Experimental report

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Proposal: 9-13-559 **Council:** 4/2014

Title: Interactions between DNA nanostarsin the high-concentration region

Research area: Soft condensed matter

This proposal is a new proposal

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Samples: oligonucleotides in D2O solution

Instrument	Requested days	Allocated days	From	To
D22	1	1	17/11/2015	18/11/2015

Abstract:

The past decade has seen huge advances in the development of design principles of DNA nanoparticles. For instance metamaterials with unusual phase diagrams can be prepared using DNA as a building block. The diverse structures that DNA can have vastly expand its potential uses in nanotechnology and biotechnology applications. Here we propose to study by SANS the structural properties of newly synthesized branched systems of DNA, nanostars with 4 arms. These systems have unique self-assembling properties. We propose to measure the S(Q) of DNA nano-stars in the high-concentration range, where they form a reversible gel phase. The SANS experimental data will be interpreted by using a theoretical model suggested by some of the proposers, that describes the self-assembly of anisotropic macromolecules. These findings will be crucial to predict the thermal and kinetic stability of self-assembled DNA hydrogels, with relevant implications in the design of commercial complex fluids with tailored properties.

Experimental report. Interactions between DNA nanostars in the high-concentration region

DNA nanostars (DNA-ns) are self-assembled DNA strands with three or four sticky terminals, mimicking molecules with controlled limited valence [1]. In the present experiment we investigated nano-stars having 4 arms with sticky tips. Sequences are designed to self-assemble at a certain temperature, forming structures with 4 double-stranded arms of 20 bases each. Each arm terminates with an equal 6-nucleotide-long sequence overhang. These self-complementary sequence promotes nano-stars association via Watson-Crick pairing of the overhangs of close-by structures.

In more detail, the solution of DNA-ns 20 mg/ml in presence of 100 mM NaCl was measured in a temperature range from 281K to 332K, in the best contrast condition (H_2O solvent). The temperature was imposed by a circulating fluid in the cell's holder rack.

The experiment was performed on the D22 small angle diffractometer at the Institute Laue Langevin, Grenoble. The samples were held in a quartz Hellma cell with a 0.5 mm path. Three sets of sample-to-detector distances D and wavelengths λ were chosen (D = 17 m, λ = 6 Å; D = 5 m, λ = 6 Å; D = 1.4 m, λ = 6 Å) so that the scattering wave vector q ranges from 0.0028 $Å^{-1}$ up to 0.5 $Å^{-1}$. The raw data were treated according to standard procedures using GRASP software provided by ILL, which yields the scattering vector *q* and the resolution, the absolute value of the scattering intensity, and the corresponding error.

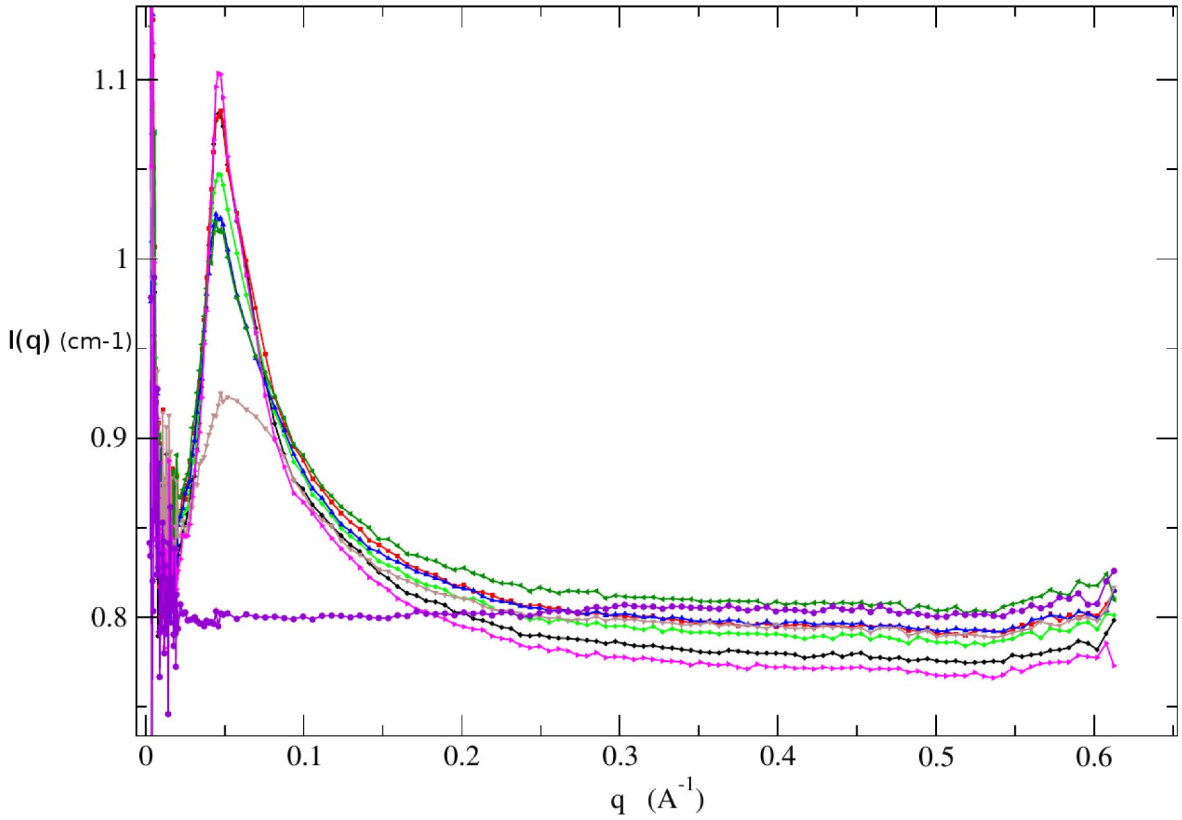

Figure 1 (pink line 281 K, black line 289 K, red line 298 K, green line 303 K, blue line 313 K, dark green line 318 K, vanilla line 332 K)

In Fig. 1 we show the measured SANS intensity for the DNA-ns at the different measured temperatures. In the figure we also show the signal from buffer measured at room

temperature (violet line). The intensity of the prominent interference peak at about 0.05 $Å^{-1}$ (corresponding to an average first neighbour distance of about 12 nm) decreases as a function of the temperature, thus witnessing the progressive weakening of the gel-like structure.

[1] S. Biffi, R. Cerbino, F. Bomboi, E. M. Paraboschi, R. Asselta, F. Sciortino, and T. Bellini, Proc. Natl. Acad. Sci. U.S.A. 110, 15633 (2013).