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Supplementary Information

Synthesis, structure and magnetic ordering of the mullite-type $Bi_2Fe_{4-x}Cr_xO_9$ solid solutions with frustrated pentagonal Cairo lattice.

M. G. Rozova, V. V. Grigoriev, I. A. Bobrikov, D. S. Filimonov, K. V. Zakharov, O. S. Volkova, A. N. Vasiliev, E. V. Antipov, A. A. Tsirlin, A. M. Abakumov

Table S1. 298K and 78K ^{57}Fe Mössbauer hyperfine parameters for $Bi_2Fe_3CrO_9$. (IS, isomer shift relative to α-Fe at ambient temperature; ΔE_Q, apparent quadrupole shift; H_{Hf}, magnetic hyperfine field; G, line width; A, relative spectral area)

T, K	Component	IS, mm/s ± 0.01	ΔE_Q, mm/s ± 0.01	H_{Hf}, T ± 0.1	A % ± 1	G, mm/s ± 0.01	Assignement
298	S1	0.37	-0.21	50.7	8	0.44	Fe_2O_3 imp
	D1	0.35	0.38	-	31	0.26	Fe^{3+} (oct)
	D2	0.24	0.99	-	61	0.31	Fe^{3+} (tet)
78	S11	0.46	-0.14	53.1	4	0.36	Fe_2O_3 imp
	S21	0.45	0	47.2	31	0.57	Fe^{3+} (oct)
	S22	0.32	0.38	43.0	60	0.53	Fe^{3+} (tet)
	S31	0.36	0.1	7.6	5	0.52	Fe^{3+} (avr)

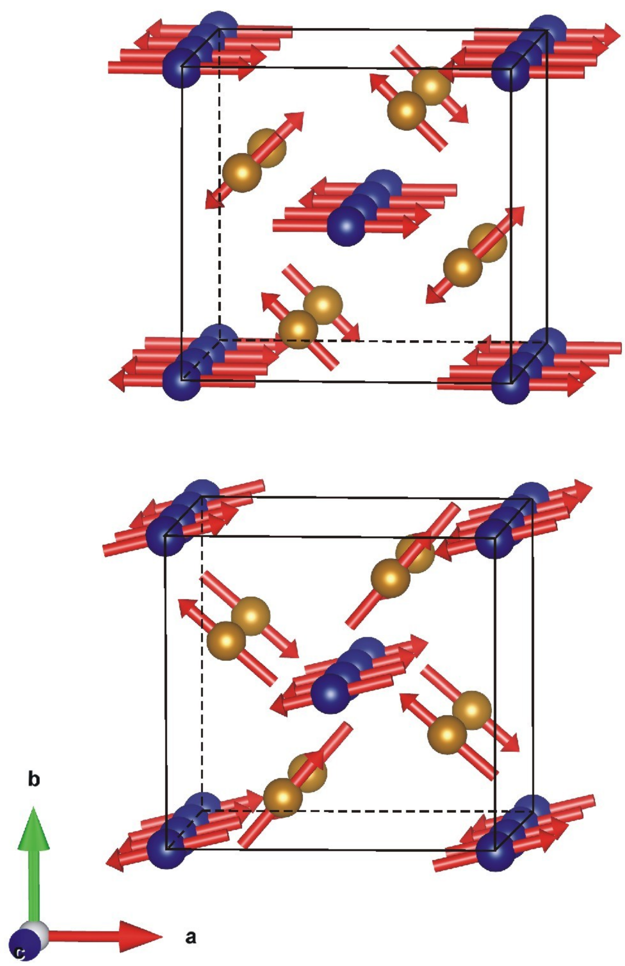

Figure S1. Variants of the $Bi_2Fe_3CrO_9$ magnetic structure with the magnetic moments confined to *ab* plane. The Fe1 and Fe2 sublattices are marked in yellow and blue, respectively. The structure is shown in the *a*, *b*, 2*c* unit cell, where *a*, *b*, *c* are the lattice parameters of the nuclear structure.

Table S2. Symmetry operators of the $F_a\bar{1}$ magnetic space group (S.G. $P_S\bar{1}$ (#2.7) in Belov-Neronova-Smirnova notations).

Seitz symbol	Symmetry operator	Seitz symbol	Symmetry operator
$(1\,|\,0,0,0)$	*x, y, z, m*	$(1\,|\,0,0,½)'$	*x*, *y*, *z*+1/2, -*m*
$(\bar{1}\,|\,0,0,0)$	-*x*, -*y*, -*z*, *m*	$(\bar{1}\,|\,0,0,½)'$	-*x*, -*y*, -*z*+1/2, -*m*
$+(1\,|\,0,½,½)$, $(1\,|\,½,0,½)$, $(1\,|\,½,½,0)$			

Table S3. Fractional coordinates of the magnetic atoms in the magnetic supercell (magn. S.G. $F_a\bar{1}$, a = 15.8982(3)Å, b = 16.7673(3)Å, c = 11.9520(2)Å, R_{magn} = 0.014, R_P = 0.013, R_{wP} = 0.014) and magnetic moments in spherical coordinates (μ,θ,φ) at T = 30K.

Atom	*x/a*	*y/b*	*z/c*	μ, μB	θ, deg.	φ, deg.
$Fe1_1$	-0.8239	0.1677	1/4	3.40(3)	51(1)	140(2)
$Fe1_2$	-0.5739	0.0823	1/4	μ($Fe1_1$)	θ($Fe1_1$)	-270 + φ($Fe1_1$)
$Fe2_1$	0	1/4	0.3746	μ($Fe1_1$)	180 - θ($Fe1_1$)	-111(2)
$Fe2_2$	3/4	0	0.6254	μ($Fe1_1$)	180 - θ($Fe1_1$)	180 + φ($Fe2_1$)

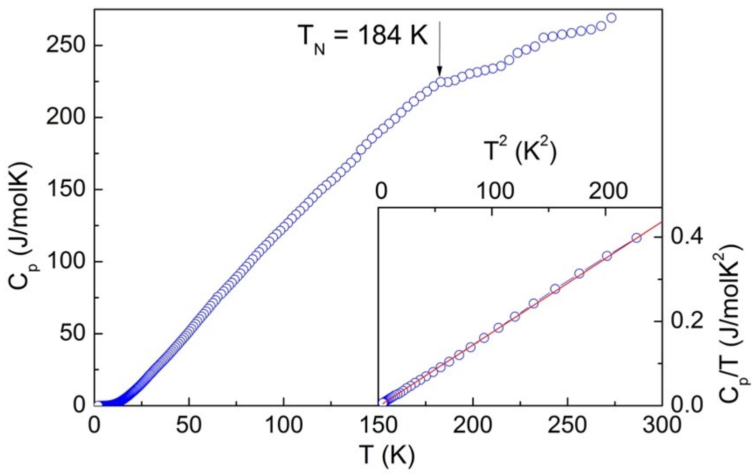

Figure S2. Temperature dependence of heat capacity for $Bi_2Fe_3CrO_9$. The insert shows fitting the low temperature part with the C_p/T - αT^2 Debye dependence.