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Atomistic calculations of the spin wave spectrum of YIG

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The spin Seebeck effect occurs in magnetic insulators where a gradient in temperature causes a spin current to flow through the material. The prototypical material in which this effect has been studied is Yttrium Iron Garnet (YIG). This material is ferrimagnetic, where Fe moments exist in two different environments. Analytic theories concerning spin Seebeck effect have often simplified the representation of YIG to a simple ferromagnet, where the magnetization is assumed to be that which is macroscopically measured. However the spin wave spectrum of YIG is radically different to that of a simple ferromagnet, containing 20 spin wave modes [1]. Early experiments found a strong temperature dependence of some of the spin wave modes and it was observed that high frequency modes could shift to much lower frequencies [2]. Recent studies have identified that the multiband spectrum should be better understood to improve the understanding of the SSE at room temperatures [3]. We have implemented a microscopic model of YIG using the techniques of atomistic spin dynamics (ASD). This many-body numerical approach is beyond analytic theories and also a significant improvement over micromagnetic approaches for such problems. We calculate the spin wave spectrum of YIG as a function of temperature and applied magnetic field to find the characteristic changes in the frequency and amplitudes of the spin wave modes. Such effects may be important in the understanding of spin Seebeck effect, especially at short length scales such as near interfaces.

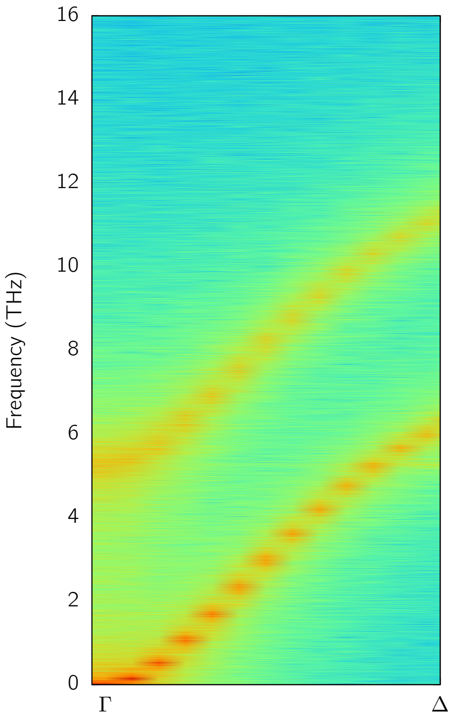

Figure 1: Example low temperature spin wave dispersion for YIG calculated from atomistic spin dynamics.

References

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