theory: fluids, radiation
 - CAMB code (Lasenby, Challinor, Lewis)
- Consistency tests: number count dipole (Ellis and Baldwin)

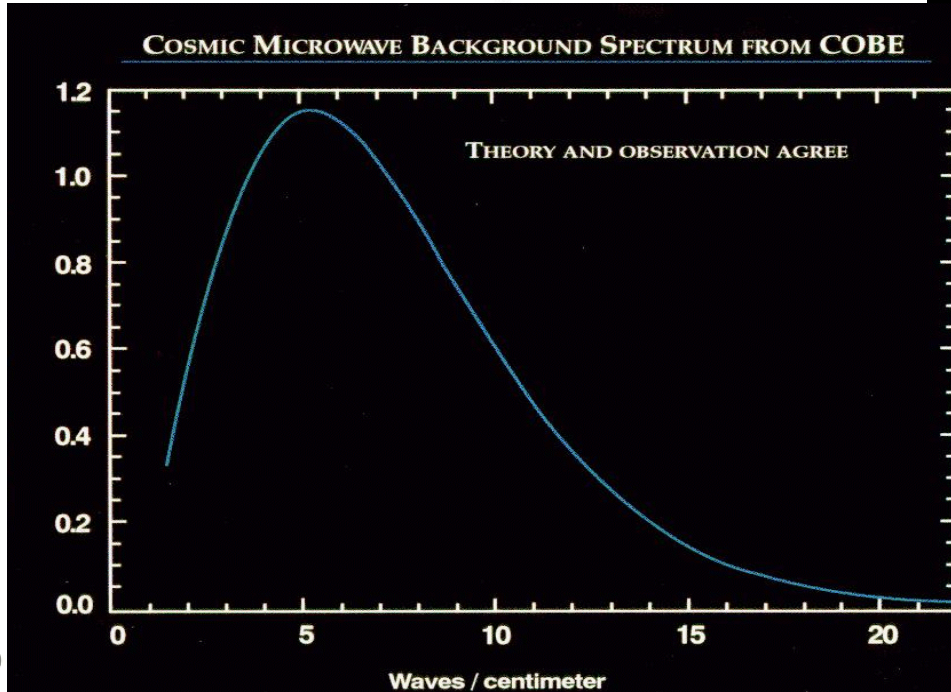
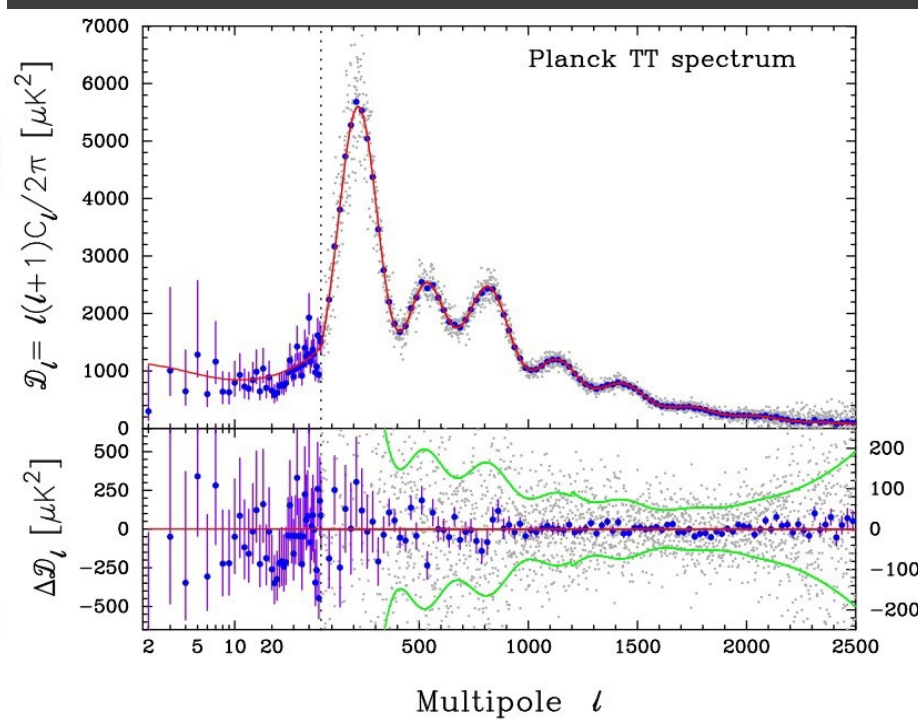
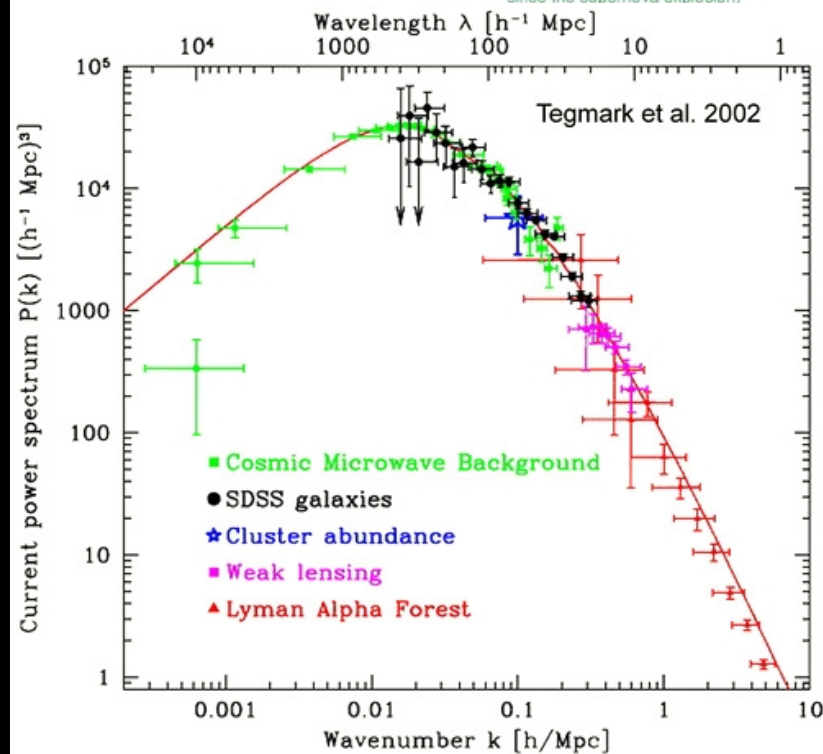
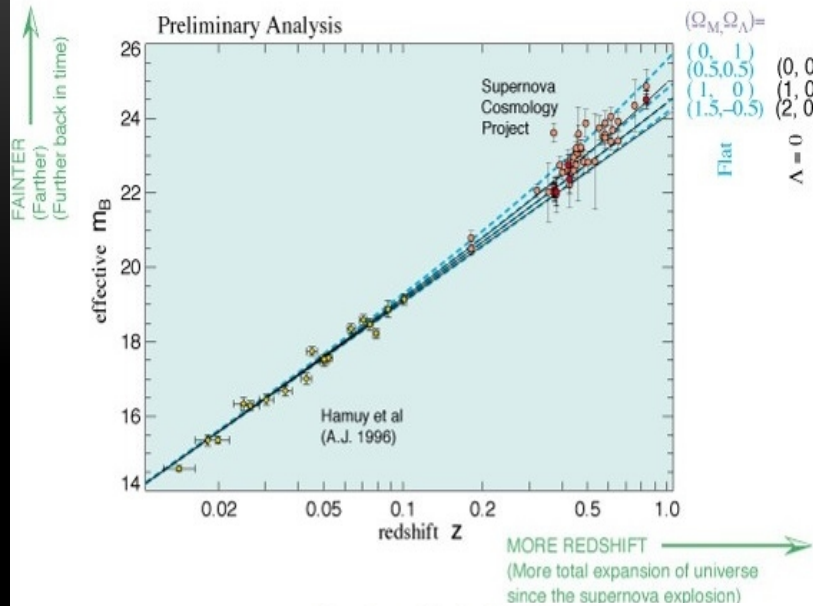
COSMOLOGY NOW (2019)

