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Dilute Fe-doping and Magnetic Properties of Type-I Germanium Clathrates YANG LI, JOSEPH H. ROSS, JR., Texas A&M University — We have prepared samples of $Ba_8Ge_{30}Ga_{16-x}Fe_x$ with $x \leq 1$. Fe substitutes on the type-I clathrate framework, with a lattice parameter decreasing with x. Ferromagnetic behavior was observed, with $T_c = 65$ K for $x = 1$, decreasing linearly to 58 K at $x = 0.2$. Fe exhibits a low-spin moment: for example 1.9 μ_B per Fe for $x = 1$, from a Curie fit above T_c. The field-cooled and zero-field-cooled magnetization exhibit a pronounced divergence below 60 K, and at 2 K the saturation magnetization is only 0.75 μ_B per Fe in a field of 7 T. These results suggests a noncollinear spin configuration. In ac susceptibility measurements, $\chi\prime$ and $\chi\prime\prime$ become frequency dependent below T_c, however with very little peak shift, rather different from the spin-glass behavior we previously observed in the more highly Fe-doped chiral clathrate. We conclude that the transition near 65 K is ferrimagnetic. At these doping levels, Fe occupancy is well below the percolation threshold. It is thus likely that the mechanism for magnetic ordering is conduction-electron mediation, as in diluted magnetic semiconductors. This work was supported by the Robert A. Welch Foundation, and by the NSF (DMR-0103455).

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