Supplementary materials

A Two-step Field-induced Magnetic Transition in a Novel Layered Cobalt Diphosphonate

Ping Yin,[a] Song Gao,[b] Li-Min Zheng,[a,*] Zheming Wang,[b] Xin-Quan Xin[a]

[a]State Key Laboratory of Coordination Chemistry, Coordination Chemistry Institute, Nanjing University, Nanjing 210093, P. R. China

[b]State Key Laboratory of Rare Earth Materials and Applications, College of Chemistry and Molecular Engineering, Peking University, Beijing 100871, P. R. China

Experimental Section

Ion exchanges:

A mixture of compound **1** and an aqueous solution of 1M KCl (or NH_4Cl, $CaCl_2$) was stirred firstly at R.T. for 1h, then at 80^{o}C for 4h. The resulted product was filtered, washed with water and dried in air. The same experiment was repeated once more. The atomic absorption spectra and elemental analysis of the final products show that 18.2%, 58.3% and 95.7% Na^+ ions in compound **1** were replaced by NH_4^+, K^+ and Ca^{2+} ions, respectively. The XRD measurements suggest that the structure of **1** is maintained after ion exchanges.

Figure Captions:

Figure S1 (a) Polyhedral representation of the structure of **1** viewed down [100]; CoO_6 octahedra dark shaded, CPO_3 tetrahedra not shaded, Na^+ ions and H_2O molecules with large and small open circles, respectively. (b) The two types of chains (top: chain I, bottom: chain II) within the layer.

Figure S2 Temperature dependent molar magnetic susceptibilities of compound **1** at 10 kOe. Inset: $\chi_M T$ versus T curve for **1**.

Figure S3 χ_M^{-1} versus T curve for **1** at the field of 10 kOe.

Figure S4 Temperature dependent *ac* magnetic susceptibilities for **1**.

Figure S5 $d(\chi_M T)/dT$ versus T curve for **1** at the field of 1 kOe.

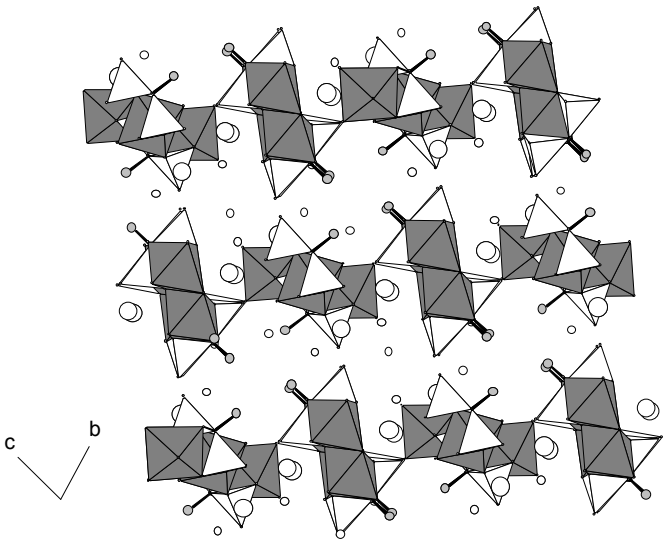
Figure S6 Field dependent *ac* magnetic susceptibilities of **1** at different temperatures.

Figure S7 Field dependent magnetization of **1** at different temperatures.

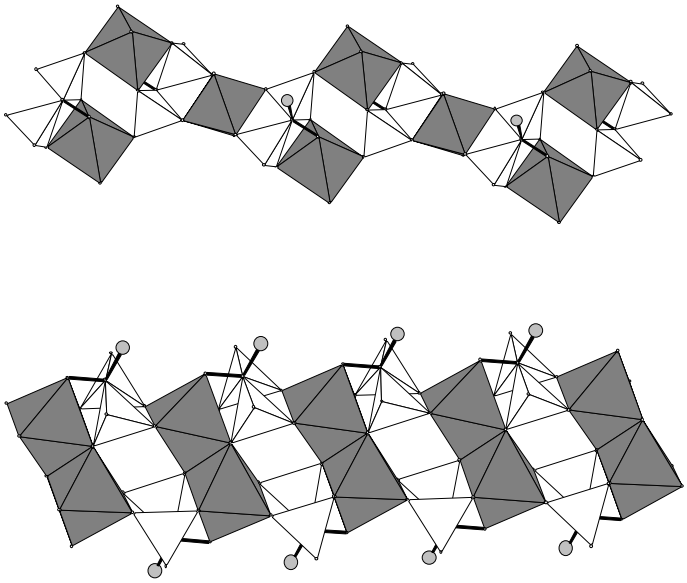
Figure S8 The magnetic phase diagram for **1**.

