

# Soft Matter Theory

## Homework 1

Due: 17 May 2022

1. Derive the limiting characteristic ratio  $C_\infty$  for a freely rotating chain with bond length  $l$  and bond angle  $\theta$ . *Hint:  $\langle \mathbf{r}_i \cdot \mathbf{r}_j \rangle = l^2 (\cos \theta)^{|i-j|}$*
2. Calculate Flory's characteristic ratio for a freely rotating chain consisting of  $n$  bonds of length  $l$  with bond angle  $\theta$ . Plot  $C_n/C_\infty$  as a function of  $n$  for bond angles  $68^\circ$  and  $10^\circ$ .
3. Write a Monte Carlo simulation that calculates the end-to-end distance and radius of gyration of a freely jointed chain and a freely rotating chain (bond angle  $68^\circ$  and bond length  $1 \text{ \AA}$ ) as a function of  $n \in [1, 1000]$ . Make a plot of  $R_e$  and  $R_g$  and compare it to your answers in 1 and 2. *Hint: Use Tree's python code to get you started.*