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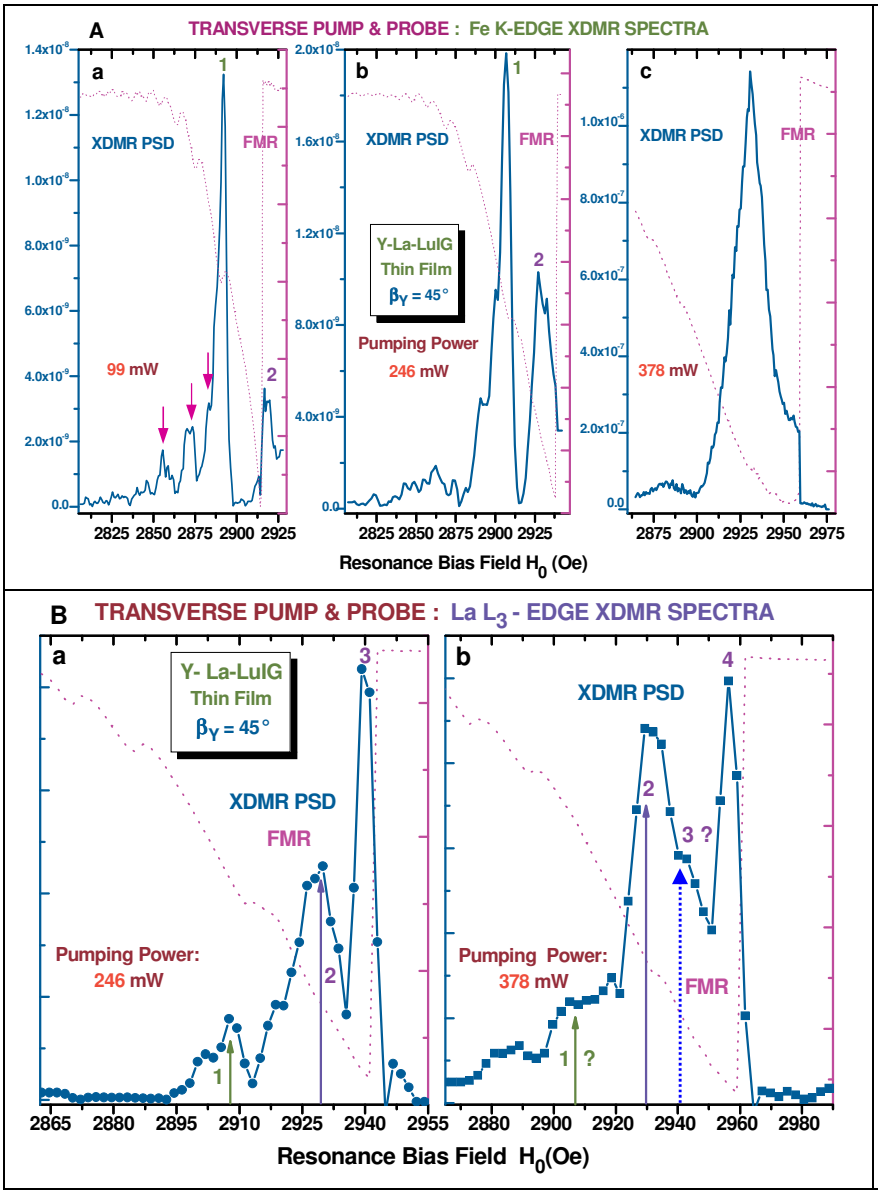
1. XDMR SPECTRA OF Y-La-LuIG THIN FILMS: A PUZZLING CASE

