X-ray Detected Magnetic Resonance:
First evidence of forced precession of polarized orbital components

X-ray Detected Magnetic Resonance (XDMR) is a novel spectroscopy in which X-ray Magnetic Circular Dichroism (XMCD) is used to *probe* the resonant precession of the magnetization caused by a strong microwave *pump* field $\mathbf{h_1}$ orthogonal to the static bias field $\mathbf{H_0}$. XDMR was measured on exciting the Fe K-edge in a thin film of Yttrium Iron Garnet (YIG) grown by liquid phase epitaxy along the (111) direction of a Gadolinium Gallium Garnet (GGG) substrate [1]. This experiment carried out on the ESRF beamline ID12 was performed in the *longitudinal* geometry, *i.e.* the wavevector $\mathbf{k_X}$ of the incident, circularly polarized X-rays being set parallel to the bias field $\mathbf{H_0}$. The XDMR signal was recorded in the X-ray fluorescence excitation mode. The microwave power could be increased up to 30 dBm at 9.5 GHz. Given the narrow FMR linewidth of the YIG film (ΔH_{fwhm} = 3.64 Oe), resonant pumping occurred in a non-linear *foldover* regime.

The XDMR signal was detected as modulation side-bands of the X-ray macrobunch repetition frequency F = 710.084 kHz. The magnitude of the XDMR signal was peaking *ca.* 20 dBV above the noise floor. The real and imaginary parts of the spectrum confirmed the expected inversion of the XDMR signal when the helicity of the incident X-ray beam was changed from *Left* to *Right*. After proper renormalization, the small differential cross-section: $\Delta\sigma_{XDMR} \approx 1.34 \cdot 10^{-5}$ would yield a critical precession angle of $\theta_{10} \approx 3.5°$ for precessing magnetization at the Fe sites.

Since the effective operators accounting for XMCD at a K-edge are exclusively of *orbital* origin, then the measured Fe K-edge XDMR signal produces clear evidence of the forced precession of magnetically polarized *orbital* components. This experiment led us to the conclusion that, in YIG, there should be *no* dynamical quenching of the magnetic orbital polarization components.

Reference

[1] J. Goulon, A. Rogalev, F. Wilhelm, N. Jaouen, C. Goulon-Ginet, G. Goujon, J. Ben Youssef and M.V. Indenbom, *JETP Letters*, **82**, (2005) 791-796.