Observation of first resonance pumping of x-ray line profiles of highly charged ions in dense plasmas at LCLS-MEC

F.P. Condamine[1,2,3,4*], D. Khaghani[5,6], E. Galtier[4], L. Gournay[2,3,7], O. Renner[1,8], S.H. Glenzer[4], B. Nagler[4], H-J. Lee[4], and F.B. Rosmej[2,3]

[1]ELI Beamlines, Institute of Physics of Czech Academy of Sciences, Prague, Czech Republic
[2]Sorbonne University, Faculty of Science and Engineering, Paris, France
[3]LULI, Ecole Polytechnique, CNRS, CEA, Palaiseau, France
[4]SLAC National Laboratory, Menlo Park, California
[5]CELIA, University of Bordeaux, CNRS, CEA, Talence, France
[6]Friedrich-Schiller-University Jena, IOQ, Jena, Germany
[7]Institut de Physique de Rennes, University of Rennes 1, Rennes, France
[8]Institute of Plasma Physics of Czech Academy of Sciences, Prague, Czech Republic

*florian.condamine@eli-beams.eu

Testing fundamental line shape models in hot and dense plasmas is of great interest for the atomic and plasma physics communities. For example, radiation transport, dependent of emission and absorption profiles, controls the energy balance and temperature profile in stars while opacity represents a key parameter to understand the evolution of various astrophysical objects [1].
In a first proof of principle experiment at LCLS-MEC end-station [2], we have investigated the fundamental line shape properties of emission and absorption of ions in dense plasmas.
For these purposes, we employed the XFEL self-seeded mode resonantly to scan the frequency dependence of x-ray bound-bound transitions of highly charged ions in dense vanadium plasmas created with an optical laser delivering 1.2J, 175ps pulses.
A spherically bent crystal spectrometer was setup and coupled to a PI-MTE CCD camera to provide high-spectral resolution.
We present the experimental setup and the measurement procedure used to perform the self-seeded resonant photo-pumping.
In addition, we show first results of the photo-pumped He-like Rydberg series and the influence of the scanning energy on the line profile. We have observed asymmetries in the emission and absorption profiles for x-ray transitions in He-like ions that question standard theories.

References

[1] A. Unsöld, Physik der Sternatmosphären, Springer, Berlin (1955)
[2] F.B. Rosmej, S. Glenzer, F. Condamine, D. Khaghani, E. Galtier, O. Renner, Solving solar opacity problems, approved beam time proposal at LCLS, LR21 (2018)