Anomalous magnetism and ^{209}Bi nuclear spin relaxation in $Bi_4Ge_3O_{12}$ crystals

V.G. Orlov[1], E.A. Kravchenko[2], Tetsuo Asaji[3],
G.S. Sergeev[1], Yu.F. Kargin[4], A.N. Vasil'ev[5], O.S. Volkova[5]

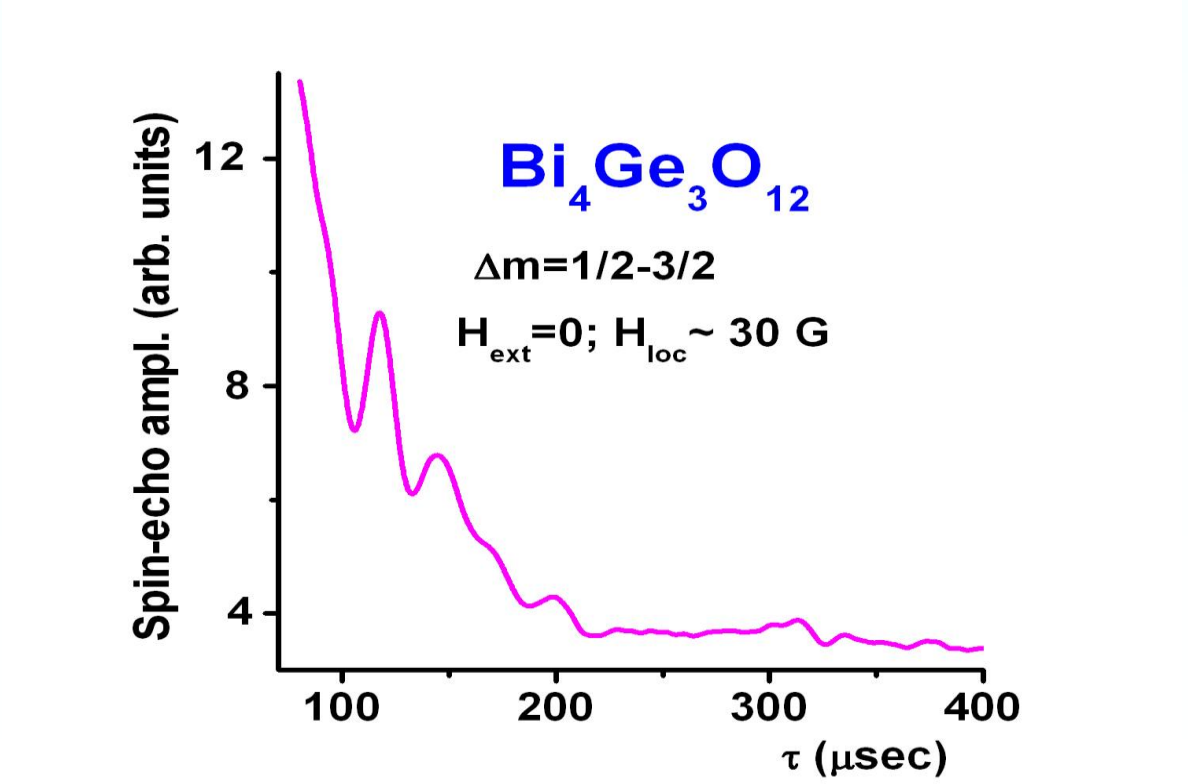
[1]*Russian Research Center "Kurchatov Institute", Moscow, Russia*
[2]*Institute of General and Inorganic Chemistry, Moscow, Russia*
[3]*Department of Chemistry, College of Humanities and Sciences, Nihon University, Tokyo, Japan*
[4]*State Institute of Metallurgy and Material Science, Moscow, Russia*
[5]*Lomonosov Moscow State University, Moscow, Russia*

$Bi_kA_lO_mX_n$ (A =Al, B, Ge, Ba; X = Cl, Br)

$H_{loc} \leq 250$ G ;

E.A. Kravchenko, V.G. Orlov, M.P. Shlykov

Russian Chem. Rev. **75** (2006)



