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Magnetic Deflagration and Turbulent Fronts of Quantum Detonation in Molecular Magnets[1]

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Spin tunneling in molecular magnets such as Mn-12, boosted by a strong transverse field, should result in quantum effects in magnetic burning or deflagration. As the dipolar field can block or unblock tunneling resonances, a new possibility of propagating fronts of spin flips opens up that coexists with the standard magnetic deflagration. Here this process is being considered within a full three-dimensional model for an elongated magnet including heat conduction, spin tunneling, and dipolar field created by the changing sample's magnetization. It is shown that within the so-called dipolar window around tunneling resonances, where spin tunneling is possible, the deflagration front is non-flat and similar to a cone with the central part of the front leading. With increasing bias toward the right end of the dipolar window, dipolar instability makes the front turbulent. The latter destroys the exact resonance condition for spins in the front core that leads to fast propagating fronts within the simplified 1d theory. Nevertheless, the dependence of the front speed on the bias is similar to that of the 1d model and the speed reaches sonic values. The latter is a signature of detonation, although here the physical nature of the process is different.

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