MS22 Complex order in magnetic materials

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Search for long-range magnetic order in icosahedral quasicrystals
R. Tamura [1]
[1] *Tokyo University of Science - Tokyo (Japan)*

Abstract
Since the discovery of QCs in 1984 [1], one of the fundamental issues in this field is to realize a long-range magnetic order in QCs, such as ferromagnetic and antiferromagnetic ones. In this respect, the discoveries of rare-earth (R) containing QCs, such as Zn-Mg-R [2], Cd-Mg-R [3] and Cd-R [4] i QCs, opened up a new field to investigate the magnetism of localized moments on a quasiperiodic lattice, and their magnetism has been extensively investigated. However, all the R containing QCs commonly exhibited a spin-glass behaviour and no long-range magnetic order (LRMO) was observed. On the contrary, Tsai-type 1/1 approximants (ACs) were found to exhibit rich magnetic orders including ferromagnetic, antiferromagnetic and spin-glass states, which may suggest that LRMO is unfavored in a quasiperiodic lattice.
The magnetism of Tsai-type approximants has been extensively investigated for the last decade in order not only to gain insight into the magnetism of QCs but also to understand the magnetism of ACs itself. As a result, the magnetism of ACs has been found to be well classified by the average electron-per-atom (e/a) ratio [5]: The physical quantities such as the Weiss temperature (Qp) and Curie temperature (Tc) are well described by the e/a ratio. In addition, the study of the magnetism in the composition-tunable Tsai-type 1/1 ACs has helped us to understand and also predict the magnetism of Tsai-type QCs to considerable extent. The absence of the LRMO in the previously studied QCs is now partly understood by the fact that their e/a ratio happens to be located in the strongly frustrating region. Recently, new Au-Ga-R QCs were synthesized in the ferromagnetic region by the melt-spinning method and they were found to exhibit ferromagnetic transitions as expected [6], which is the first LRMO observed in i QCs.

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References
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