While publishing the resuts of your simulations based on this code please reference C.S.Chang et al., *Appl. Phys. Lett.* **104**, 032408 (2014).

This worksheet calculates characteristics of excitation and reception of Damon-Eshbach spin waves in thin ferromagnetic films by microscopic coplanar stripline antennas.

SI units are used in this code!

Film thickness in metres:

$$L := 110\cdot 10^{-7}\cdot 10^{-2}$$

Saturation magnetisation in A/m:

$$M0 := 886\cdot 4\cdot \pi\cdot 80 = 8.907\times 10^{5}$$

in Gauss this is equivalent to:

$$\frac{M0}{80} = 11133.80436$$

Circular frequency in rad/sec:

$$\omega := 2\cdot \pi\cdot 10\cdot 10^{9}$$

In GHz this is equivalent to:

$$\frac{\omega}{2\cdot \pi\cdot 10^{9}} = 10$$

If your material is not a continuous film, but a stripe of a finite width in the direction along the antenna, you may account for this approximately, by adding some demagnetizing field to the applied field. A valid estimation for the demag field value is a mean value of the demagnetising field of a stripe of an infinite length. it may be calculated with OOMMF (use the "Fast Pipe" option for a quicker result) or with LLG Micromagnetic Simulator. The Demagnetising field of the stripe is entered in A/m:

$$H_{dem} := 40\cdot 80 = 3.2\times 10^{3}$$

In Oe this is equivalent to:

$$\frac{H_{dem}}{80} = 40$$

Gyromagnetic ratio in (rad/s)/(A/m):

$$\gamma := \frac{2\cdot \pi\cdot 2.8\cdot 10^{6}}{80} = 2.199\times 10^{5}$$

In Hz/Oe this is equivalent to:

$$\frac{\gamma\cdot 80}{2\cdot\pi} = 2.8\times 10^{6}$$

Gilbert alpha:

$$\alpha_G := 0.007$$

The width of the signal and the ground lines of the coplanar line in meters

$$w := 1.5\cdot 10^{-4}\cdot 10^{-2} = 1.5\times 10^{-6}$$

The width of the gaps between the signal and the ground lines:

$$\Delta := w\cdot 0.8$$

Enter here the width of the Permalloy stripe in meters

$$ws := 50\cdot 10^{-6}$$

Enter the dielectric constant for the stripline substrate

$$\varepsilon_s := 11$$

Note that it is assumed that the characteristic impedance of the stripline is 50 Ohm!

Enter here the distance between the axes of the input and output antennas in meters:

$$l_d := 30\cdot 10^{-6}$$

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Enter the coordinate range along the direction of wave propagation over which you wish to calculate spin wave amplitude. zs is the normalised co-ordinate, the respective absolute co-ordinate is zs*ws.

$$zs := -20, -19.9 .. 20$$

Guess value for the internal field:

$$H0 := 80\cdot 1000$$

Calculated FMR (*k*=0) internal field for the given frequency:

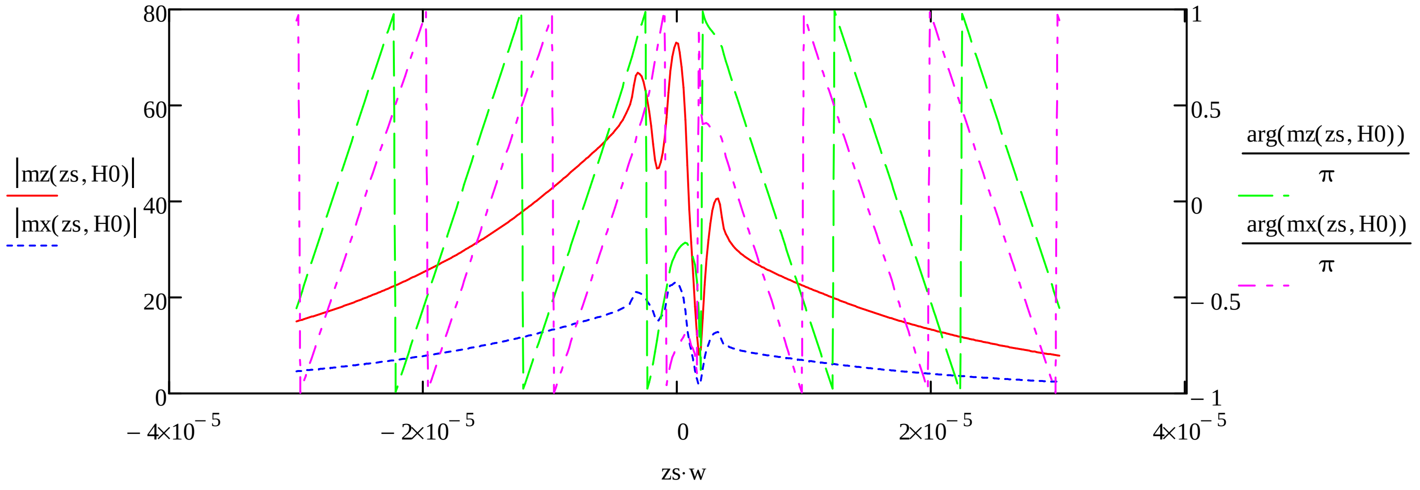
$Hr := \text{root}\left[\sqrt{H0\cdot(H0+M0)} - \frac{\omega}{\gamma}, H0\right] = 8.377\times 10^{4}$ $\frac{Hr}{80} = 1.047\times 10^{3}$

