Hanbury Brown and Twiss (HBT) demonstrated an interference effect between two light intensities [1]. In fact, using the correlation between two different points on Sirius, which is a random/thermal light source, they determined its angular size. Classen and coworkers [2] proposed to use the HBT effect for molecular imaging. Here, by treating the heavy atoms as random light emitters, they suggest that the intensity correlation from the x-ray fluorescence of the heavy atoms can be exploited for retrieving high-resolution structural information. Motivated by the work by Classen and coworkers [2], we theoretically examined the fluorescence spectrum of a nanocluster from XFEL pulses with our MC/MD method [3]. As a first step, using Ar clusters as a prototype, we focused on fluorescence processes in intense x-ray fields. We found that non-linear x-ray absorption leads to a high-degree of ionization and creates a dense electron environment within the sample on the femtosecond timescale. Already during the pulse, electron-ion recombination and massive electron rearrangement begin to transform the exposed cluster into core-shell structure (neutral core and highly charged shell). These ultrafast processes produce x-ray emission profiles in an extended sample that are very different from the atomic profile [4]. Most notably, in addition to the direct photoionization pathways, electron-ion recombination processes provide additional pathways to reach the same fluorescence channels and gives rise to higher Kα and Kα\textsuperscript{H} yields in clusters (Figure 1). Depending on the fluorescence channels involved, the presence of the recombination pathway leads to extended fluorescence emission time beyond the lifetime of the core-excited states. We show that the Kα\textsuperscript{H} emission line can be a good candidate for incoherent imaging as it has relatively short emission time (a few femtosecond) compared to the x-ray induced distortion time [3].

References: