# Antiferromagnetic THz oscillations excited by sub-picosecond structured laser pulses

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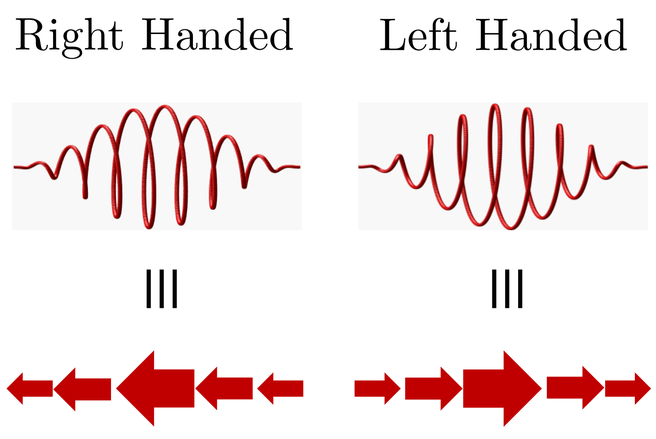
## Abstract

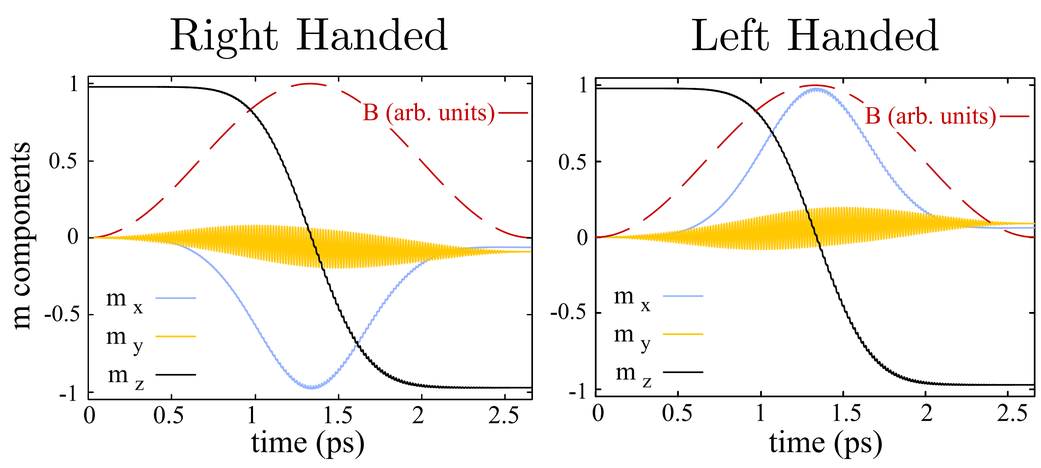
Ultrafast laser sources provide unique tools to control the magnetic properties of materials, both spatially and temporally. Since the pioneering work on ultrafast laser induced demagnetization [1], femtosecond (fs) laser pulses have been widely used in theoretical and experimental studies of femtomagnetism [2-4]. Recent proposals using structured laser beams have enlightened the possibility to generate intense femtosecond magnetic fields (B), spatially isolated from the electric field (E) [5-7]. Such configuration offers a unique opportunity to perform pure magnetic interactions with intense fs B-fields. Here we numerically studied the effect of such interactions on a uniaxial antiferromagnet showing the excitation of self-sustain oscillations despite the driver frequency is orders of magnitude above the resonance modes.

## Drift field

The effect of a fast oscillating circularly polarized magnetic field is equivalent to a drift field for the slow dynamics in ferromagnets [8].

$$\frac{d\vec{m}_0(t)}{dt} = \vec{m}_0(t) \times \vec{B}_d. \qquad \vec{B}_d = \frac{\gamma}{2\omega} \sin\phi_0 \left(\vec{B}_x \times \vec{B}_z\right)$$




## Results

We have perform full micromagnetic simulations using a modification of the software package MuMax[3] so as to include a two sublattices model.

