ESRF	**Experiment title:** Elementary Excitations of Correlated Counterion Fluids on Biopolymer Surfaces	**Experiment number:** SC-1454
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Shifts: 18	**Local contact(s):** Dr Alexandre BERAUD	*Received at ESRF:*

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Report:

We measured the dynamical behavior of counterion density waves (CDW) condensed on biological polyelectrolytes. These CDW's have been observed previously in *elastic* SAXS measurements of condensed f-actin bundles (Angelini *et. al.*, PNAS **100**, 2003). By varying the mass and density of the counterions in the bundles, we expected to see changes in ion dynamics. To this end, we measured samples of actin bundles prepared over a range of ion concentrations (25mM to 60mM), and over a range of ion molecular weights (Mg^{2+}, Sr^{2+}, Ba^{2+}). In order to make unambiguous assignments for this complex system, we measured a large number of reference samples, including a sample with just divalent ions and water (25mM Mg^{2+}), a sample with highly concentrated f-actin in the *absence* of divalent ions, and a sample with ions, water, and f-actin, but with insufficient ion concentrations (2mM Mg^{2+}) to form CDW's. The 18 shifts were distributed nearly evenly over all measured samples. However, count times had to be extended for the last two days due to the changeover of the synchrotron to 16-bunch 90mA mode.

For the reference samples, we observed an acoustic mode similar to what is seen in water. For multivalent ion condensed f-actin, we observed a new mode with acoustic character that is correlated with the formation of CDWs in the condensed bundles of f-actin. Further, this new mode is not observed in any of the reference samples. A sample spectrum is shown in figure 1a, a measurement of 35mM Ba^{2+} condensed f-actin at a momentum transfer $q=8\ nm^{-1}$. A reference spectrum (concentrated f-actin in the absence of multivalent ions) is shown in figure 1b, in which this excitation was not observed. The dispersion relation for the new mode has been mapped out (figure 2a) and can be compared to the dispersion of the reference sample (figure 2b). We are currently conducting further analysis of the counterion density and molecular weight dependence of this new mode.

The biggest obstacle in this study was maximizing scattered signal by preparing samples in over-sized quartz x-ray capillaries. Quite often the capillaries could not withstand vacuum within the sample chambers, and usually only the narrowest capillaries survived the measurements. This undermined the goal of maximizing the path length of the x-rays through the sample. In future runs we plan to improve our methods of sample containment to surmount this problem. Additionally, we plan to perform equivalent measurements on samples of f-actin condensed with ions of more finely varying molecular weight.