$H_B := \frac{\omega}{\gamma} - \frac{M0}{2} = -1.596\times 10^{5}$ $\frac{H_B}{80} = -1.995\times 10^{3}$

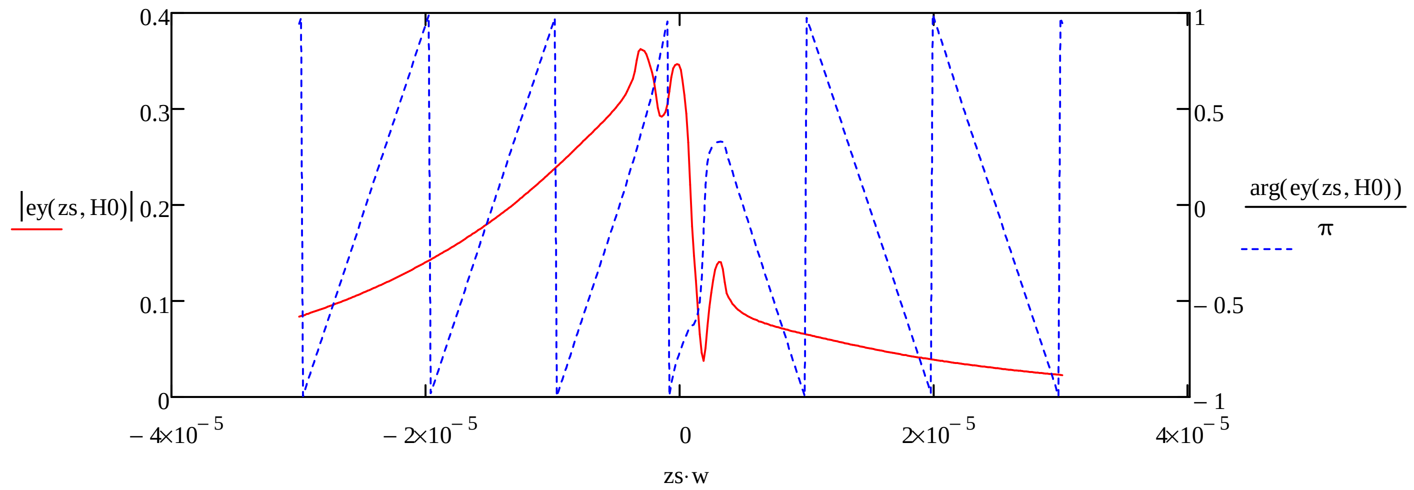
Enter here some field value H0 for which you wish to calculate the dynamic magentisation profile for travelling DE waves. The excitation antenna axis is at zs=0. mz is the in-plane magnetisation component, mx is the out-of-plane one, and ey is the electric field of the wave.

$H0 := Hr\cdot 0.7$

Dynamic magnetisation as a function of in-plane co-ordinate. Units along the horizontal axis: meters



The electric field of dynamic magnetisation (it is parallel to the antenna)



$-ez$

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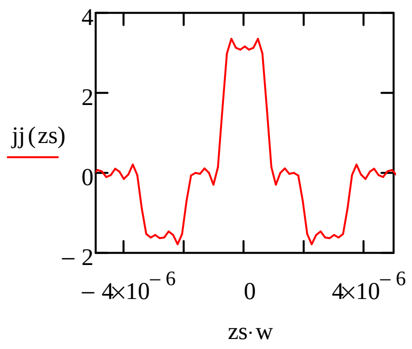
microwave current density distribution across CPW via inverseFourier transform