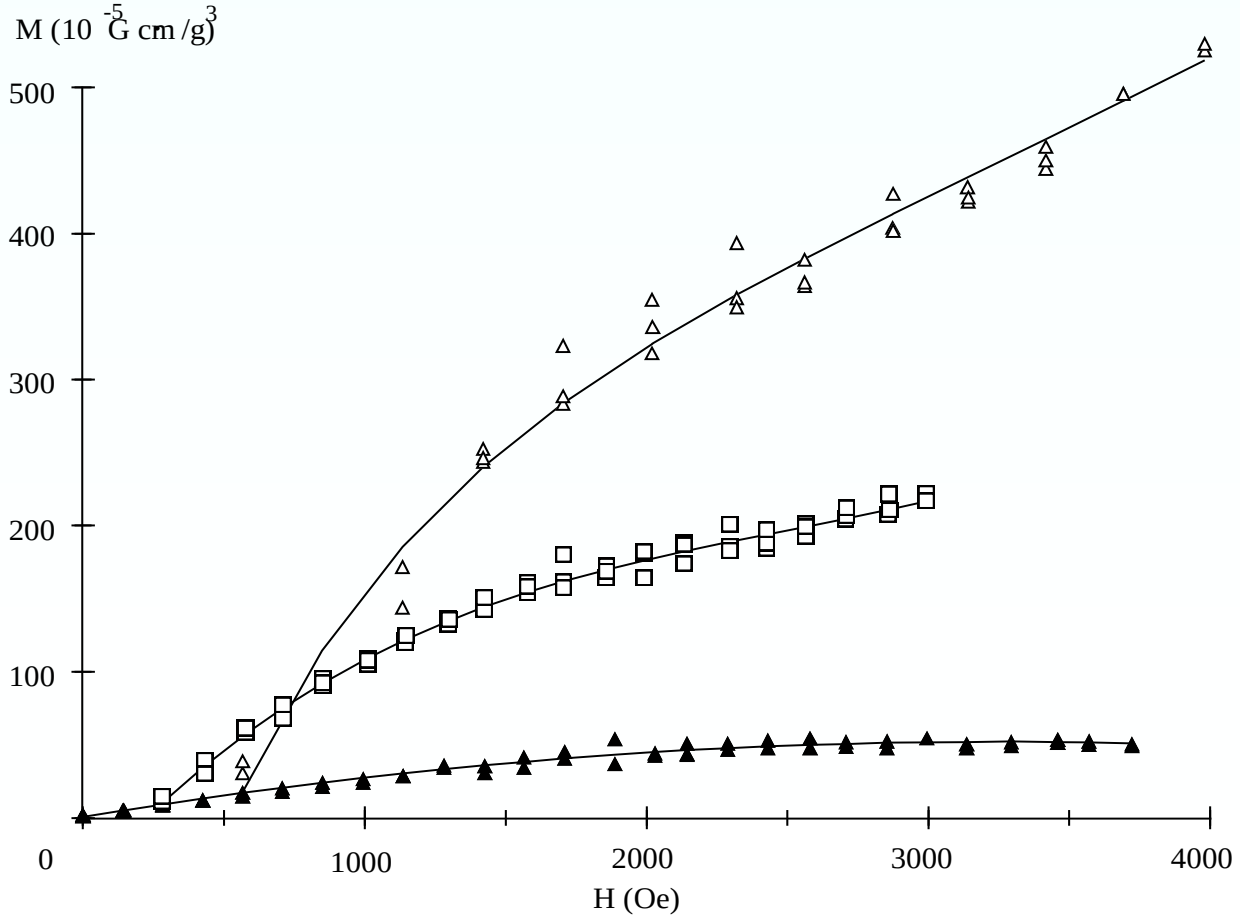
E.A. Kravchenko, V.G. Orlov et al., *JETP Lett.* **86** (2007)

α-Bi_2O_3

V.I. Nizhankovskii, A.I. Kharkovskii, V.G. Orlov