Figure S9 Hysteresis loop for **1** at 1.8 K.

Figure S10 Thermal analysis of **1** with a heating rate of 20^oC/min at N_2.



(a)



(b)

Fig. S1

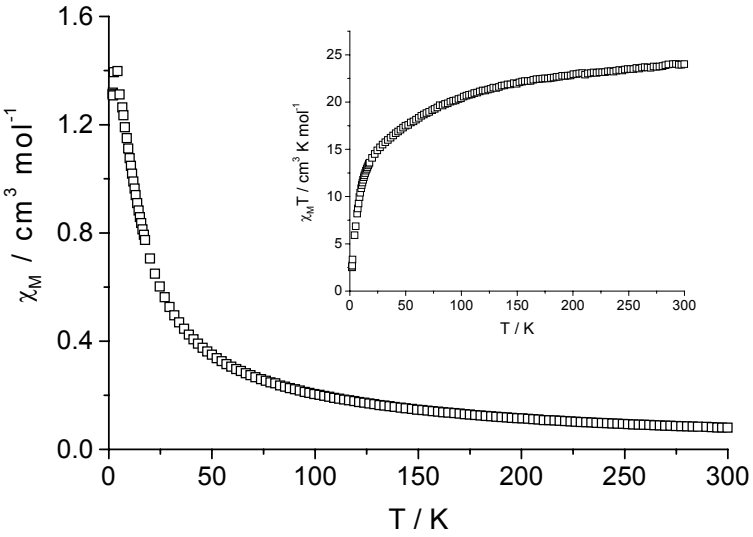

1.6
1.2
0.8
0.4
0.0
χM / cm3 mol-1
0
50
100
150
200
250
300
T / K
25
20
15
10
5
0
χMT / cm3 K mol-1
0
50
100
150
200
250
300
T / K

Fig. S2

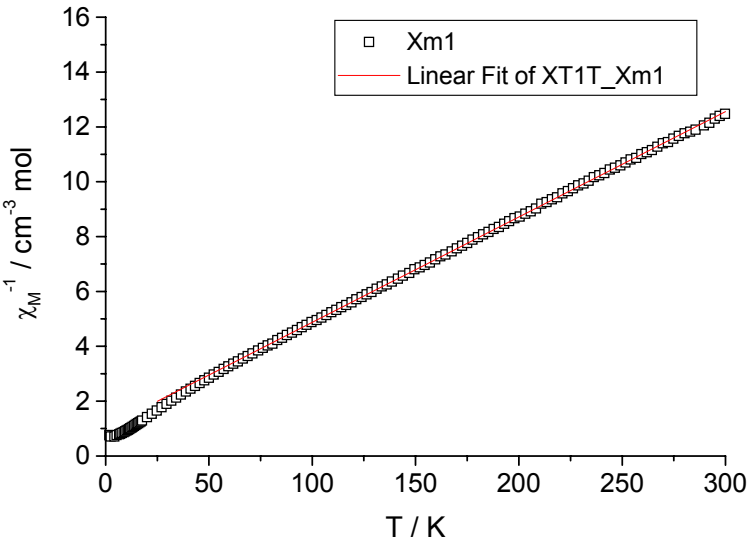

Xm1
Linear Fit of XT1T_Xm1
16
14
12
10
8
6
4
2
0
χM-1 / cm-3 mol
0
50
100
150
200
250
300
T / K