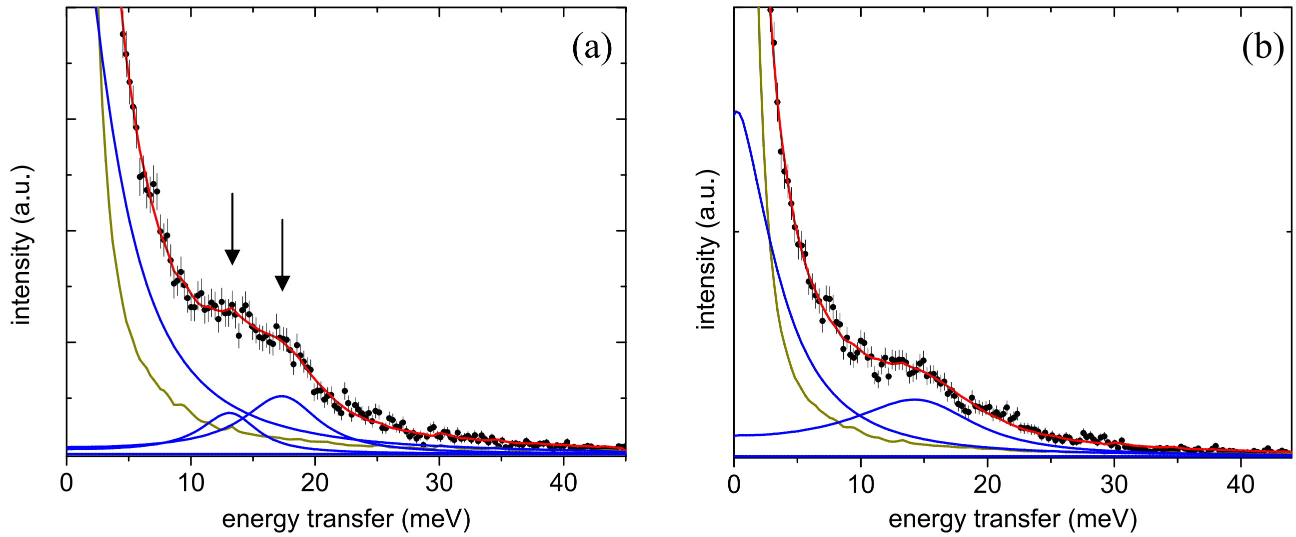

figure 1. IXS spectra at q = 8nm^{-1} for (a) 35mM Ba^{2+} condensed f-actin and (b) 50 mg/ml concentrated f-actin with no added divalent ions.

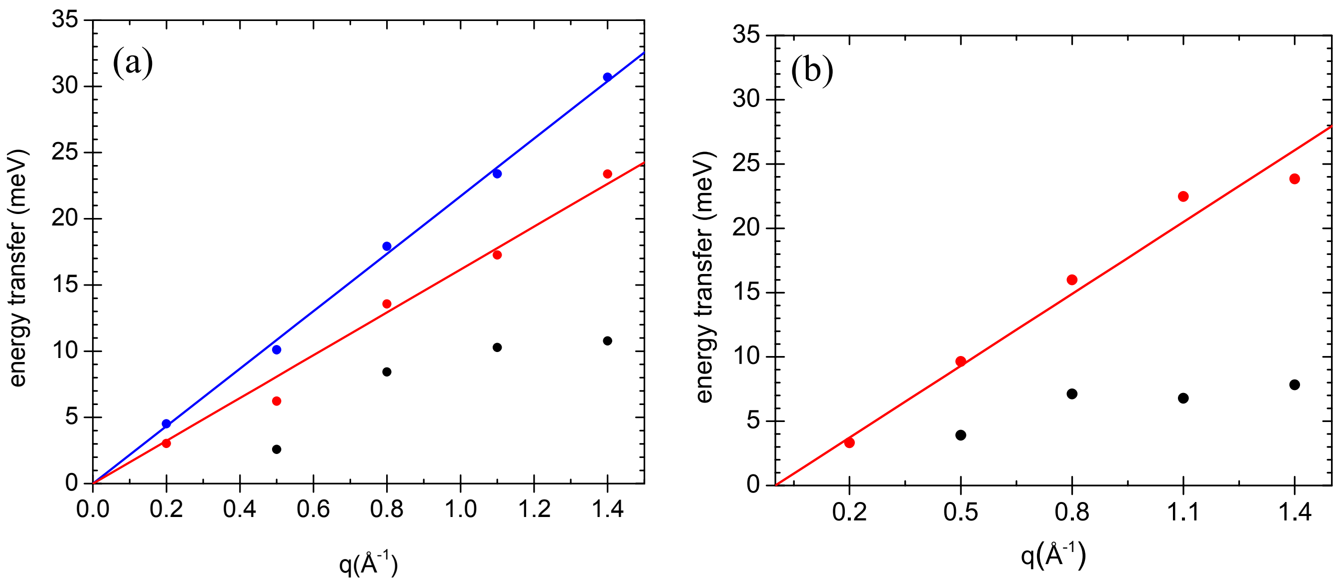

figure 2. Dispersion curves extracted from IXS spectra of (a) 35mM Ba^{2+} condensed f-actin, and (b) 50 mg/ml concentrated f-actin with no added divalent ions. The Ba^{2+} condensed f-actin exhibits a second acoustic-like excitation (blue points) not seen in the abscense of added multivalent ions. A low energy, over damped, weakly dispersing mode (black points) is also seen in both types of sample.