Ferroelectrics **279** (2002)

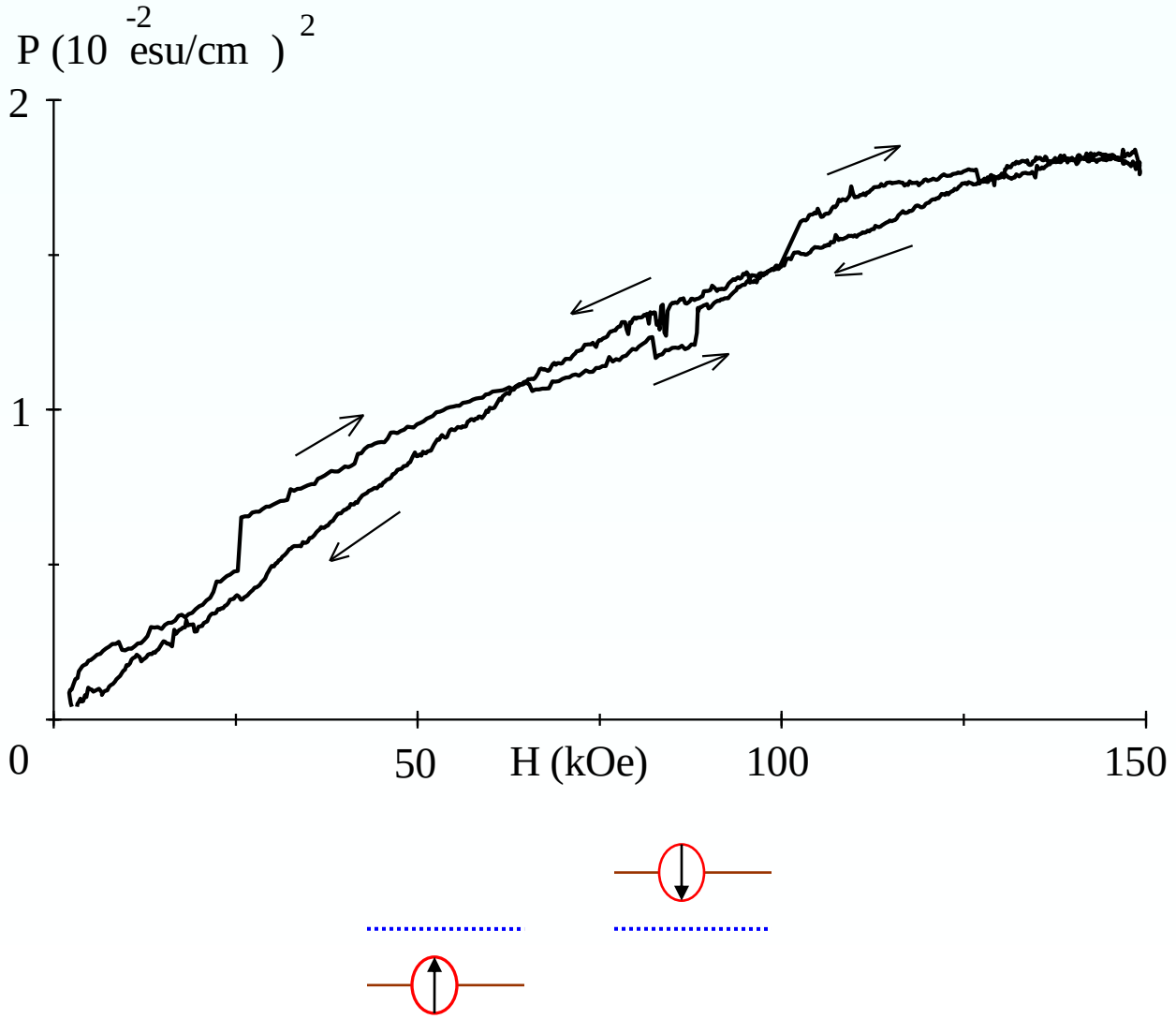
T = 4.2 K; H || c; – ZFC; – FC, H = 284 Oe; Δ – FC, H = 566 Oe;