It was basically the aim of proposal HE-3432 to try to clarify what was the origin of the puzzling differences which we had previously observed in the XDMR spectra of two iron garnet thin films grown by liquid phase (LPE) on GGG substrates: whereas the stoichiometry of the first film did correspond to pure yttrium iron garnet (**1** =YIG = $Y_3Fe_5O_{12}$), yttrium was partly substituted with lanthanum and lutetium in the second (**2** = Y-La-LuIG = $\{Y_{1.3}La_{0.47}Lu_{1.3}\}$ $Fe_{4.84}O_{12}$). It may be relevant to mention here another difference which is that film **1** was grown on oriented GGG single crystals cut parallel to the (111) planes, whereas film **2** was grown on GGG wafers cut parallel to the (100) planes. Given that La^{3+} and Lu^{3+} were both "*diamagnetic*" ($^1S_0$) rare earth cations, and that the static XMCD spectra recorded either at the Fe K-edge or at the Y L-edges (for films **1** and **2**) and at the La L-edges (film 2) did look fairly similar [1], we were not prepared to anticipate any significant difference in the XDMR spectra recorded on both films as this turned out to be the case for the Fe K-edge XDMR spectra recorded on film **2** in the longitudinal detection geometry (LOD) [2,3]. A tentative interpretation was proposed for this puzzling result: it was based on the different nature and dynamics of the ***collective*** excitation processes (exchange spin waves *versus* collective orbital ordering processes) which may take place at the iron sites when the spectra are recorded under very high pumping power. This looks quite possible if one takes into consideration structural defects caused by the faily different ionic radii of the La^{3+} cations (too large) and Lu^{3+} cations (too lsmall) which poorly match the basic YIG lattices. The non uniform distribution of the rare earth cations induces local fluctuations in the lattice parameter, dynamical strains and stresses resulting in the excitation of magnetoelastic waves [4]. Recently, the reality of such effects was confirmed by a careful FMR study of film **2** which revealed a growth anisotropy considerably larger than in film **1**. This prompted us to envisage a variety of test experiments which could help us in clarifying the exact nature the mechanism affecting the Fe K-edge XDMR spectra of film **2**. Recall that the latter spectra give us a unique information regarding the precession dynamics of *orbital* magnetization components located at the tetrahedral coordination sites of iron (24d). Recall that Orbital magnetization components are inherently most sensitive to magneto-elastic couplings. Unfortunately, the beamtime allocated to this project was much too short to allow us to carry out all the time-consuming experiments we had in mind and we rapidly realized that we had to restrict ourselves to only one single experiment which we report below.

2. RESULTS

Owing to recent progresses made in XDMR instrumentation which allow us now to record high quality spectra in the *transverse* detection geometry (TRD), we finally decided to compare XDMR spectra recorded on film **2** at the Fe K-edge and at the La L_3-edge under increasing pumping power. Another advantage of the superheterodyne detection method developed at the ESRF is the possibility to recover some information regarding the relative phase of the precessing moments.



We could hardly have anticipated the nice splitting of the Fe K-edge XDMR line reproduced in Fig. 1A. Even though spectrum (a) was recorded under a rather high pumping power (99 mW), the linewidth of the split lines is considerably narrower than that of the FMR signal which was recorded simultaneously. Arrows point to satellite resonances assigned to magnetostatic modes. Increasing the pumping power up to 375 mW, led the split lines labeled 1 and 2 to merge progressively together and to saturate as well. A vector analysis also revealed that the phase of signatures labeled 1 and 2 in Fig. 1A(a) were unambiguously shifted by nearly 180° [4].

As illustrated with Fig 1B, the XDMR spectra recorded at the La L_3-edge split differently: the resonance previously labeled 1 in Figs. 1A(a,b) is getting very weak, whereas one may identify two high-field signatures labeled respectively 2 and 3. Vector analyses again confirm the phase inversion of the weak signature labeled 1 with respect to signatures labeled 2 and 3 that apparently have more or less the same phase [4].

We thus expect the XDMR spectra recorded at the La L-edges to be dominated by spin magnetization components precessing in antiphase with both the spin and orbital magnetization components precessing at the tetrahedral iron sites (24d). Exchange interactions should, however, weakly couple in a different way the spins precessing at the dodecahedral lanthanum (24c) sites with the spin precessing at the antiferromagnetically coupled (24d) or (16a) iron sites. This may well cause the La L-edge and Fe K-edge XDMR spectra to split into lines of systematically unequal intensity as discussed elsewhere [4].

REFERENCES

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