Fig. S3

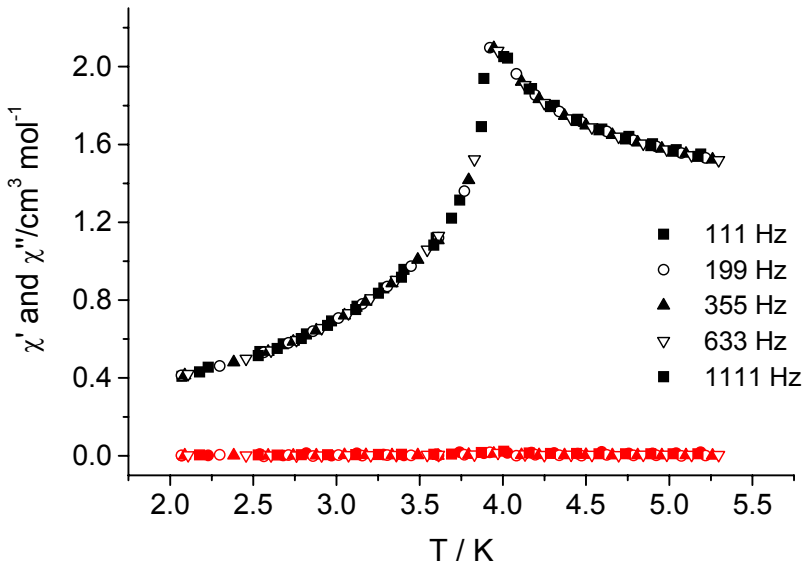

χ' and χ''/cm3 mol-1
T / K
111 Hz
199 Hz
355 Hz
633 Hz
1111 Hz

Fig. S4

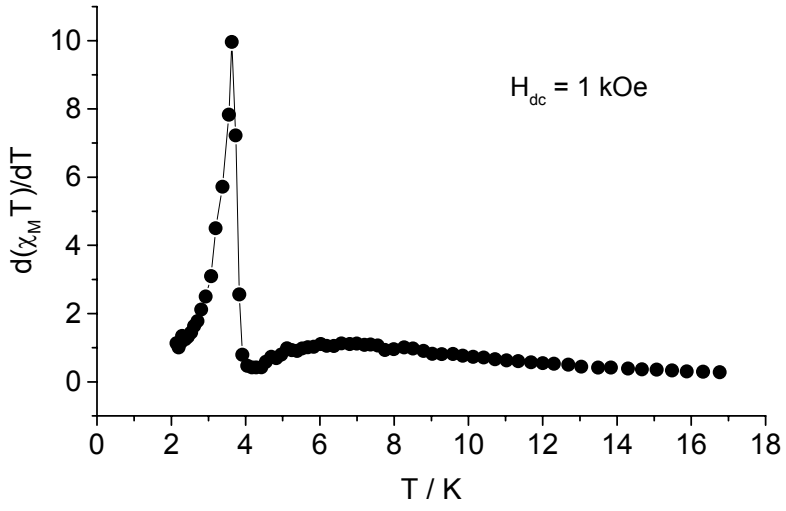

d(χM T)/dT
T / K
Hdc = 1 kOe

Fig. S5

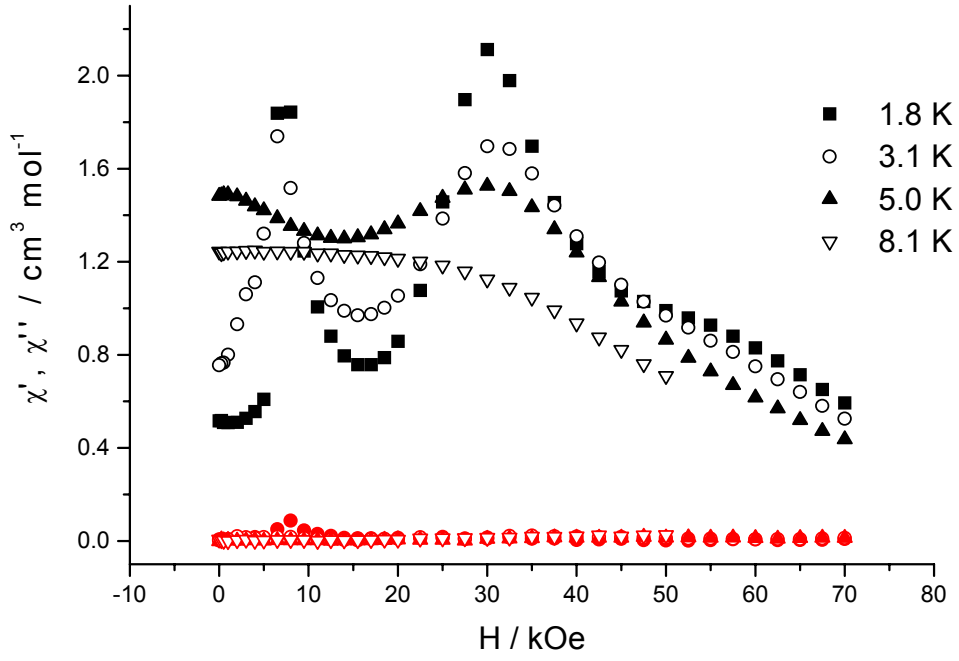

2.0
1.6
1.2
0.8
0.4
0.0
χ', χ'' / cm3 mol-1
-10
0
10
20
30
40
50
60
70
80
H / kOe
1.8 K
3.1 K
5.0 K
8.1 K