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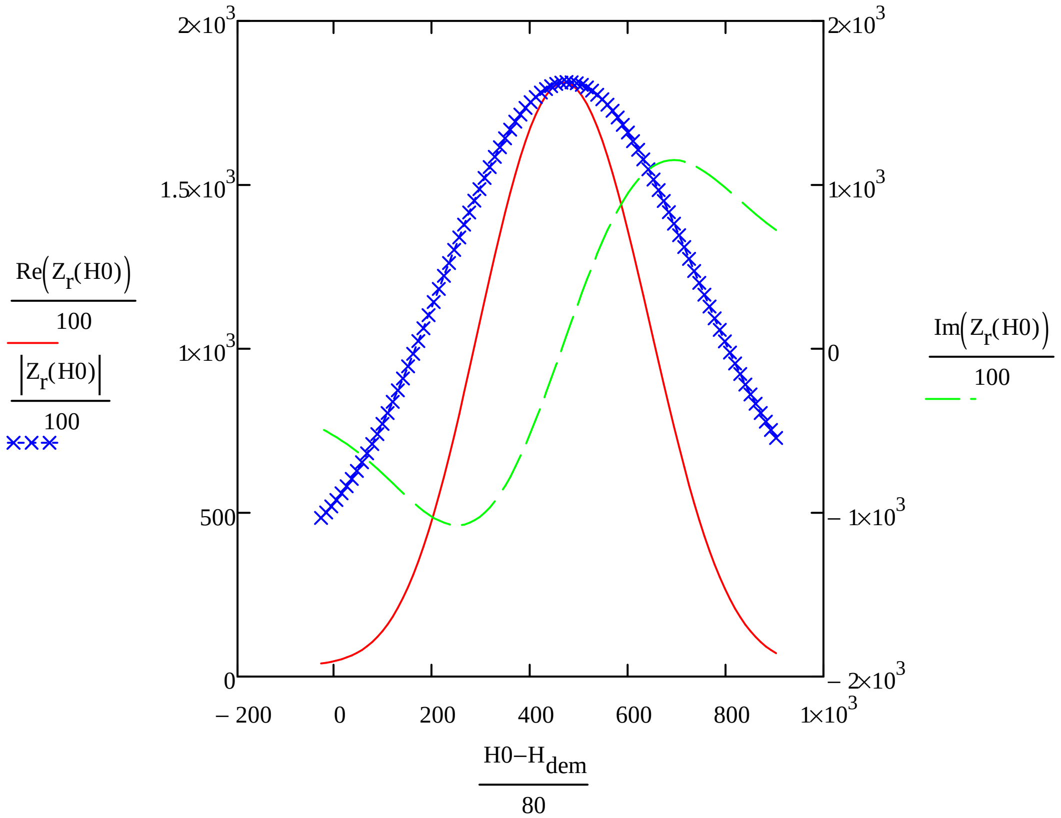
All characteristics are calculated applied-field resolved for a given frequency. Please contact me if you need frequency-resolved traces for a given value of the applied field.

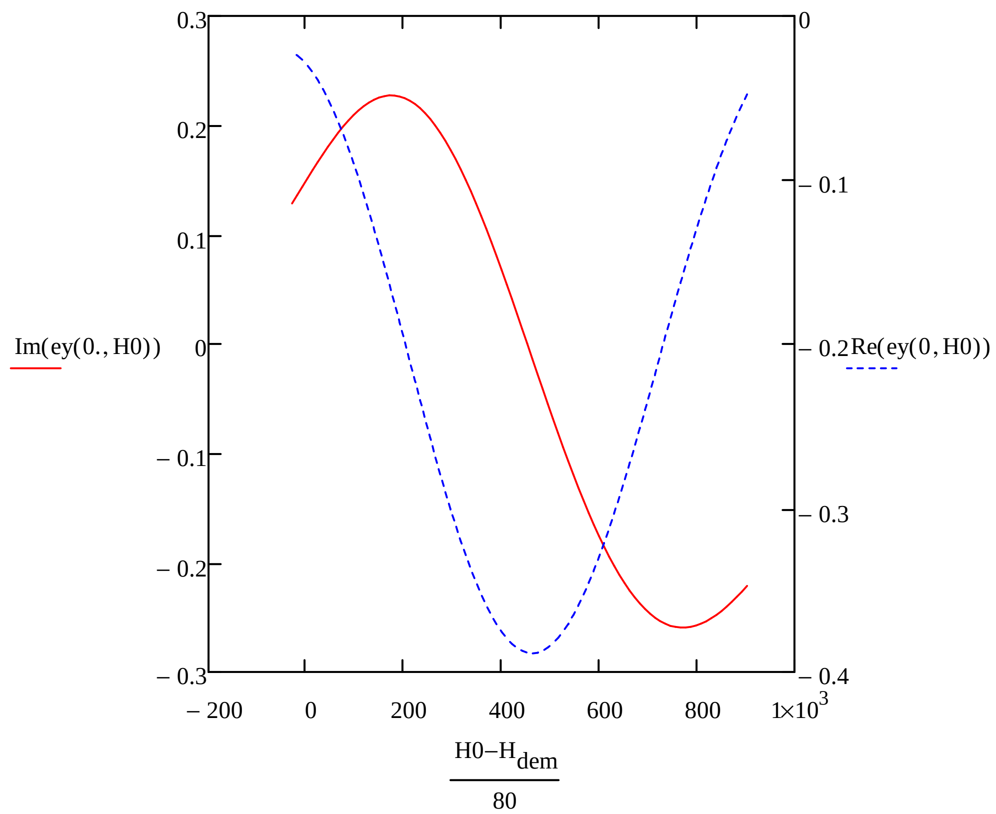
The applied field range:

