Abstract

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"High-Pressure Investigation of Magnetism in Intermetallic and Oxidic Compounds using $^{151}Eu/^{155}Gd$-Mössbauer Effect and Transport Measurements"

(German title: Hochdruckuntersuchungen zum Magnetismus in intermetallischen und oxidischen Verbindungen mit $^{151}Eu/^{155}Gd$-Mössbauereffekt und Transportmessungen)

The central topic of this work concentrates on combined ^{155}Gd-Mössbauer and transport measurements under high pressure for the investigation of the magnetic properties of GdM_2 Laves Phases (M = Al, Fe, Gd). A new high pressure cell with boron carbide anvils was developed for performing simultaneous transport and Mössbauer measurements.

Temperature dependent studies on (2) intermetallic Eu_2PdSi_3, Gd_2PdSi_3 and on (3) the oxidic Gd_2BaNiO_5 compounds were performed with the 21.5 keV/86.5 keV resonance of $^{151}Eu/^{155}Gd$.

This work is concerned with the investigation of complex magnetic properties of the systems. Magnetic models based on (modified) molecular field approximations, as well as on the local and itinerant magnetism (including spinfluctuations) were used for interpretation of the results.

(1) Applying high pressure on $GdMn_2$ results in a decoupling of the Mn sublattice from the (ferromagnetic) Gd sublattice. Due to frustration effects of the Mn moments the Mn sublattice shows strong spinfluctuations.

The Gd sublattice at ambient pressure exhibits a (relatively low) magnetic ordering temperature of 40 K. The spinfluctuations of the Mn moments were suppressed with increasing pressure accompanied by a strong increase of the ordering temperature of the Gd sublattice up to 100 K, where at 1.2 GPa the magnetic ordering of the Mn moments was completely vanished. Above 1.2 GPa a slower increase of the Curie temperature up to 165 K and 8 GPa was observed. At 1.6 GPa a characteristic change of the ^{155}Gd Mössbauer spectrum was observed and interpreted as a phase transition from the cubic C15 to the hexagonal C14 laves phase of $GdMn_2$.

The Laves phases $GdFe_2$ and $GdAl_2$ are studied as magnetic reference systems for the case of a magnetic and a nonmagnetic alloy partner in GdM_2. The comparison of hyperfine parameters of the Gd-Laves phases enabled an elaborate discussion of the magnetic exchange mechanisms under application of different models.

(2) Intermetallic compounds of the type R_2PdSi_3 (R = Eu, Gd) show a complex magnetism of the two non equivalent R-Sites (R1:R2 = 1:3). A ferromagnetic ordering temperature of 40 K was observed for the minority site (Eu1) in Eu_2PdSi_3. The majority site (Eu2) shows antiferromagnetic ordering at 10.8 K. Simultaneously to the magnetic order of the Eu2 sublattice, a spin reorientation of the Eu2 moments from the c-axis into the (ab)-plane is observed. This magnetic behavior is described with a molecular field model and critical exponents revealing a quasi one-dimensional magnetism of the Eu1 sublattice.

(3) Gd_2BaNiO_5 belongs to a family of orthorhombic crystal structures, which is considered because of the isolated Ni-O-Ni chains, as model systems for one dimensional Heisenberg

antiferromagnets (Y_2BaNiO_5). The large spin moment of Gd in Gd_2BaNiO_5 leads to complex magnetic interactions between the magnetic Gd and Ni sublattices. The Ni-O-Ni chains first arrange its magnetic moments along to the a-axis with quasi one-dimensional character. With the onset of the Gd-Ni exchange interactions one observes a spin reorientaton of the Gd moments and presumably also of the Ni moments from the a to the b axis. The magnetic hyperfine field can be described by two different molecular field models.

The information was derived from the analysis of the ^{155}Gd-Mössbauer spectra with combined electric and magnetic hyperfine interactions and comparisons with calculations of the electric field gradient based on a point charge model.