ESRF	Experiment title: Diffuse scattering and phason modes in the InAgYb quasicrystal and its 1/1 and 2/1 approximant.	Experiment number: 02-02-766
Beamline: BM02	Date of experiment: from: 07/04/2010 to: 13/04/2010	Date of report: 29/07/2010
Shifts: 18	Local contact(s): Marc de Boissieu	Received at ESRF:

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Report:

Introduction

The discovery of the first stable binary quasicrystal in the CdYb system has been a breakthrough [1]. Indeed in this system both the icosahedral phase and the 1/1 and 2/1 periodic cubic approximants, having almost the same chemical composition, can be synthesised. It has been shown that the quasicrystal and its approximant are built up with the same atomic cluster [2], packed on the quasiperiodic lattice or the periodic body centered cubic lattice. This knowledge together with a data collection carried out on the D2AM beamline of the ESRF and a 6D approach lead to the first accurate atomic model of a quasicrystal [3].

An isostructural quasicrystal and 2/1 and 1/1 cubic approximant can be obtained in the AgInYb system [4], where AgIn substitutes for the Cd atoms. Large single grains can be obtained in these systems, and the purpose of the experiment was to compare the diffuse scattering distribution between the icosahedral phase and 2/1 approximant. Indeed the aperiodic long range order brings in new long wavelength excitations named phasons for the quasicrystal. As for the phonon, phason modes give rise to phason diffuse scattering located nearby the Bragg peaks and with a characteristic shape [5]. It has been evidenced in the AlPdMn quasicrystal [6] and in the ZnMgSc quasicrystal [7]. This experiment was the first comparison of the diffuse scattering present in a 2/1 aapproimant and a quasicrystal.

Exprimental data and results

Large single grains of the quasicrystal and the 2/1 approximant were polished with a surface perpendicular to a 2-fold and 3-fold axis, respectively. Diffuse scattering has been measured using incoming x-ray energy equal to 18 keV. For the 2/1 approximant, the Q-scans along the high symmetry axes could be indexed with a primitive lattice (for quasicrystal, see experimental report 02-02-744).

Diffuse scattering has been compared between quasicrystal and 2/1 approximant by Q-scans along the high symmetry axes as shown on figure 1. This evidences that the diffuse scattering intensity around Bragg in the quasicrystal is larger than that in 2/1 approximant. In quasicrystal, diffuse scattering decays as $1/q^2$ along high symmetry directions due to phason fluctuation. The decays could be fitted by $1/q^2$ for the AgInYb quasicrystal but that in the 2/1 approximant found to be fitted by $1/q^n$ (n>2). This indicates that such decay is characteristic of quasicrystals. On the other hand, strong streaks of diffuse scattering oriented along the 2-fold (100) axis and equivalent has been observed. These streaks measured in two directions and thus correspond to planer defect. A further analysis of these defects is underway (see figure 2).

It has been shown that the quasicrystal displays a characteristic distribution of diffuse scattering (report 02-02-744). In this experiment, we carried out systematic scan for 2D map using a point detector and automatic attenuators. The mapping for 2/1 approximant have also evidenced the existence of diffuse scattering around Bragg as shown on the figure 3 and the diffuse scattering distribution is clearly different from the quasicrystal.

In conclusion we have shown that the diffuse scattering distribution in the 2/1 AgInYb approximant is different from what we observed in the quasicrystal.

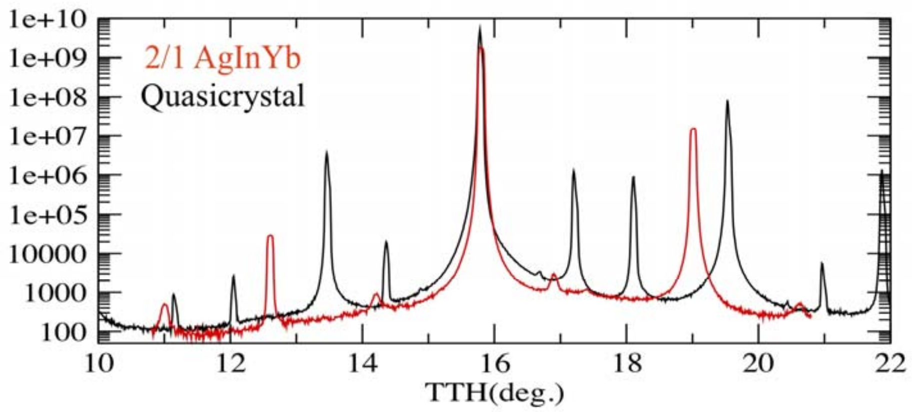

Figure 1: Comparison of the systematic Q-scans along a 2-fold axis between the AgInYb quasicrystal (black) and the 2/1 approximant (red)

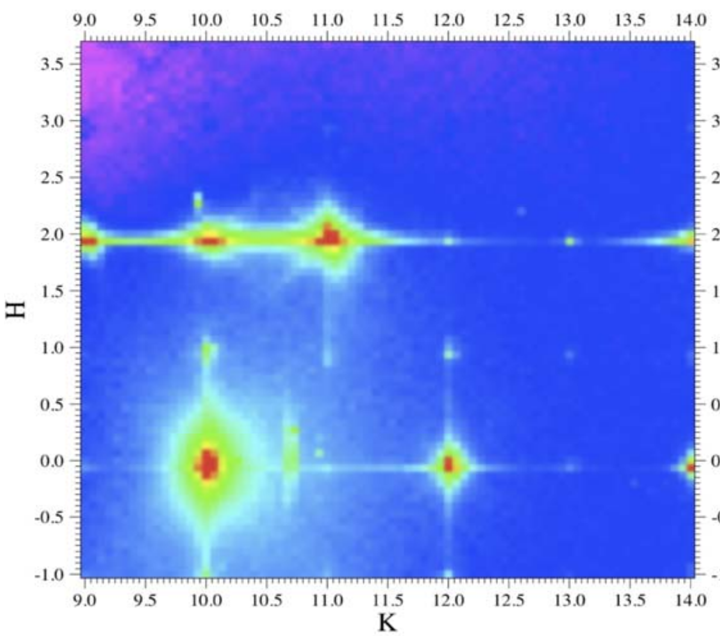

Figure 2: Diffuse scattering measured in a 2-fold plane in AgInYb 2/1 approximant. Streakes of diffuse scattering are visible along H and K axis.

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