$H0 := Hr\cdot 0.9, Hr\cdot 0.89 .. Hr\cdot 0.01$

The radiation resistance of the antenna in Ohm/cm vs. the internal field in Oe



The electric field of spin waves on the axis of the excitation antenna



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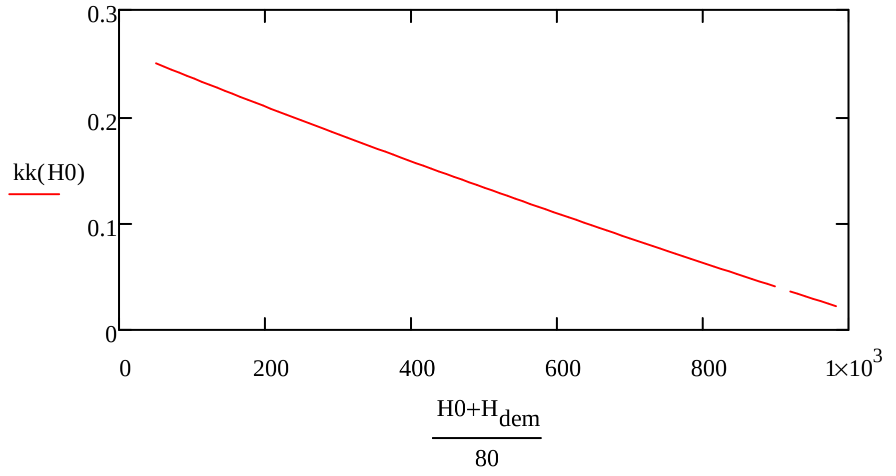
Field-resolved Damon-Eshbach spin wave dispersion:



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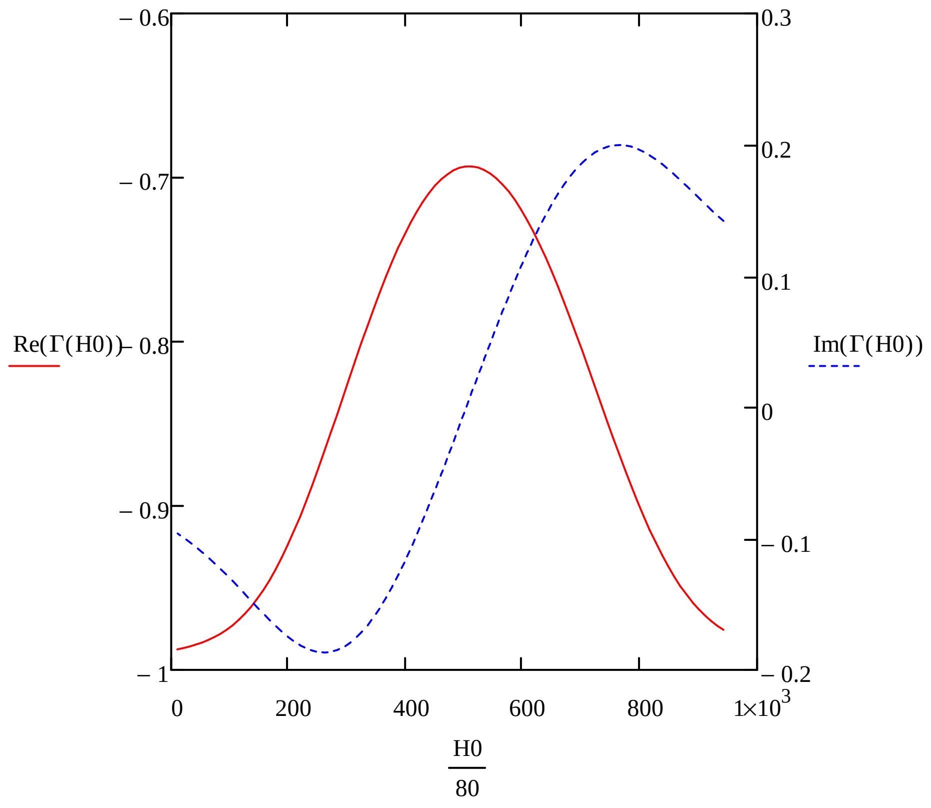
Microwave reflection coef from the input of the excitation antenna:



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Transmission coefficient of the whole fixture as a function of the applied field (left-hand axis). Beat of the transmitted signal with the signal of the direct inductive coupling between the two antennas (right-hand axis, given here for illustration purposes). The amplitude of the direct coupling is assumed to be 1 and field-independent.