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Abstract

Direct Detection of Multiple Backward Volume Modes in Yttrium Iron Garnet at Micron Scale Wavelengths †

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Spinwave propagation in yttrium iron garnet (YIG) films has a long history [1] but has recently attracted renewed attention due to the observation of an unusual coherent phenomenon [2] in a heavily pumped magnon gas in the backward volume geometry [3] where the spectrum displays a minimum. The effect has been termed Bose condensation or, from a more classical perspective, a Rayleigh-Jeans condensation. The time dependence of the observed behavior has recently been simulated and shown to arise from a dynamic equilibrium state of a classical magnon gas interacting through three and four magnon scattering processes [4].

The measurements cited above utilized the Brillouin scattering technique which has the advantage allowing studies over a broad spectral range, but for which the resolution is limited. To better understand the properties of magnons in the vicinity of the minimum in the spectrum (where the condensation occurs) we have patterned a set of wave-vector-specific, multi-element, ″ladder″ antennas, with which we can *directly couple* spin waves with micron and submicron wavelengths to a microwave generator and determine the resulting absorption. Our measurements, which are shown in the Figure 1, were carried out on a 2.84 micron film and have resolved the dispersion relations of multiple (ten or more depending on the wavelength) low lying backward volume modes for wavelengths of 10, 3, 1 and 0.6 microns. Overall the data are in excellent agreement with theoretical predictions based on a Heisenberg model Hamiltonian [5]. Data are also compared with solutions of Landau-Lifshitz equation that include both dipolar and exchange effects [6].

We will also report our recent experiments in which we use our one micron antenna to detect *coherent spin waves* at the minimum which arise via a Suhl two magnon decay processes where we pump at twice the detected frequency; this is the first time such modes have been detected to our knowledge. Other parametric pumping experiments will also be described.

The techniques developed in this work now facilitate the characterization of spin waves at length scales limited only by available lithography and with a spectral resolution that greatly exceeds that of Brillouin scattering.

Dispersion curves of magnons in a 2.4 micron thick film in the backward volume geometry.

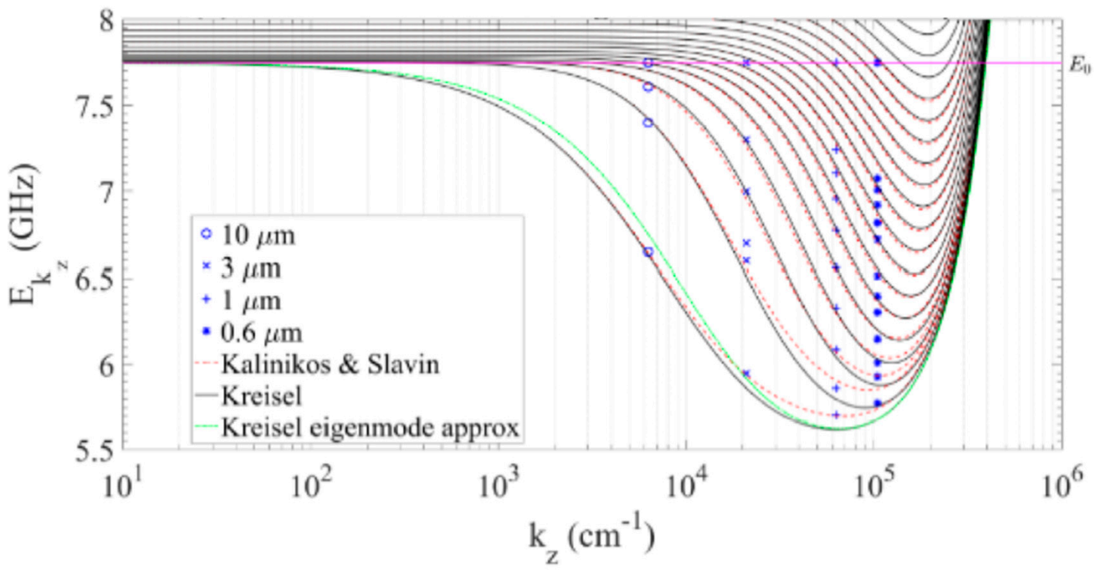

Figure 1. Dispersion curves of magnons in a 2.4 micron thick film in the backward volume geometry.

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