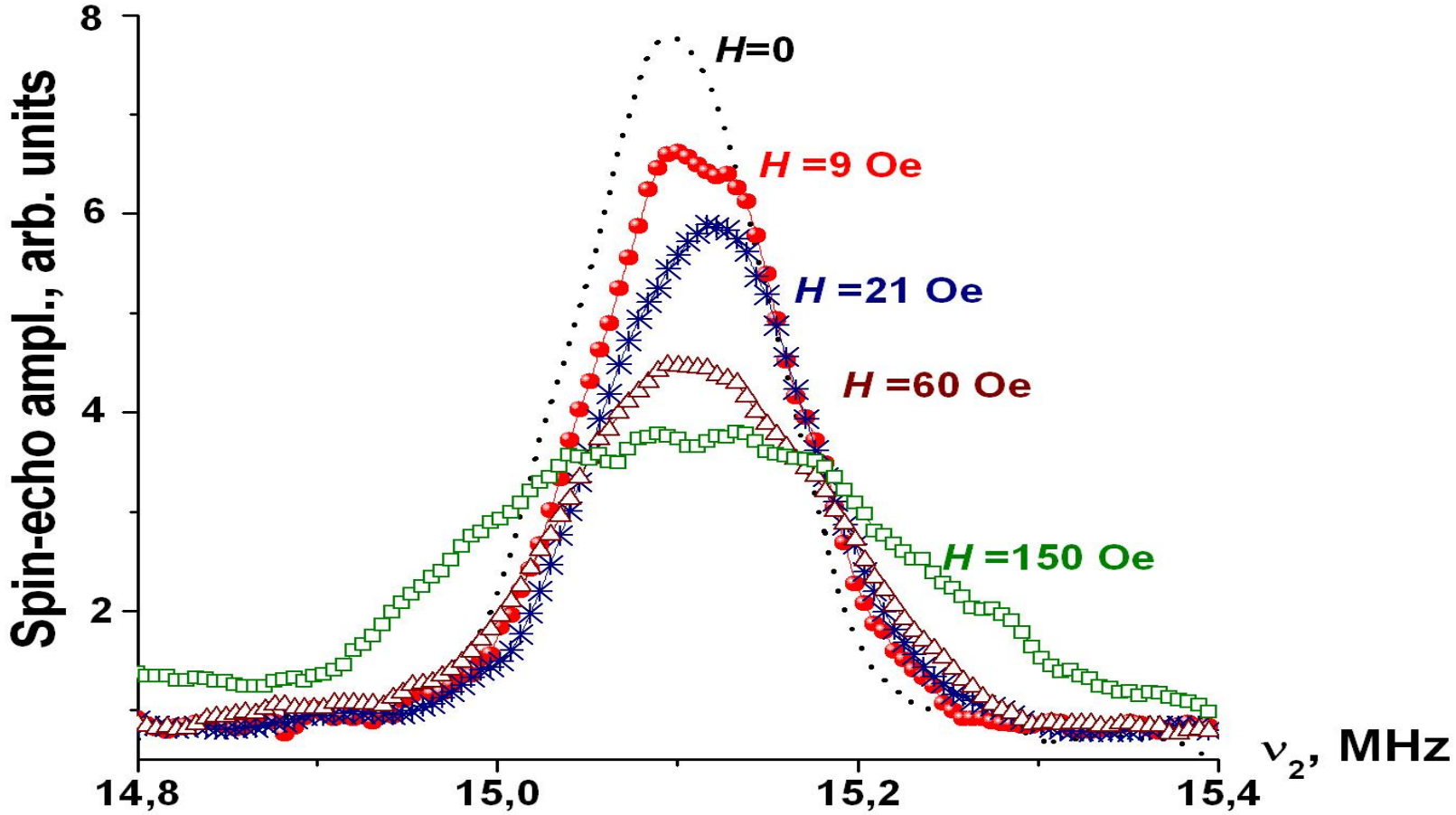
α-Bi_2O_3

V.I. Nizhankovskii, A.I. Kharkovskii, V.G. Orlov

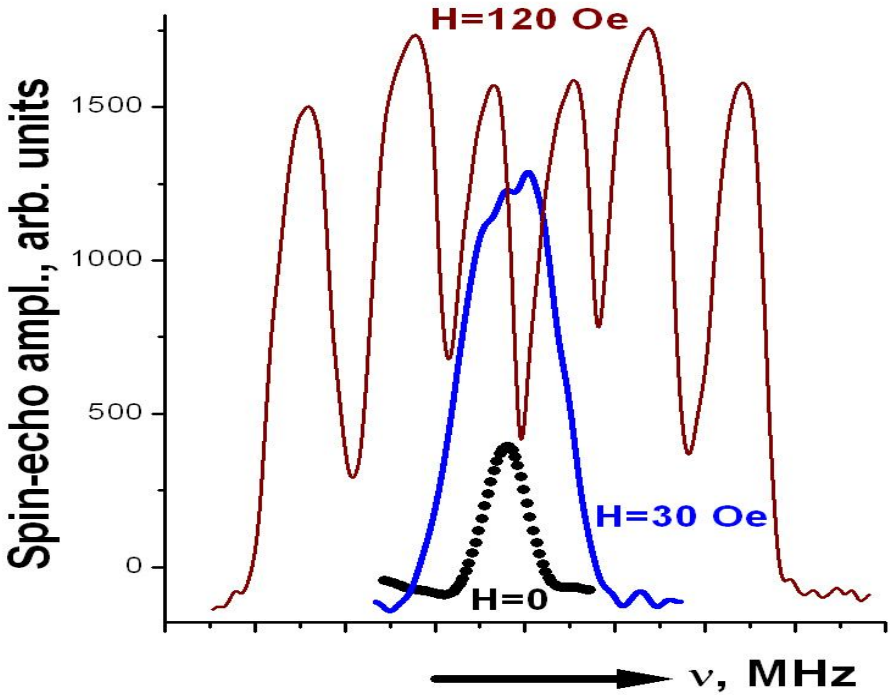
Ferroelectrics **279** (2002)



