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Deflagration, fronts of tunneling, and dipolar ordering in molecular magnets

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Although there is no exchange interaction in crystals of molecular magnets characterized by a giant effective spin S (S =10 for Mn_{12}, and Fe_8), magnetic field $B^{(D)}$ generated by magnetic moments $g\mu_B S$ of magnetic molecules creates energy bias $W^{(D)}$=$2Sg\mu_B B^{(D)}$ on a molecule that largely exceeds the tunnelling splitting Δ of matching quantum states on different sides of the anisotropy barrier. Thus the dipolar field has a profound influence on the processes of tunnelling and relaxation in molecular magnets. Both theoretical and experimental works showed a slow non-exponential relaxation of the magnetization in both initially ordered and completely disordered states since most of the spins are off tunneling resonance at any time. Recently a new mode of relaxation via tunneling has been found, the so-called fronts of tunneling, in which (within a $1d$ theoretical model) dipolar field adjusts so that spins are on resonance within the broad front core. In this "laminar" regime fronts of tunnelling are moving fast at speeds that can exceed that of the temperature-driven magnetic deflagration, if a sufficiently strong transverse field is applied. However, a "non-laminar" regime has also been found in which instability causes spins to go off resonance and the front speed drops. In a combination with magnetic deflagration, the laminar regime becomes more stable and exists in the whole dipolar window $0 \leq W \leq W^{(D)}$ on the external bias W, where the deflagration speed strongly increases. Another dipolar effect in molecular magnets is dipolar ordering below 1 K that has recently been shown to be non-uniform because of formation of magnetic domains. An object of current research is possible non-uniformity of magnetic deflagration and tunneling fronts via domain instability that could influence their speed.