

# The Plasma Phase

## **Chapter 1. An experiment - measure and understand transport processes in a plasma**

Three important vugraphs

What we have just talked about

The diagnostics

## **Chapter 2. An introduction to plasma physics**

Occurrence

Temperature

Debye Length

Plasma Oscillations

Discreteness

Collective versus individual behavior

Applications of Plasma Physics

Fundamental Physics Studies at Texas

Research at the Fusion Research Center

Some notes on electrostatics

Notes on identities

## **Chapter 3. Magnetic diagnostics for plasmas**

Basic equations

Integration

Alternate measurement techniques

Experimental techniques

Plasma current (the Rogowski coil)

Loop volts

Deductions from loop voltage

Position and  $b_I + I_i/2$  for a circular equilibrium

Modified Rogowski and saddle coils

Moments

    position

    shape

$b_I + I_i/2$

separation of  $b_I + l_i/2$

Diamagnetism

Fast surface reconstruction

Full reconstruction

Mirnov oscillations

Internal measurements

## **Chapter 4. Probes (and sheaths)**

Trapping probes

Gridded analyzer

Emissive probes

To calculate a probe characteristic

Orbit theory

Langmuir floating probes

The collisionless sheath

The triple probe

Effects of B field

## **Chapter 5. Refractive index measurements (e.g. density)**

Waves in a plasma

    wave representation

    group velocity

    index of refraction

    polarization

    small amplitude variations

    some elementary waves in plasmas

    em waves with  $B_0 = 0$  in vacuum.

    dielectric properties of plasmas

    em waves with  $B_0 = 0$  in a plasma

    including a magnetic field

        O mode

        X mode

        Cutoffs and resonances

General em waves in plasmas

Electron density measurements in the earth's ionosphere.

The interferometer

Michelson

Mach Zender

Fabry Perot

simple analysis

determining the phase shift

modulation and detection

coherence, diffraction, refraction

frequency choice

Abel inversion

Interference imaging

Schlieren and shadowgraphs

Faraday rotation

Reflectometry

Physical optics and Fourier analysis

Phase contrast imaging

**Chapter 6. Electromagnetic radiation from free electrons**

Cyclotron radiation

Theory

Electron cyclotron motion

Propagation of perpendicular waves

Typical detection systems

lens

waveguide system

optical system

- Results from TEXT
- e-m radiation detectors
  - General considerations
  - Types
  - Construction
  - Heterodyne detection
- Cerenkov radiation

## **Chapter 7. Electromagnetic radiation from electron ion collisions (bremsstrahlung, recombination)**

- Introduction
- Theory
  - bremsstrahlung
  - Recombination
- Temperature measurements
  - X-ray pulse height analysis

Z<sub>eff</sub> measurements

X-ray tomography

Hard X-rays

## **Chapter 8. Electromagnetic radiation from bound electrons**

Introduction

Transitions

Equilibria

Rate coefficients

Line broadening

Line intensities

Doppler width

Flow velocity

Stark width

Bolometry

Resonance fluorescence

Zeeman splitting

Spectrometers etc.

## **Chapter 9. The heavy ion beam probe**

Principles of operation

Apparatus

ions source

accelerator

beam bending system

sweep plates

analyzer

Sample volumes

Space potential

Space potential fluctuations

Density fluctuations

Two-point measurements

wave numbers

coherence

particle flux

Line-Integral effects

Finite sample volume effects  
Magnetic field measurements

## **Chapter 10. Scattering of radiation**

Theory  
Incoherent (Thomson) scattering  
Coherent scattering  
Magnetic field effects

## **Chapter 11. Laser plasma diagnostics**

Introduction  
Facilities  
Indirect drive  
Spectra  
Large area back lighters  
Point back lighters  
Rayleigh Taylor instability  
Femto-second laser produced plasmas

## **Chapter 12. Gaussian statistics**

Volume sampling diagnostics  
Finite sample volume effects  
Two features  
Line integrals, common mode, path effects  
Application of Gaussian statistics to line integral effects

## **Chapter 13. Active spectroscopy** (A neutral beam diagnostics for Alcator C-Mod)

Introduction  
The diagnostic neutral beam  
    Description  
    Neutral Beam Penetration  
Diagnostics  
    Profiles  
    Turbulence  
Conclusions