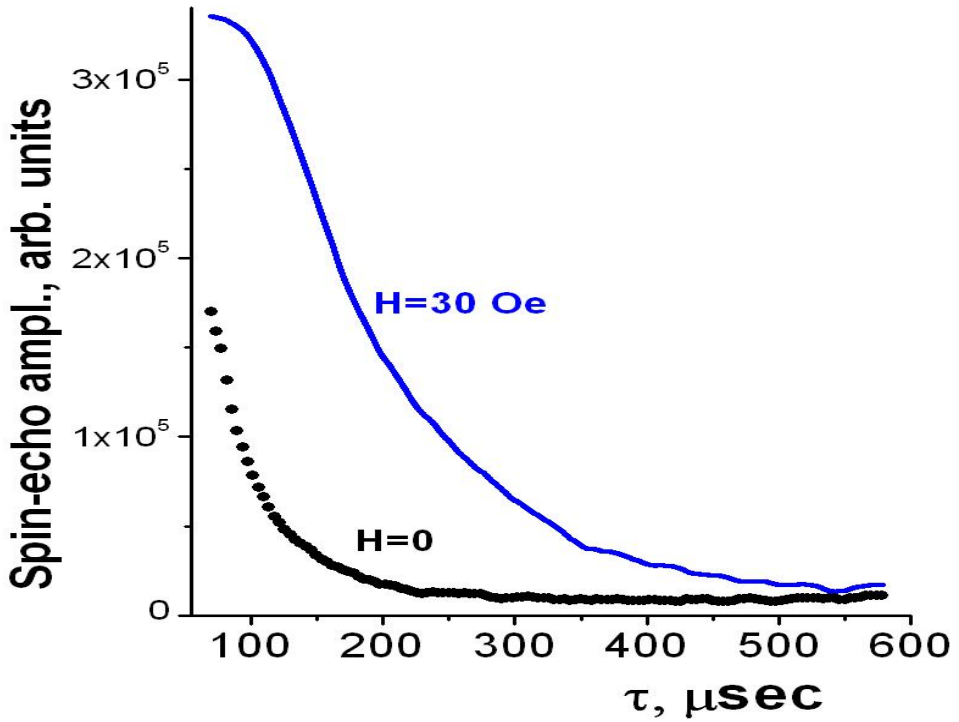
In_2Te powder 77K
In(1) ν_2=15.12 MHz



$Bi_4Ge_3O_{12}$

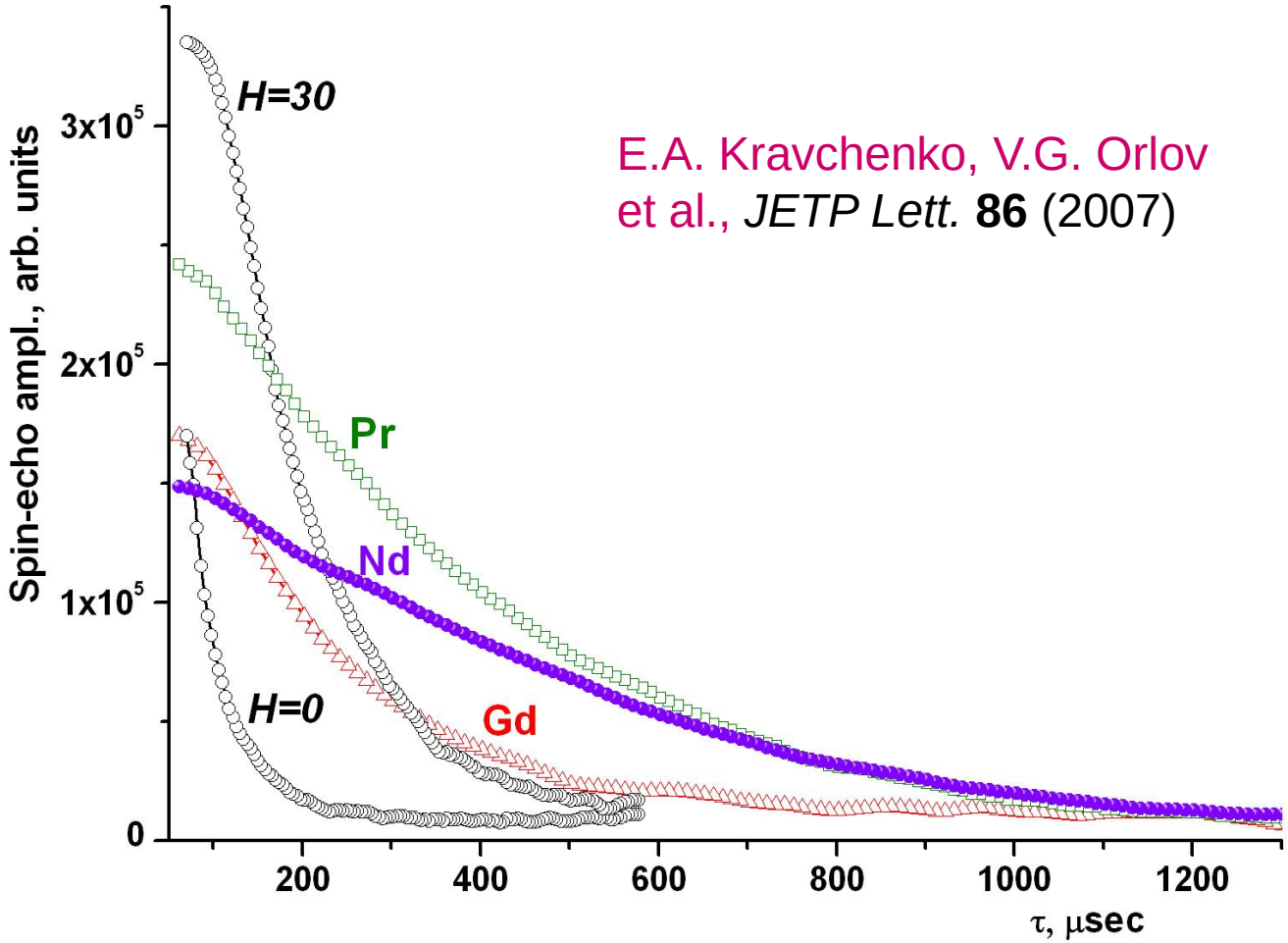


E.A. Kravchenko, Yu.F. Kargin,
V.G. Orlov, T. Okuda, K. Yamada,
JMMM **224** (2001)



E.A. Kravchenko, V.G. Orlov et al.,
JETP Lett. **86** (2007)

