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#### **ACCEPTED MANUSCRIPT**

# Effect of Zn-site substitution with Ga on non-Fermi liquid behavior in PrIr<sub>2</sub>Zn<sub>20</sub>

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#### **Abstract**

PrIr<sub>2</sub>Zn<sub>20</sub> exhibits an antiferroquadrupolar (AFQ) order at  $T_Q = 0.11$  K, above which temperature the electrical resistivity  $\rho(T)$  shows an upward curvature and the magnetic specific heat divided by temperature  $C_m/T$  follows  $-\ln T$  dependence. The non-Fermi Liquid (NFL) behaviors have suggested formation of a quadrupole Kondo lattice. In the present work, we have studied the effect of Ga substitution for Zn on the NFL behavior by the measurements of the specific heat C, the magnetic susceptibility  $\chi$ , and  $\rho$  of PrIr<sub>2</sub>Zn<sub>20-x</sub>Ga<sub>x</sub> ( $0 \le x \le 0.25$ ). With increasing x, the characteristic temperature  $T_0$  defined as the temperature where the magnetic entropy  $S_m$  reaches (3/4)Rln2 is increased by a factor of 3.5. Similarly, another characteristic temperature  $T_R$  below which  $\rho(T)$  starts decreasing with the upward curvature increases with x by a factor of 1.2. The increments of both  $T_0$  and  $T_R$  may be attributed to the possible split of the  $\Gamma_3$  doublet by symmetry lowering of the Pr sites. Otherwise, the quadrupole Kondo lattice would be stabilized by the enhanced c-f hybridization due to the increment of the 4p electronic density and/or the chemical pressure effect.

Keywords: quadrupole, non-Fermi liquid, quadrupole Kondo effect

#### I. INTRODUCTION

Praseodymium-based intermetallic compounds  $\Pr T_2 X_{20}$  (T = transition metal, X = Al, Zn, Cd) with  $4f^2$  configuration have received remarkable attention because of exotic phenomena arising from the quadrupolar degrees of freedom [1]. In the cubic  $\text{CeCr}_2\text{Al}_{20}$ -type structure, the Pr ion sits at a symmetric site with the cubic  $T_d$  point group [2]. The crystalline electric field (CEF) ground state of the Pr ions in most  $\Pr T_2 X_{20}$  systems is the non-Kramers  $\Gamma_3$  doublet, having no magnetic dipole but electric quadrupoles [3-7]. The active quadrupoles lead to a variety of phenomena at low

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