Math 280: Random Knotting

Instructor: Javier Arsuaga (jarsuaga@math.ucdavis.edu)

Random knotting is the mathematical theory that provides a rigorous explanation to the formation of knots and links in physical systems. In this course we will review theoretical and computational results and present open questions for lattice and off-lattice models. Applications to physical systems, in particular to DNA and other polymers, will also be discussed.

Topics

1.- Basic concepts in knot theory, probability, real analysis and complexity of algorithms.
2.- Random knotting and linking in the simple cubic lattice Z^3: entropic and free energy models
- i) Knotting and linking of random polygons in Z^3.
- ii) Knotting and linking of random polygons in confined geometries of Z^3.
- iii) The writhe of random polygons in Z^3
- iii) Knotting and linking of random polygons in Z^3 with free-energy: the collapsed polymer model
- iv) Overview of models, results and open problems

3.- Minicircle models
- i) Linking of minicircles
- ii) Percolation in minicircle systems
- iii) Description of minicircle systems: mean valence, percolation and average saturation densities

4.- Random knotting and linking in off-lattice models
- i) Density functions for off-lattice models: Equilateral random polygons (ERPs)
- ii) The knotting probability of ERP in R^3
- iii) The average crossing number of an ERP in R^3 and in confined geometries
- iv) The Uniform random polygon (URPs): linking in confinement
- v) Linking of mini and maxicircles

The course will be based on the discussion of published papers and a final project. Attendance and participation will be part of the final grade.