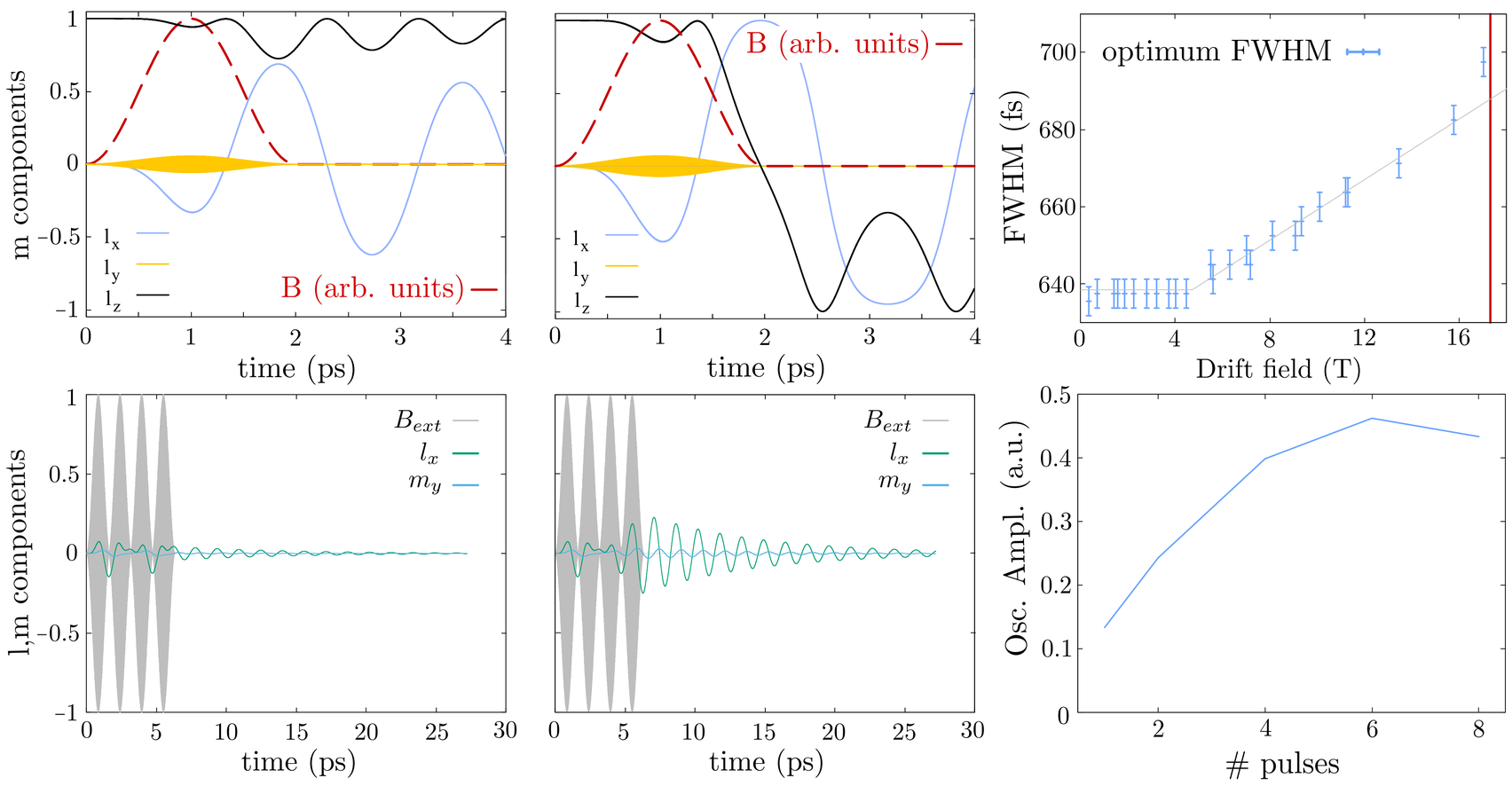
The drift field mechanism can also be applied to antiferromagnets.

The inertia imprinted to the antiferromagnet due to the drift field can sustain self-oscillations

Oscillations amplitude depends on the pulse duration: there is an optimum pulse width.

The amplitude can be increased with consecutive pulses, but required proper timing

Applying pulses with different helicity can inhibit the excitation




## Conclusions

It is possible to excite THz self-sustain oscillations in antiferromagnets using infrared structured laser pulses exploiting the non-linear response previously found in ferromagnets [8]. This effect has enough degrees of freedom to allow a fine tuning of the excitation characteristics, allowing to accumulate or inhibit the stimulus, thus paving the way to build artificial neurons.

## References

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