Fig. S6

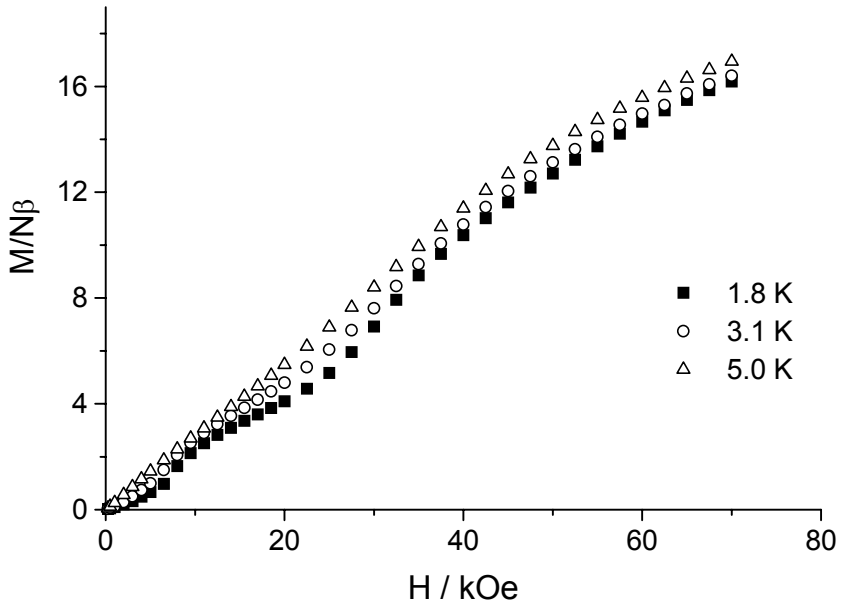

16
12
8
4
0
M/Nβ
0
20
40
60
80
H / kOe
1.8 K
3.1 K
5.0 K

Fig. S7

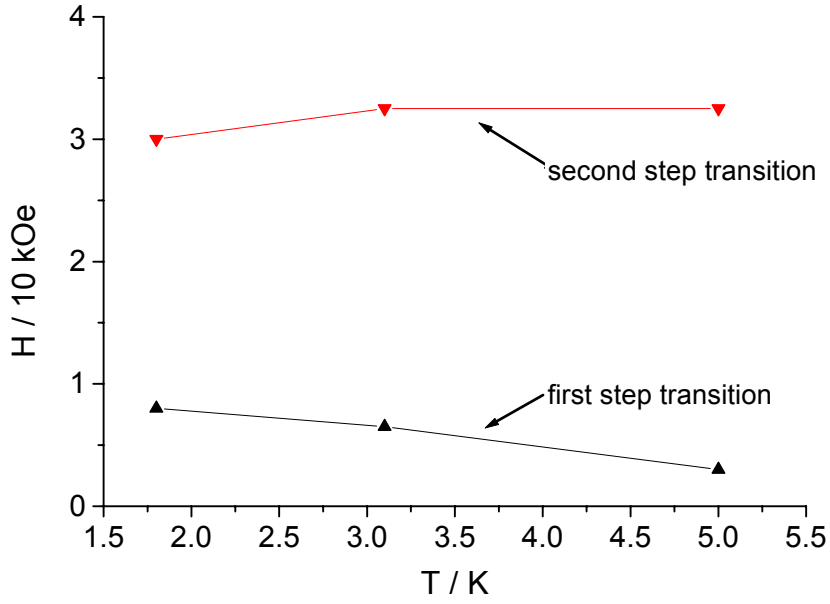

H / 10 kOe
T / K
second step transition
first step transition