$Bi_4Ge_3O_{12}$



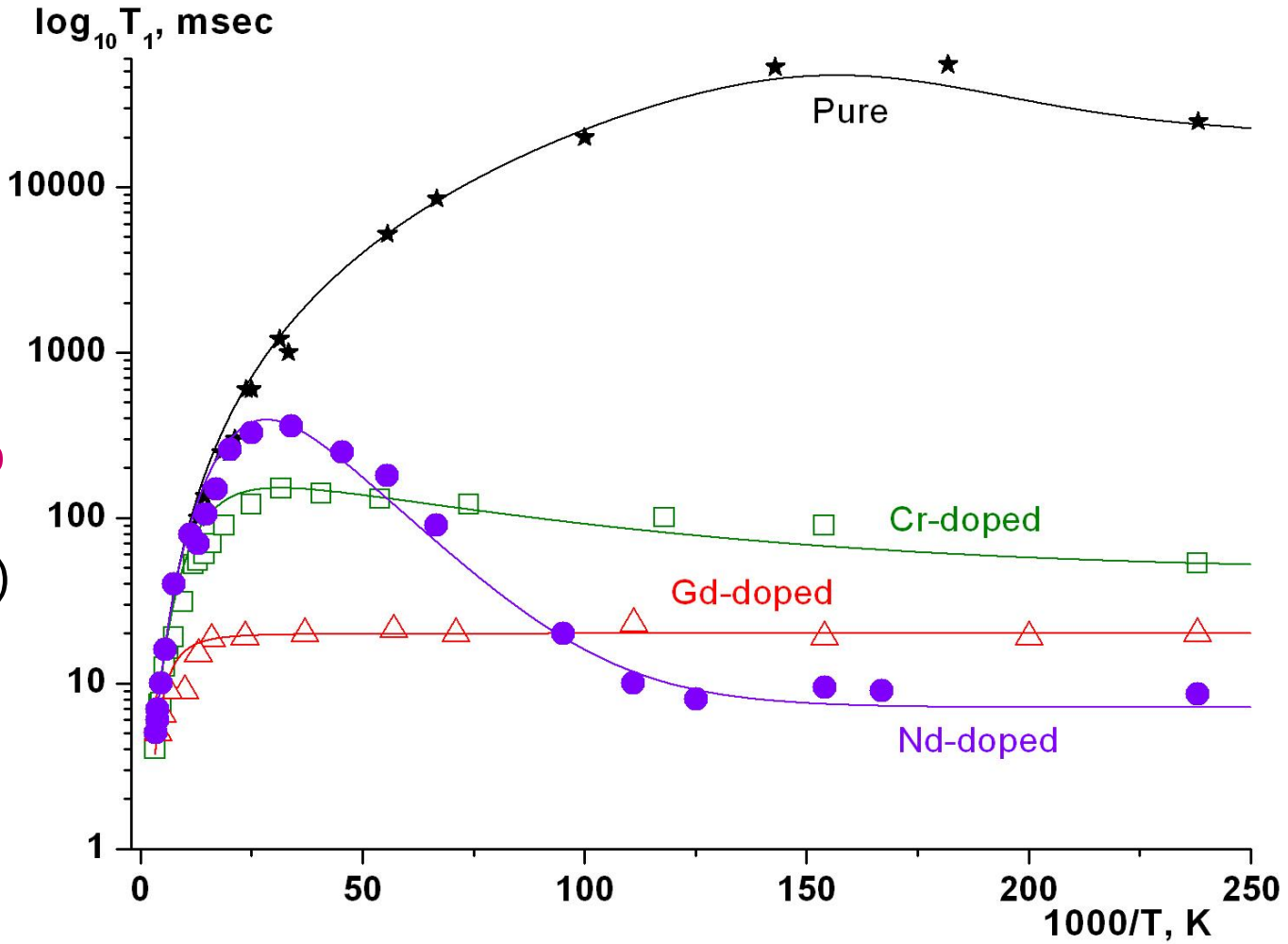
E.A. Kravchenko, V.G. Orlov et al., *JETP Lett.* **86** (2007)

$$I(\tau, H_{ext}, T) \propto A(\tau, H_{ext}, T) \cdot \exp(-\tau / T_2)$$

	Pure, H=0	Pure, H=30 Oe	Gd-doped	Nd-doped	Pr-doped
T_2 μsec	**50**	**100**	**220**	**400**	**400**