- New generation ground telescopes, e.g. SALT, ACT, BICEP
- Interferometers and VLBI, e.g. EVN, VLBA, ALMA, SKA
- Space telescopes, e.g. Hubble, Highest redshift 11.09. COBE, WMAP, Planck.



- Need major computing facilities to handle the resulting Big Data

Hubble Plots



COSMOLOGY NOW: TELESCOPES/SURVEYS

- SALT
- SDSS (BAO)
- HESS/CTA
- * Atacama Cosmology Telescope
- Meerkat/SKA
- LSST
- No neutrino/ gravitational wave
- Support: NASSP, SKA

SA COSMOLOGISTS (THEORY)

- Matrovers (UCT \square Portsmouth)
- Hellaby (UCT)
- Dunsby (UCT)
- Weltman (UCT)
- Larena (UCT)
- Dombroz (UCT)
- Osano (UCT)
- Bassett (UCT/AIMS)
- Beesham (Unizulu)
- Moodley (UKZN)
- Goswami (UKZN)
- Colafrancesco (Wits)
- Faltenbacher (Wits \square Germany)
- Jejjala (Wits)
- Maartens (UWC/Portsmouth)
- Santos (UWC)
- Umeh (UWC) \square UK
- And collaborators:
Uzan, Clarkson, ...

