On the Double Holes X-ray Emission Spectroscopy

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XES is a methods to obtain electronic information about the valence states by observing the X-ray emission spectrum after the inner shell hole creation. This is one of the powerful experimental methods in solid state physics from which the knowledge of the density of states on the valence band can be deduced. This method is applied to the investigation of the highly correlated electron system such as transition metal oxides and high T_c superconducting cuprites

In case of the X-ray excitation, generally one hole is created in an inner shell, while in case of high energy X-ray excitation or electron impact excitations, two holes are probable to be created. Because the hole creation in these cases are due to complicated Coulomb interaction or Auger process that the elucidation of obtained spectrum is not a simple matter. Thus the XES experiments are conducted by suppressing the creation of the spectator hole by use of low energy X-rays near the binding energy of the relevant inner shell.

On the other hand, even low energy X-rays are able to create two holes under a definite condition with high probability if the Bose degeneracy of the X-ray beam is extremely high. In this case, two holes state takes different energy depending on which orbital the two holes are created. From the separation of the spectrum, we can evaluate the order of the correlation energy within the inner shell. Comparison with the spectrum of the singlet hole and the triplet hole, we can evaluate the order of the exchange interaction between the valence electrons and the inner shell electrons. These knowledge is inaccessible with one hole spectroscopy.

Plasma based X-ray laser is even a single shot and single energy pulse source, twenty minute in repetition, 13.9nm in wave length, however, it is a SASE mode coherent source with several picoseconds in pulse width, 0.5mrad in divergence, 10^{-4} in energy spread, 10^9 in Bose degeneracy. The two hole creation probability use of this plasma X-ray source is estimated up to an order of 10^{-3} to the one hole creation probability. Instrumentations are now under construction at JAEA-APR intending to apply to the 3d transition metal oxides and the high T_c cuprates. More discussions on the information that can be deduced from this type of two hole emission spectrum will be presented at the Symposium.