MS23-1-2 1/1 and 2/1 QC approximant in the Ce-Au-Al System
#MS23-1-2

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Abstract
Since the discovery of the stable binary $Cd_{5.7}Yb$ [1] and $Cd_{5.7}Ca$ [2] icosahedral quasicrystals (QCs), there has been an increasing interest in these quasicrystalline structures and their approximants. These quasicrystalline phases, known as Tsai-type QCs, and their related approximants (1/1: $YbCd_6$ Type, SG: *Im-3*, and 2/1: $Yb_{13}Cd_{76}$ SG : *Pa-3*) are built from similar clusters consisting of concentric shells of disordered tetrahedra, dodecahedra, icosahedra, icosidodecahedra and defected triacontahedra from the inside out.
Similar approximant structures, called 1/1 QC approximant, crystallizing with the body centred space group *Im-3*, have been reported in ternary systems like RE-Au-X [3-5], RE-Ag-X [6] with RE = Rare earth, Ca [7] or Na [8] and X a metalloid element or in Sc-Mg-Zn system [9]. All these systems have similar clusters but differ significantly by their respective composition. For example, gold systems usually crystallize with composition around $RE_{15}Au_{65}X_{20}$, for silver it is approximately around $RE_{20}Ag_{40}In_{40}$ and for the Sc-Mg-Zn the 1/1 composition is $Sc_{14}Mg_{0.8}Zn_{84}$ [10]. The same behaviour can be observed for the 2/1 approximant.
In this frame, we will concentrate here on the Ce-Au-Al systems, where Kondo effect behaviour have been reported recently [10], but without complete structural determination. Indeed to date both quasicrystal approximants have been only reported in the Sc-Mg-Zn [9] and in the Ca-Au-Sn[7] systems. Therefore, this paper will report the structural characterization of both 1/1 and 2/1 approximants in a ternary system where magnetic element like cerium is involved. In both cases, the two approximants' structures have been characterized by powder and single crystal X-ray diffraction.
The single crystal XRD analysis performed on the as-cast sample reveals the existence of two types of structure. First, a body centred cubic structure (Im-3) isotypic to those previously reported for the Ge or Sn-containing systems [3,4] was observed with $a_{1/1}$ = 14.927 Å for the 1/1 approximant. In agreement with the X-ray powder diagram a second crystal analysis reveals the existence of a primitive cubic unit cell with $a_{2/1}$ = 24.12 Å, crystallizing with the *Pa-3* space group and in agreement with the 2/1 approximant reported for the Sc-Mg-Zn and Ca-Au-Sn systems. This paper will precisely describe these two related structures explaining their structural relationship and differences with those already reported in similar systems.

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