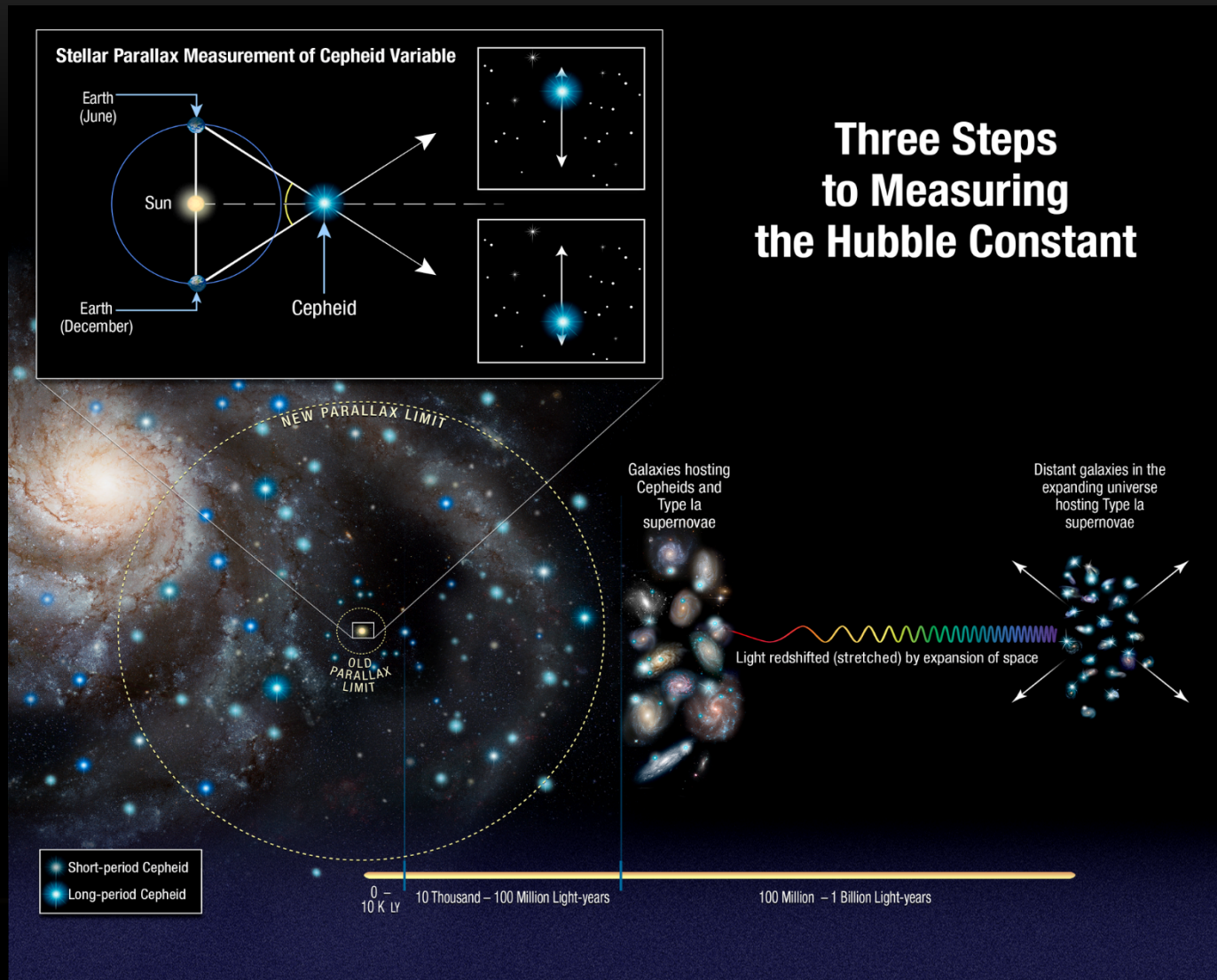
COSMOLOGY NOW: ISSUES

- Dark energy: chameleon particle (Weltmann)
- Non-linear Gr affects: Maartens, Larena, Ume, Faltenbacher, Clarkson
- $F(R)$ theories: Dunsby, Dombriz
- Number count dipole: Maartens
- SKA and cosmology: Maartens
- Emergent universe: Ellis, Murugan, Maartens
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- Bouncing models: Ellis, Weltmann, Platts
- Machine learning: Bassett

