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Free electron lasers: the light sources of the future

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Extreme ultraviolet and x-ray Free Electron Lasers (FELs) are based on technologies developed for synchrotron light sources, but the light produced has properties which are a unique combination of those of optical laser light (ultrashort pulses, high intensity, coherence), synchrotron light (short wavelength) or both (variable polarization). These properties open new frontiers for research in several fields, particularly coherent imaging, dynamics and high field physics: the last two applications will be illustrated with some recent results and planned experiments at the Low Density Matter end-station [1]. Nano clusters or droplets of helium excited by intense fields show complex ionization dynamics [2], which may be relevant to other nano scale systems to be studied by FELs. Photodynamical processes are important in biological systems, for example in the control of damage to DNA due to ultraviolet light. In the nucleobase adenine, the photodynamics after UV absorption occur on a time scale comparable to or longer than the pulse length of FERMI (50-100 fs) [3], so that pump-probe experiments can reveal details of this important process. FERMI is a unique FEL source because it is seeded and temporally as well as (transverse) spatially coherent, and this promises to inspire new experiments that cannot be performed at other FELs.

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[2] Y. Ovcharenko, V. Lyamayev, R. Katzy, M. Devetta, A. LaForge, P. O’Keeffe, O. Plekan, P. Finetti, M. Di Fraia, M. Mudrich, M. Krikunova, P. Piseri, M. Coreno, N. Brauer, M. Drabbels, T. Mazza, S. Stranges, C. Grazioli, R. Richter, K. C. Prince, C. Callegari, F. Stienkemeier, and T. Moeller, *Phys. Rev. Lett.* 112 (2014) 073401.

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