

CMB Physics (fall 2007)

P. POLARIZATION

- P1. Classical Monochromatic Plane Wave
 - Stokes parameters, Rotation of coordinates
 - P2. Classical Quasi-Monochromatic Plane Wave
 - Cohesion tensor, Measurement by a linear polarimeter
 - P3. Quantum Treatment: One-Photon System
 - Rotation of coordinate system, Helicity basis,
 - P4. Quantum Statistical Physics: Density Operator
 - Pure state, Expectation values, Summary
 - P5. Statistical One-Photon System
 - Pure and mixed states
 - P6. Fock Space
 - P7. Statistical Many-Photon System
 - P7.1 Classical N -body and 1-body Phase Space
 - Identical particles
 - P7.2 Quantum Many-Particle System and Reduced Density Operator
 - 1-particle operators, Reduced density operator
 - P7.3 Application to Stokes Parameters
 - P8. Including Different Momentum States: Observing
 - Brigittors in SI Units, Polarization-Sensitive Detector, Collecting area
 - P9. Photons in Thermal Equilibrium
 - P10. CMB Perturbations
 - Perturbations in CMB temperature and occupation number, The polarization tensor
- Appendix: Detector Beam
- Intensity, Euler angles, Rotating the detector and its beam, 2nd definition of Euler angles,
 - Circularly symmetric beam, Asymmetric beam and polarization
- Appendix: Conversion Factors and Units
- CMB and antenna temperature

Y. SPHERICAL HARMONIC EXPANSION OF THE POLARIZATION FIELD

- Y1. Flat-Sky Approximation
- Y2. Geometry of the Sphere
- Y3. Tensor Spherical Harmonics
- Y4. Properties of Tensor Spherical Harmonics
Antipodes, N-S reflection, N and S poles
- Y5. Spin-2 Spherical Harmonics
E and B modes, Properties of spin-2 spherical harmonics
- Y6. Correlation Functions and Angular Power Spectra

Y_l^m
s/c

F. COLLISIONLESS BOLTZMANN EQUATION (T only, taught before polarization)

- F1. Phase Space and the Distribution Function
- F2. Energy Tensor in the Local Orthonormal Frame
- F3. Photon Redshift and Free Streaming
- F4. Boltzmann Equation
- F5. Tensor and Spherical Harmonic Expansion
- F6. Spherical Harmonics (spin-0)
Rotation of ind. system, Product of two spherical harmonics (CG series)
- F7. Generation of CMB Anisotropy by Metric Perturbations
 - F7.1 Scalar Perturbations
 - F7.2 Vector Perturbations
 - F7.3 Tensor Perturbations
 - F7.4 Summary
- F8. Free Streaming

C. COLLISIONAL BOLTZMANN EQUATION

- C1. Thomson Scattering
- C2. The Case of Unpolarized Incident Radiation
- C3. Boltzmann Equation
1) Doppler effect, 2) Effect of anisotropy and polarization, The full collision term, Fourier transform
- C4. Wigner D-Functions
CG series (product of two D-functions)
- C5. Spin-s Harmonics

Y_l^m
s/c

C6. Rotation of the Collision Term

C7. Multipole Expansion

Loss term, Doppler effect, Gain term, Summary of effect of Thomson scattering, What's left

L. LINE-OF-SIGHT INTEGRATION

L1. Boltzmann Equations

L2. Line-of-Sight Integration

L2.1 Temperature anisotropy

L2.2 Polarization

L3. Radial Functions

L4. Optical Depth and Visibility Functions

L5. Delta Function Approximation

L6. Angular Power Spectra

L6.1 Inversion and Rotation

L6.2 Primordial Power Spectra

L6.3 Transfer Functions

L6.4 Angular Power Spectra

L7. The Full Set of Equations

L7.1 Energy Tensor Perturbations and Multipoles

L7.2 Neutrino Multipoles

L7.3 Scalar Perturbations

L7.4 Tensor Perturbations

L7.5 Transfer Functions and Calculation at C_L

L8. Approximate Results for C_L

L9. Photon-Baryon Fluid

L10. CAMB Plots at C_L