COSMOLOGY NOW: ISSUES

- Hubble trouble
- Inflaton?? – Higgs??
- Dark matter?? - experimental tests
- Dark Energy/Cosmological constant ?? – problems if $w < -1$.
- Consistency tests:
 - Copernican principle
 - Matter dipole same as CMB dipole
 - High z element abundances
 - Age of the universe $>$ age of stars!
- Multiverse???
- Limits of observations and of physics tests

KEY ISSUE: THE DISTANCE SCALE!



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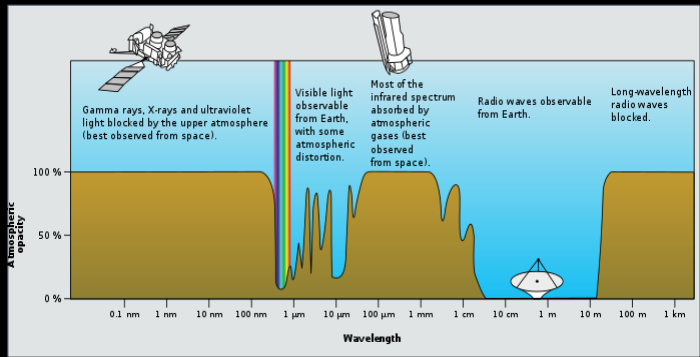
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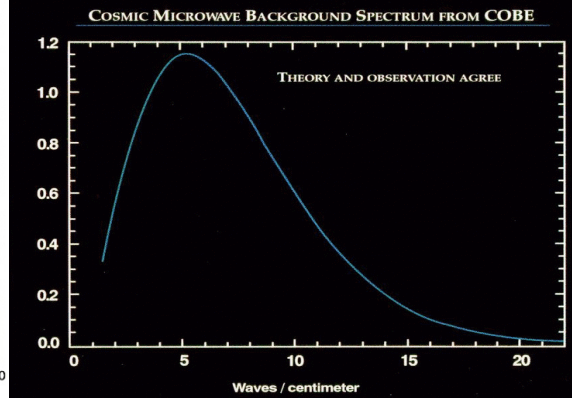
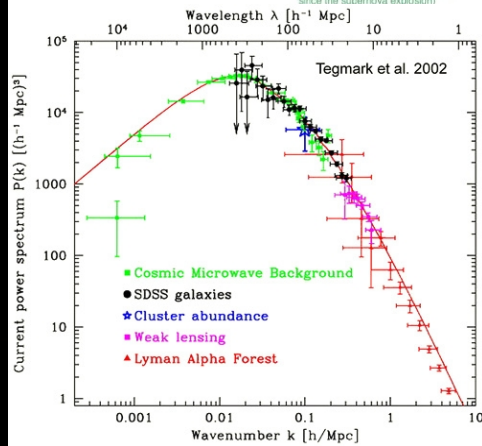
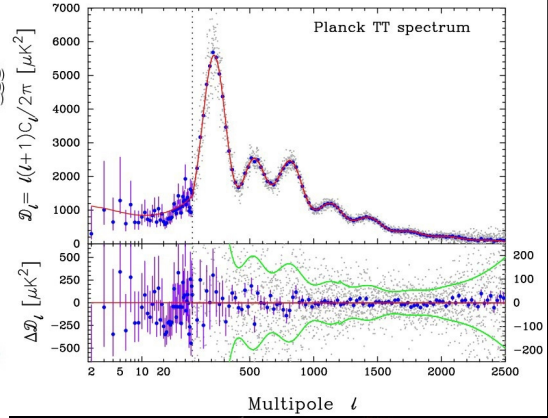
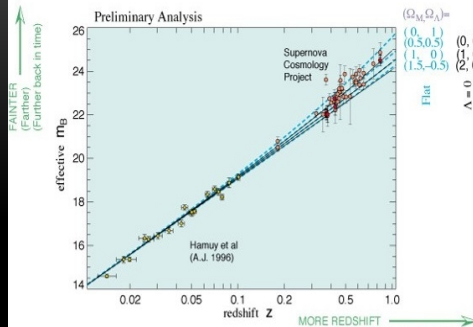
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