$Bi_4Ge_3O_{12}$

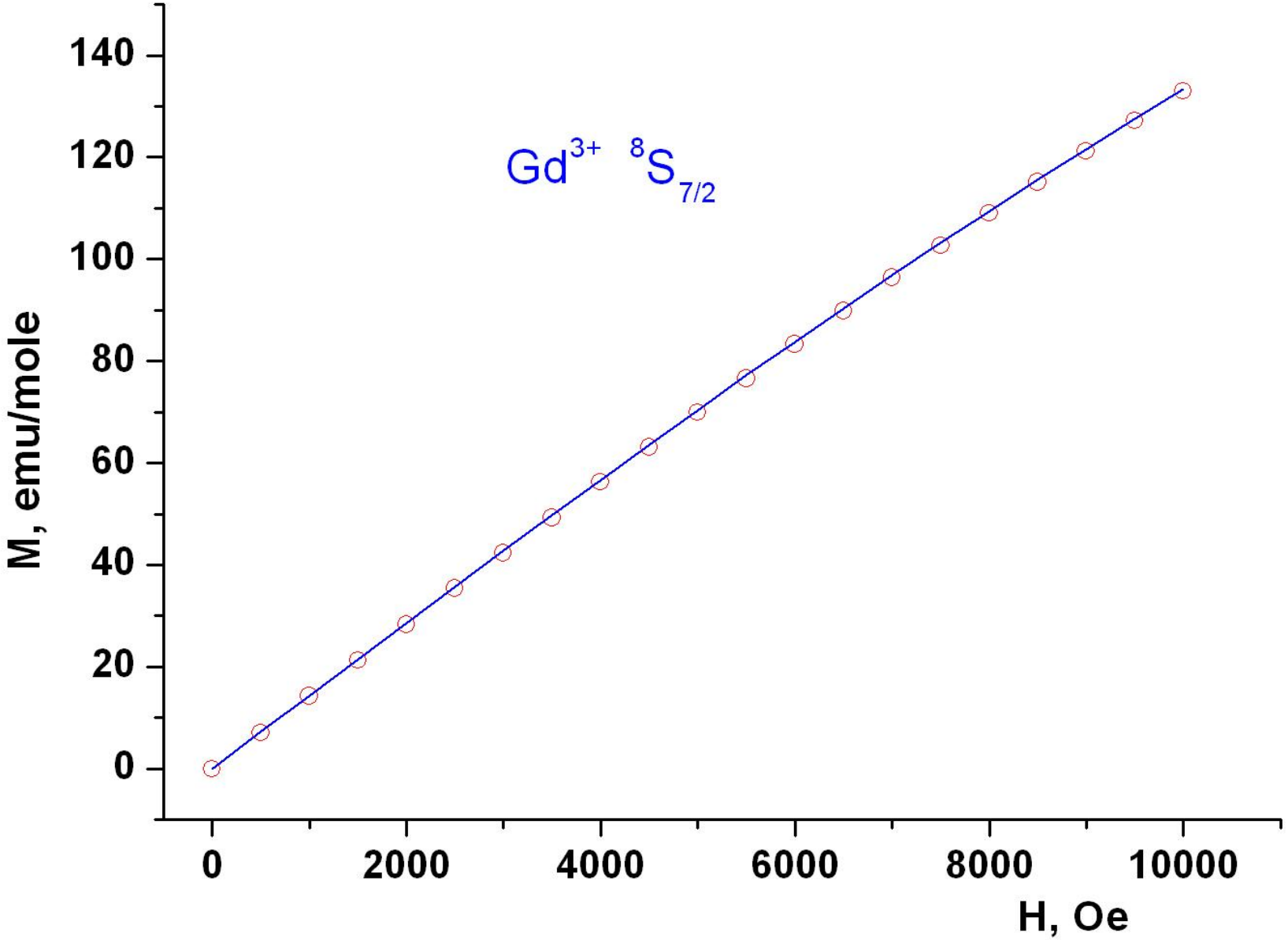
V.G. Orlov
T. Asaji
E.A. Kravchenko
et al.
JETP **137** (2010)



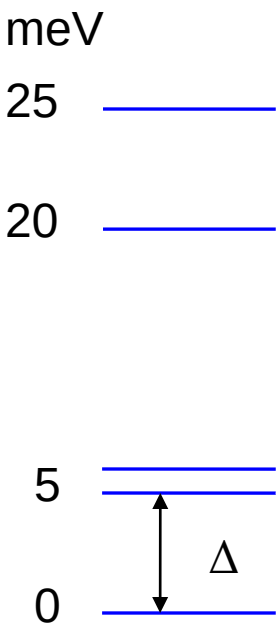
$$T_1^{-1} = (T_1^{-1})_l + (T_1^{-1})_e; \qquad (T_1^{-1})_l = b \cdot T^n; \qquad (T_1^{-1})_e = K \cdot \tau_e;$$

