

Elastic properties of the approximant GdCd₆ proved by ultrasonic measurement

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We have investigated elastic properties of the Cd-based approximant GdCd₆ for an icosahedral quasicrystal by means of ultrasonic measurements. A salient anomaly was observed in the temperature dependence of the principal elastic constants, most probably being associated with magnetic phase transitions. It was found that GdCd₆ manifests long-range magnetic order at low temperatures.[3] Its magnetism is based on Gd magnetic moments residing on the icosahedral shell, which are interacting through the Ruderman-Kittel-Kasuya-Yoshida (RKKY) type indirect exchange interaction. From the view of the magnetic Gd sites, GdCd₆ can be viewed in two equivalent ways: either by a periodic arrangement of magnetic icosahedral units or by distorted corner-sharing octahedral units. They both provide potentially geometric magnetic frustration. Thus, spin-glass (SG)-like behavior is highly expected in this system.

Based on the experimental data, an updated magnetic field vs temperature phase diagram was constructed for the GdCd₆ approximant. In a zero magnetic field, some phases seem to exist. It is worth noting that the phase diagram for the magnetic field applied is richer, and some phase boundaries correspond to the development of field induced phases and allude to a multiphase convergence at a specific point in the phase diagram. The obtained result provides an extended insight into fundamentals of the cooperative/collective behavior of interacting magnetic moments coming from the long-range order of locally aperiodic quasicrystalline lattices. We discuss the elastic property, and also the nature of the order parameter and some types of possible phases obtained in GdCd₆.

References

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