Networks of semiflexible polymers play an important role in the structural and mechanical properties of cells. The statistical mechanics of randomly cross-linked semiflexible polymers requires simultaneously taking into account the positional and orientational fluctuations of polymer configurations as well as the constraints imposed by the quenched random cross-links. In a three-dimensional model, we consider random cross-links which constrain the corresponding polymer segments to be parallel or antiparallel. Using a semi-microscopic replica field theory, we obtain a phase diagram which contains a liquid (sol), a statistically isotropic amorphous solid (orientational glass), and a nematic gel. The control parameters are the polymer stiffness and the density of cross-links. A two-dimensional implementation of the same theoretical scheme allows us to consider cross-links which prescribe a finite angle. If the cross-linking angle $\theta$ is a rational fraction of $2\pi$, the rigidity of the crosslinks in concert with the bending stiffness of the polymers leads to the formation of gels with long-range m-fold orientational order, e.g., ”hexatic” or ”tetratic” for $\theta=\pi/6$ or $\pi/4$, respectively.

We also discuss the effect of permanent random cross-links on an array of flexible directed polymers confined with freely sliding ends between two planes. We obtain the height-dependent distribution of localisation length and the relevant elastic moduli.