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Protein folding dynamics is of great interest as being closely related to protein functions and the origin of many diseases. Many proteins collapse within the first hundred of microseconds thus requiring submillisecond-time resolution techniques to observe the effect. At the Advanced Photon Source we have applied a microfluidic continuous-flow mixer and a highly focused X-ray beam at the 18ID beamline in order to study protein folding by small-angle X-ray scattering (SAXS). This made possible to achieve time resolution of about 0.1 millisecond using final protein concentrations as low as 1 mg/ml. Refolding of guanidine-induced denatured state of cytochrome c studied by this technique in submillisecond and millisecond time range demonstrated progressive increase of compactness of the protein molecules indicated by the decrease in radius of gyration from 24 to 15 Å. The SAXS data from the α-subunit of tryptophan synthase demonstrated that the collapse of urea-denatured state of the protein occurred within the first 150 microseconds of dilution experiment. The measured radius of gyration of 33 Å was significantly smaller than that for the denatured state (43 Å). This work was supported by NIH grants RR08630 and GM23303 and NSF grant MCB0327504. Use of the Advanced Photon Source was supported by DOE under Contract No. W-31-109-Eng-38.

**Keywords: small-angle scattering, time-resolved studies, protein folding**

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## Spin Chirality in Non-centrosymmetric MnSi as Probed by Polarised Neutrons

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MnSi is a prototype of a weak itinerant ferromagnet that orders below T=29 K in a left-handed helical spin structure. Because MnSi crystallises in the non-centrosymmetric space group P213 that lacks a center of symmetry the Dzyaloshinski-Moriya interaction (DM) is allowed in this compound. The antisymmetric DM stabilises the spin helix along the [1 1 1] crystallographic axis. Here we will present results of elastic and inelastic neutron scattering experiments performed both below and above the ordering temperature. We will show that because the chemical structure of MnSi is non-centrosymmetric the neutron cross section depends upon the polarisation of the neutron beam. This allows to separate the symmetric from the antisymmetric part of the dynamical susceptibility unambiguously. Consequently it was possible to show that 1) there is only one type of magnetic helix in MnSi in the magnetically ordered state [1], 2) the critical fluctuations in the vicinity of the magnetic phase transition as measured by triple-axis spectroscopy [2] and small-angle scattering [3] have a chiral character. In addition measurements of the dependence of the spin structure under applied magnetic field will be presented.

[1] Shirane G. et al., *Phys. Rev. B*, 1983, **28**, 6251. [2] Roessli B. et al., 2002, **88**, 237204. [3] Okorokov A.I. et al., *Physica B*, 2004, **350**, e323 [4] Georgii R. et al., *Physica B*, 2004, **350**, 47.

**Keywords: Dzyaloshinski-Moriya interaction, polarised neutrons, chirality**

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## Near Field Heterodyne X-ray Speckles

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We report on the observation of stable, low contrast speckles obtained with synchrotron radiation by simply letting static scattered X-Ray radiation fall onto a high resolution camera.

The speckles have circular symmetry, their diameter being typically a few microns. Their size does not change as the sample to sensor distance is varied between few millimeters up to several centimeters. It is argued that the speckles are due to a self-referencing scheme where both the scattered radiation and the heterodyne local oscillator originate from the same rapidly changing, local coherent beam patch.

It is suggested that the X-Ray speckles are of the same type of those obtained with the newly reported optical Near Field Scattering method that has been shown to be equivalent to static light scattering, as the scattered intensity distribution can be retrieved by the statistical analysis of the speckle intensity distribution.

The simple lensless arrangement described above could be used as a new ultra low scattering method operative at extremely small scattering angles where conventional X-Ray scattering methods fail.

Speckle generated X-Ray scattering data are reported for the cellulose acetate filters that exhibit a quasi spinodal structure. A minimum appears at q=0, and an anticorrelation peak at finite wavevectors is also reported. The data are in good qualitative agreement with light scattering data from the same samples.

**Keywords: small-angle scattering, Fourier optics, fractals**