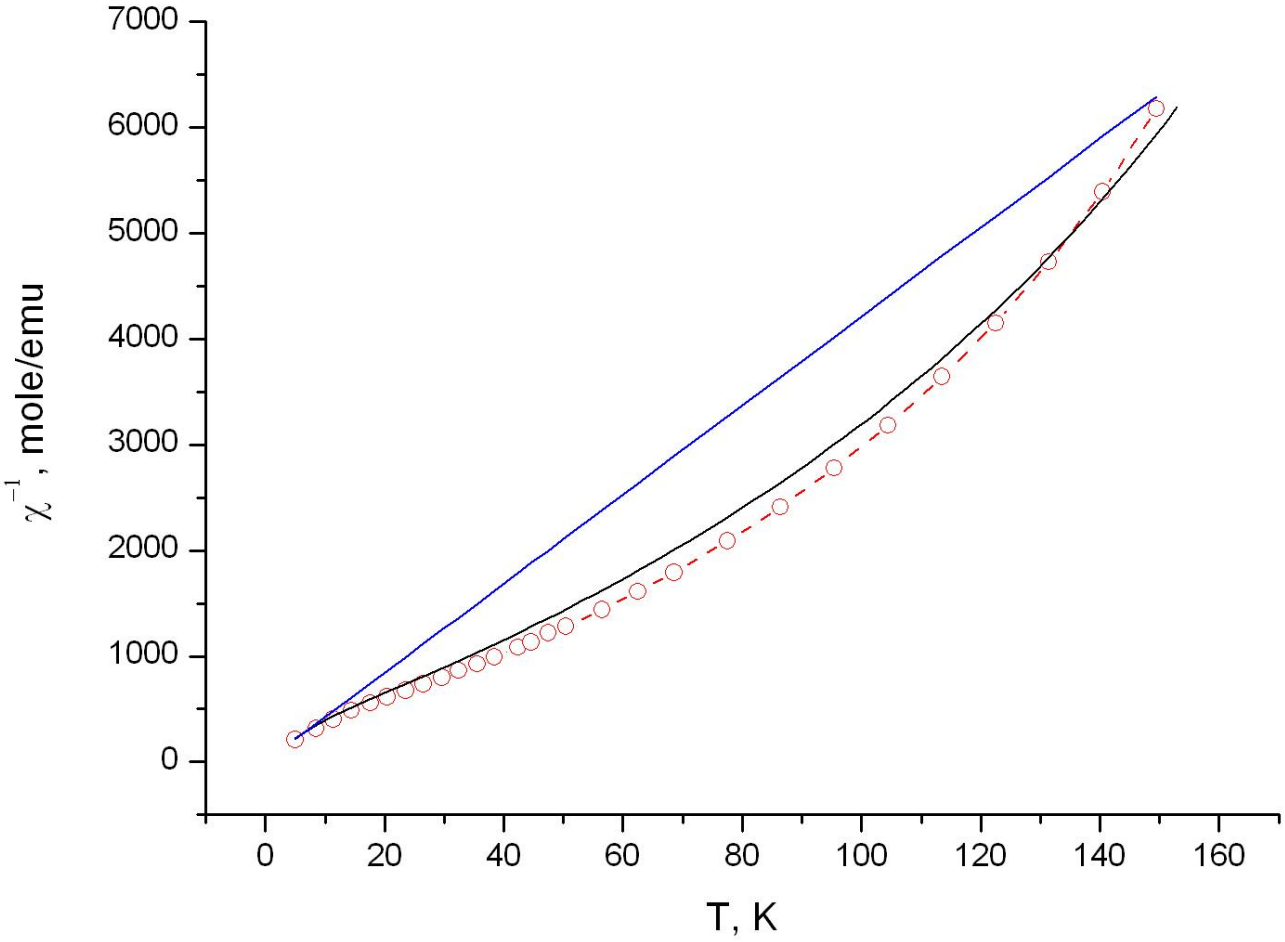
$$\tau_e^{-1} = T_{1e}^{-1} + \tau_s^{-1}; \qquad T_{1e} = a \cdot \exp(\Delta / T);$$

Gd-doped $Bi_4Ge_3O_{12}$



Nd-doped $Bi_4Ge_3O_{12}$





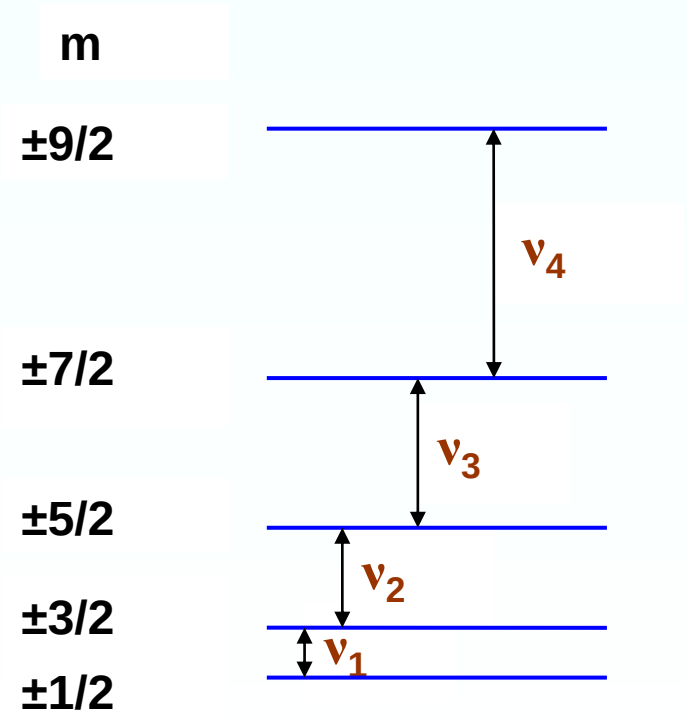
$$\hat{H}_{CEF} = B_2^0 O_2^0 + B_4^0 O_4^0 + B_4^4 O_4^4 + B_6^0 O_6^0 + B_6^4 O_6^4$$

Conclusion

- A strong influence of minor amounts of paramagnetic dopand atoms on the relaxation processes of the ^{209}Bi nuclear spin was observed for $Bi_4Ge_3O_{12}$ crystals.
- Both weak external magnetic field and paramagnetic atoms inserted into the crystal lattice of $Bi_4Ge_3O_{12}$ result in considerably increasing spin-spin relaxation time T_2.
- In pure $Bi_4Ge_3O_{12}$ crystal, intrinsic paramagnetic centers are found to exist which decrease the spin-lattice relaxation time T_1 at low temperature.
- The crystal electric field splits the ground multiplet of the paramagnetic dopants and results in non-monotonous dependence of spin-lattice relaxation time T_1 on temperature in the temperature interval 4.2-77 K.

$Bi_4Ge_3O_{12}$

^{209}Bi $I = 9/2$ $H = 0$



$$\hat{H}_Q = \frac{eQq_{z'z'}}{4I(2I-1)}[3I_{z'}^2 - I(I+1) + \frac{\eta}{2}(I_+^2 + I_-^2)]$$