ESRF	**Experiment title:** Critical dynamics by x-ray photon correlation spectroscopy	**Experiment number:** HS-506
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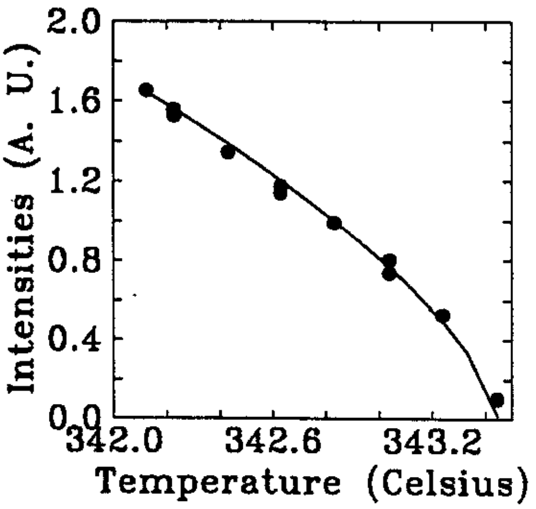
Report:
This experiment was intended to observe the dynamics of the critical fluctuations in the $AuAgZn_2$ alloy.
These critical fluctuations correspond to the ordering transition between Au and Ag atoms ("Heussler"): in the high temperature phase, they occupy indifferently simple cubic lattice positions, and, under the critical temperature (T_c), they order, and the symmetry is FCC, with a double cubic unit size. This is observed from the appearance of a ($\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$) superstructure peak. For temperatures above T_c, strong fluctuations are observed (see experimental report from 02-06-66). This alloy is a model alloy for the study of "second-order transition without conserved order parameter"
For carrying out coherent scattering experiments, the penetration depth of x-rays must be of a few microns, and the wavelength was 1.52Å. For the same reason, a beam of diameter $12\mu m$ was used.
During heating of the $AgAuZn_2$ single crystal, the region of the $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ Bragg peak was measured by means of our high resolution ($22\mu m$) CCD detector, used with our photon-counting droplet algorithm developed for this application/1/.
At low temperature, the observed speckle structure is explained by crystal mosaicity of the surface after mechanical polishing and by antiphases between ordered domains. After heating close to 340C, only one Bragg superstructure peak was observed, because of surface recovery and of growing of domain size. As the extinction length is much larger than the penetration length, measured Bragg intensity (I) is proportional to the square of the order parameter η:



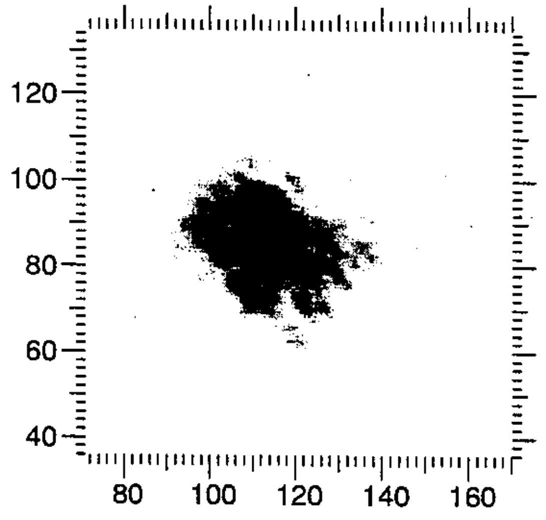


Fig.1-Temperature dependence of peak intensities Fig.2-Speckles observed above T_c .

$$I \propto \eta^2 \propto ((T_c - T)/T_c)^{2\beta}$$

as is shown in Fig. 1, where $\beta = .325$ and $T_c = 343.44(2)C$. This is a check that this transition very closely follows the Ising model.
Above T_c, diffuse intensity was measured. For temperatures above $T_c + 1K$. no speckle structure was observed: the dynamics of the fluctuations was too fast, and measured intensities were too low (less than .01c/s). Closer to T_c, the intensity becomes strongly peaked, and dynamical measurements were carried out.
Our results can be summarized from Fig. 2 ($T_c + .02K$). In this temperature range, a stable speckle structure is observed close to the Bragg position. For larger angles, these speckles disappear, and only an average diffuse intensity is observed: For larger q-values, the fluctuation time τ is shorter ($\tau \propto q^{-z}$, $z \simeq 2.$) and the intensity is smaller, so that time evolution of speckles cannot be observed. The stable speckle structure observed at small q can be related to superficial oxydization. This latter is observed after a few hours because of the poor quality of the vacuum (about .1mbar) of our furnace. With better vacuum (10^{-5}mbar), oxydization becomes negligible.
New improvements in vacuum and in beam intensity are necessary to obtain results of a better quality.

/1/ F. Livet, F. Bley, R. Caudron, E. Geissler, d. Abernathy, G. Grübel S. G. J. Mochrie, M. Sutton, J. Mainville,
"Direct illuminated CCD used as Photon Counting Detector"
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