Fig. S8

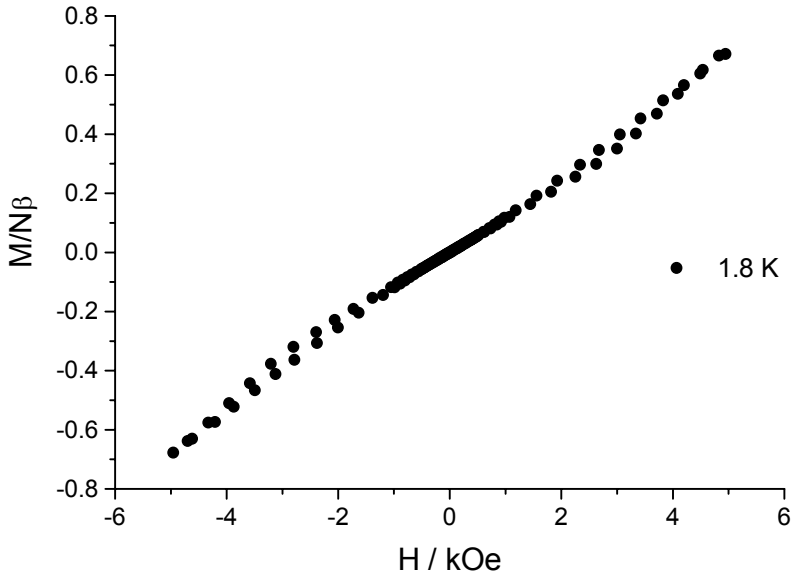

M/Nβ
H / kOe
1.8 K

Fig. S9

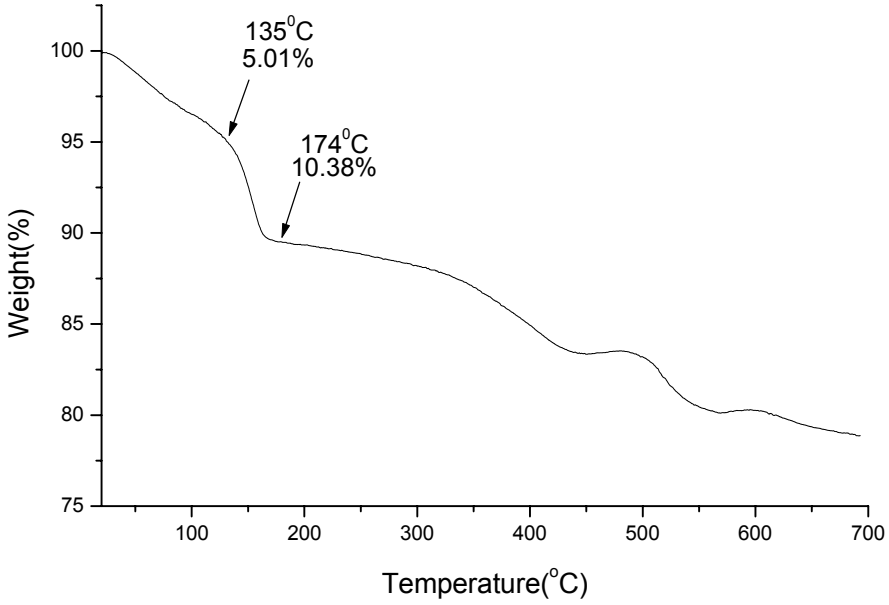

135°C
5.01%
174°C
10.38%
Weight(%)
100
95
90
85
80
75
100
200
300
400
500
600
700
Temperature(°C)

Fig. S10