

# MODERN COSMOLOGY

## KEY KNOWLEDGE FOR MID-TERM REVIEW

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### 1. The Observable Universe

- Why are Cepheids useful for distance indicators?
- Why are Supernovae Ia useful for distance indicators? Why not Supernovae II?
- Hubble's galaxy classification scheme.
- The Hubble–Law and the present value of the Hubble constant.
- The distance modulus.
- The principal experiments for CMB (Penzias and Wilson, COBE, WMAP, Planck) with: years of operation, frequency range, angular resolution, sensitivity of detectors and main results.
- The brightness distribution  $B_\nu(T)$  for the CMB radiation and the Wien displacement for the calculation of the maximum frequency  $\nu_{\max}$ .
- Results of the galaxy surveys: CfA, 2dF and SDSS.

### 2. Special and General Relativity

- The Relativity Principle.
- Lorentz transformations in x–direction.
- Velocity addition theorem.
- The two equivalence principles: EEP and SEP.
- What is a metric?
- Schwarzschild spacetime with coordinates. How to calculate the gravitational redshift from a star?
- What is a Black Hole?
- What is the Levi-Civita connection? How to calculate the Christoffel symbols out of metric?

- The covariant derivative of scalar functions, vector fields, covector fields and second rank tensor fields (metric tensor, energy–momentum tensor, Faraday tensor).
- The definition of geodesics.
- The definition of curvature. How to calculate the Riemann tensor out of the Christoffel symbols, the Ricci tensors and the Einstein tensor?
- Einstein’s field equations including the Lambda–term.
- What is the Brans-Dicke theory?
- How many independent components can the Riemann tensor of a spacetime have? How many the Ricci tensor?
- What are the Planck–length, Planck–time, Planck–mass and Planck–temperature?

### 3. The Friedmann Universe

- The cosmological principle and its consequence?
- The three standard expressions for the FLRW line element and interpretation of degrees of freedom (in quasi-spherical, hyper-spherical and conformal coordinates).
- What is the cosmological redshift?
- The two Friedmann equations (no derivation!).
- What is the parameter  $q_0$ ?
- What is the parameter  $w$ ?