ESRF

Experiment title: .	Experiment number:
Excitations in ^3He and ^4He mixture at intermediate momentum transfers	HS86

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Report:

The experiment aimed to investigate the dynamics of liquid ^3He and ^4He in the 2-20 A-' momentum transfer Q range, and, in particular, the oscillations in Q of the energy width of the dynamic structure factor $S(Q,\omega)$ in the liquid phase at low temperatures.
Due to a leak in the cryogenic system first, and then to poor quality of the beam in the available beamtime (16 bunches, short lifetime, four injections per day, long injection periods) we were not able to complete the desired experiment. We were able, however, to perform a text experiment on the $S(Q,\omega)$ of ^3He and ^4He at room temperature and 2.5 kbar. In this thermodynamic state the density of the fluids are comparable to that of the liquids at 4 K. This experiment, performed using the Si(11 11 11) reflection with 1.5 meV energy resolution in the 0.2-l A-' momentum range, gives us confidence that also the the cryogenic experiment is feasible with such pushed energy resolution. In the figure are reported the inelastic x-ray scattering spectra at selected Q values. The intensity scale is in counts per 10 minutes. The signal quality allows for a quantitative data analysis even with the small flux available. The IXS spectra have been fitted with the generalized hydrodynamic model in order to extract the values of the relevant parameters, namely the excitations energy, their widths, the central line width and the intesity ratio between elastic and inelastic terms. These measurements allow to investigate the dynamics of ^3He and ^4He super-critical fluids in a thermodynamic state which was not yet reached using neutron technique. From the Q dependence of the fitting parameters, preliminary results are: i) in the smal Q limit the sound velocity is consistent with the hydrodynamic value; ii) the energy of the excitations follows a universal behaviour showing a minimum for a Q value correspondent to the maximum of S(Q). In particular, for ^4He, we find that the shape of the dispersion relation bears a striking similarity to what is referred to as the roton minimum in the dispersion of the liquid. iii) The excitations width follows the hydrodynamic Q^2 behaviour up to the Q value where the sound velocity starts to decrease, thus indicating the onset of the break-down of the hydrodynamic regime.

iv) The intesity ratio between the central peak and the inelastic signal decreases with Q as already observed in many other fluids.

This study needs to be complemented with more measurements on ^{3}He at room temperature and high pressure, and of course, by the analogous mesurements at cryogenic temperatures.