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Report:

The THz dynamics of human cells of the U937 line and their chromatin has been investigated by high-resolution inelastic X-ray scattering. To highlight its dynamical features in situ, nuclear DNA has been stained by the uranyl-acetate salt, in a similar way as in electronic microscopy experiments focussed on nucleic acids cellular component.

Inelastic x-ray scattering (IXS) measurements have been performed on untreated cells, on cells treated with uranyl-acetate and on DNA gels (DNA:water in proportion of 1:15 by weight). The experimental resolution has been determined by measuring the S(Q,E) of a plexiglass plate at a reference wave-vector (Q = 1.0 $Å^{-1}$) and at a temperature of 20 K in order to reduce to a negligible level the inelastic contributions.

IXS measurements were performed at the inelastic x-ray scattering beamline ID16 of the European Synchrotron Radiation Facility (Grenoble, France). The (11 11 11) reflection of the silicon crystal monochromator was exploited to select an incident photon energy of 21.747 keV with a resolution of 1.5 meV. Spectra were acquired in an energy window from -40 to 40 meV and a momentum transfer range from 0.26 to 1.43 A^{-1}. Measurements were performed at 310K, i.e. cells physiological temperature.

In Fig. 1 we show typical IXS spectra of untreated cells (a), of the chromatin contribution, i.e. the signal of stained cells after subtraction of signal from untreated cells (b), of DNA gels (c), together with the fitting function (composed of two DHO contribution and a Lorentzian quasielastic line, convoluted by the experimental resolution).

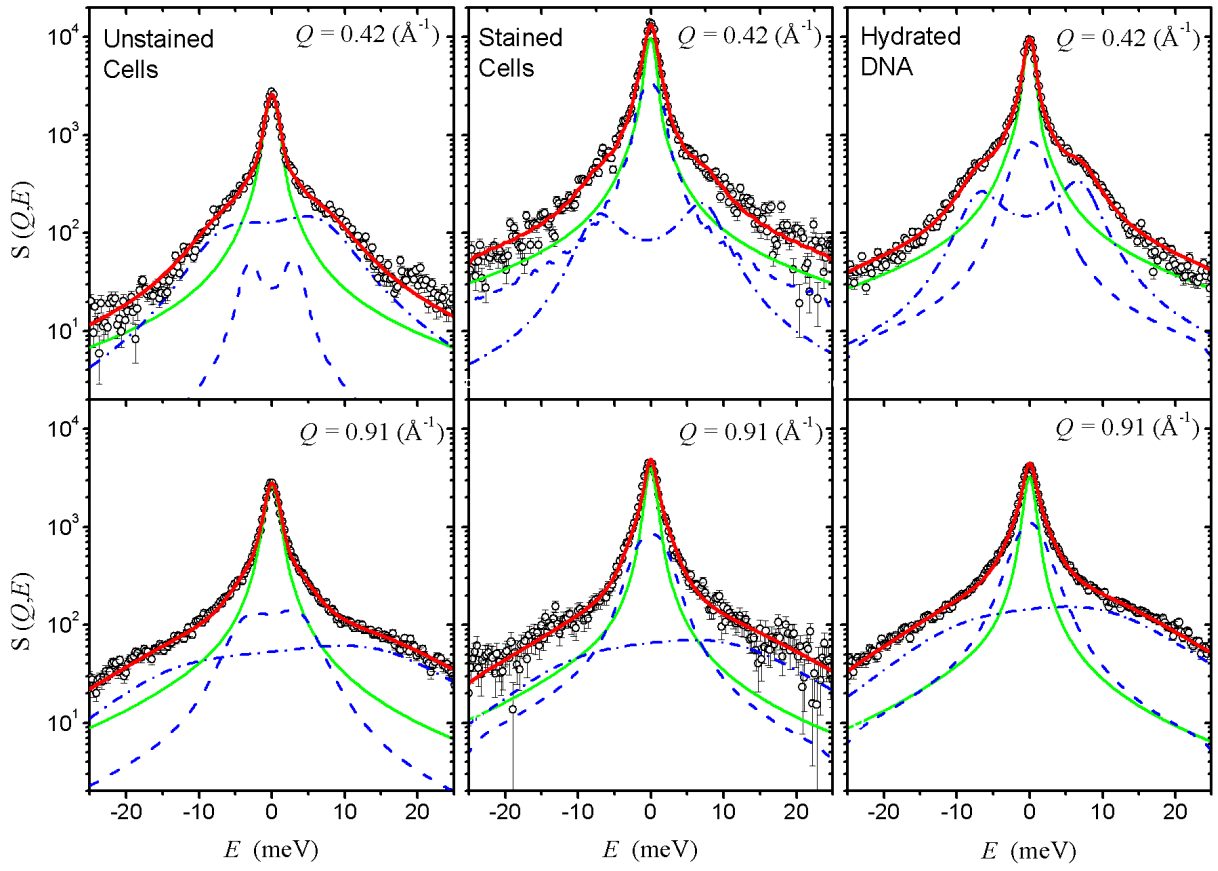

FIG.1

In Fig. 2 we show the dispersion curves of the stained sample after subtraction of the untreated cells signal, corresponding to the chromatin spectral contribution.

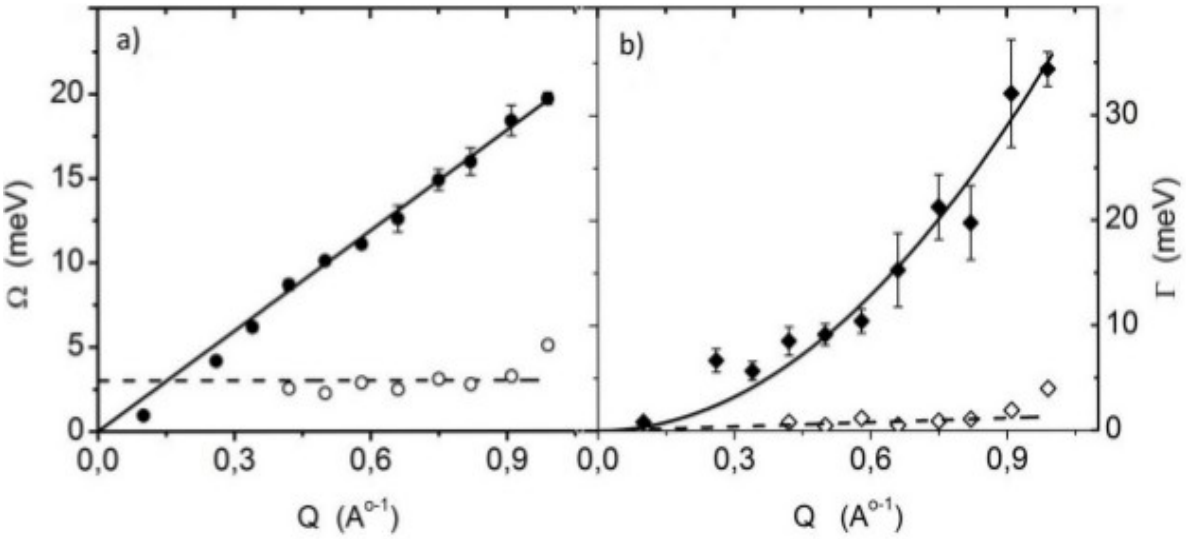

FIG.2

It can be seen that chromatin sustains coherent density fluctuations in the THz frequency regime, with a wavevector-independent mode centered at about 2.5 meV. The propagating mode is quite similar to that of the whole cell (not shown) in the low-wavevector region, with a corresponding speed of sound of 2820 ± 80 m/s. This mode gets overdamped above 0.5 Å^{-1}. The dispersion curves of purified DNA gels (not shown) display the same behavior as chromatin, thus suggesting that THz collective dynamics is quite independent of packaging and interaction with histone proteins.