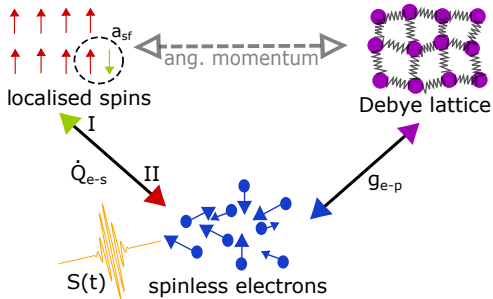


M3TM model concept



- decoupled systems of spinless electrons, phonons and localized spins in Mean field approximation (MFA)
- laser pulse heats electron system
- energy distribution to lattice and spins
(for FGT: no remagnetization so energy flow \dot{Q}_{es} (see next slide) unidirectional $e \rightarrow s$)
- spin flips (/magnon excitations) upon e-p scattering event from Elliott-Yafet spin mixing
- implicit angular momentum exchange between spins and lattice

M3TM equations

Dynamics of electronic, lattice and spin subsystems⁶

$$C_e \frac{dT_e}{dt} = g_{e-p}(T_p - T_e) + S_0 G(t, z) + \dot{Q}_{es}$$

$$C_p \frac{dT_p}{dt} = -g_{e-p}(T_p - T_e)$$

$$\frac{dm}{dt} = Rm \frac{T_p}{T_C} \left(1 - \frac{m}{B_S \left(\frac{J_m}{k_B T_e} \right)} \right)$$

$C_{e(p)}$ electron (phonon) heat capacity

g_{ep} electron phonon coupling

$\dot{Q}_{es} = Jmin/V_{at}$ energy exchange of spin-and electron system

$$R = 8 \frac{a_{sf} g_{ep} T_C V_{at}}{\mu_{at} k_B T_{Deb}^2}$$

magnetization rate parameter

a_{sf} spin flip probability upon e-p-scattering event

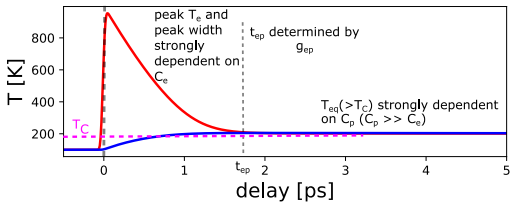
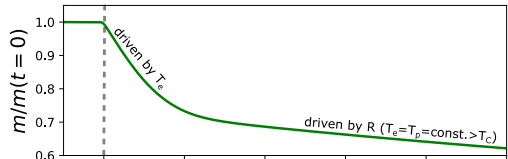
B_S Brillouin function for effective spin S

parameter impact

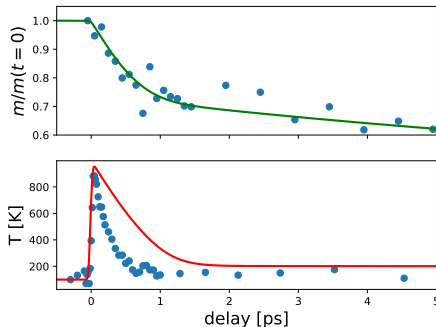
easy first attempt: take parameters used before for a very similar model

Model	symbol	meaning	estimate	unit
M3TM	μ_B	Atomic magnetic moment ^a	1.47×10^{-23}	Am ²
	γ	Electron heat capacity constant ^b	1561	Jm ⁻³ K ⁻²
	V_{at}	Atom spin density volume ^a	1.68×10^{-29}	m ³
	T_C	Curie temperature ^b	191	K
	σ	pulse width ^b	85	fs
	g_{ep}	Electron-phonon relaxation rate ^c	1.33×10^6	Jm ⁻³ K ⁻¹ ps ⁻¹
	C_p	phonon heat capacity ^c	6.28×10^6	Jm ⁻³ K ⁻¹
	E_D	Debye energy ^c	6.49×10^{-21}	J
	α_{ef}	Spin-flip probability	0.14	unity

Lichtenberg et al., arXiv:2206.01452v1

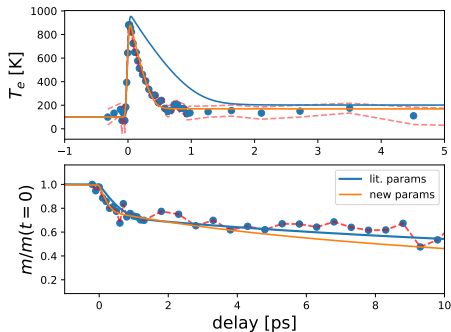


Fitting with literature parameters



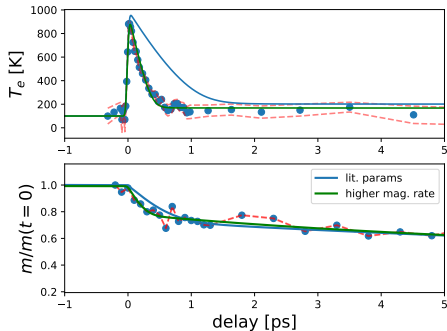
- parameters used to fit magnetization dynamics in paper cited above
- good fit of mag dynamics
- electron dynamics ≈ 3 times slower than in experiment
- equilibrium temperature too high in simulations

first try of fit adjustment



- increase c_p by a factor of 1.5 to adjust equilibrium magnetization
- increase g_{ep} by a factor of 3 to speed up electron dynamics
- decrease spin flip probability by a factor of 3 to stabilize magnetization dynamics
- → **electron dynamics well reproduced**
- **magnetization rate after e-p-equilibration seems to fast**
- **next try: increase a_{sf} at the cost of pump power to match the magnetization behaviour for $t > \tau_{ep}$**

state at the moment



- both T_e and m are nicely reproduced
- lattice dynamics data important to validate use of g_{ep} , c_p
- instead of rate parameter, also c_e can be changed to adapt peak of T_e and magnetization rate
- investigation for multiple fluences important (I'd like to talk again about the initial conditions and repetition rate/effective starting temperature)