First observation of neutron beam generated He_2^* excimer clusters in superfluid helium via laser induced fluorescence

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The molecular excimer - He_2^* - is an exciting new tracer particle for visualization of the superfluid ^{4}He velocity field, which is of high importance for a better theoretical understanding of quantum turbulence. A long excited state lifetime of about 13 s allows repeated interrogation of the excimer with a laser by probing higher lying vibrational states of the molecule. Production of particles in the excimer state can be realized in ionizing processes such as spark discharge, highly intense laser pulses or ionizing radiation via recombination processes.

In particular, the ^{3}He(n,p)^{3}T neutron absorption reaction is expected to produce localized clusters of the excimer along the stopping tracks of the nuclear recoil ions. The MLF facility at J-PARC provides a source of cold neutrons produced by proton impact on a target, which are distributed to various experimental beamlines. In previous experiments performed at BL22 the fluorescence light was captured by photomultiplier tubes (PMT) and the excimer was clearly identified by the characteristic lifetime of the fluorescence transition. While a few first camera images were taken, with the low detection efficiency only long averaged signals were measured, so that individual clusters could not be identified. In a recent experiment we obtained new results using an upgraded laser system and image intensifier enhanced CCD camera. This finally allowed the capture of isolated clusters as shown in Figure 2. The existence of long-stretched clusters suggests that the clusters are partly produced via gamma-ray compton scattering and not only by the neutron absorption reaction.

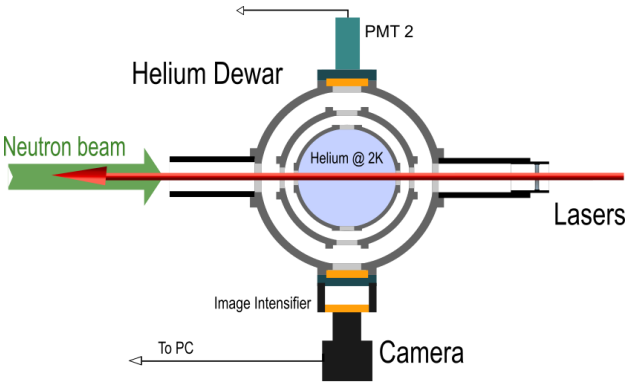

Figure 1: Simplified system setup

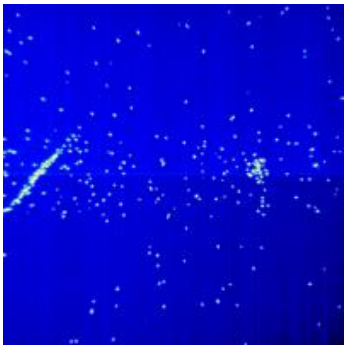

Figure 2: Observation of two different excimer clusters