

## *Fundamental Forces*

*P. Pincus*

*Physics and Materials Departments  
University of California, Santa Barbara*

The aim of these lectures is to provide the necessary background for understanding the various interactions that operate in polymer solutions. In that sense, there is very little new in this material although there may be non-standard points of view. My purpose is not to develop technical theoretical/computational methodologies but rather to instill a physical intuition for the forces. The outline below is meant to be very approximate. The timing will certainly slip.

Some general references are:

A. Safran, *Statistical Thermodynamics of Surfaces, Interfaces, Membranes*

T. A. Witten, *Structured Fluids*

J. N. Israelachvili, *Intermolecular and Surface Forces*.

Vozken Adrian Parsegian, *Van Der Waals Forces: A Handbook for Biologists, Chemists, Engineers, and ...*

### Lecture 1 - Introduction to Soft Matter and Fluctuation Forces

- Introduction
- Some thermodynamics
- Dilute Solutions
- Osmotic Pressure
- Fluctuating Dipoles

- Intermolecular potential between neutral molecules
- Second virial coefficient
- Depletion interaction
- Van der Waals interaction between half spaces
- Photon depletion model for the Casimir- Lifschitz interaction

## Lecture 2 - Electrostatic Forces

- Introduction to aqueous solutions
- Salt Solutions
- Boltzmann- Poisson Approximation
- Debye-Hückel Theory
- Highly Charged Surfaces
- BP Theorem
- Salting Out and Stern Layer
- Attractive Forces
- Patterned Globally Neutral Surfaces
- Bloomfield-Rouzina interaction

## Lecture 3 - Hydrogen Bonds and Hydrophobic Forces

- Hydrogen bonds
- Hydrogen bond network of water
- Hydrophobic Force
- Hydration