Contribution ID: **1** Type: **Oral**

Resonant coherent excitation under swift heavy ion channeling

Thursday, 21 May 2015 11:20 (30 minutes)

For decades we have been involved in the selective excitation of the heavy atomic ions from Ar to U in the x-ray energy domain making use of a thin single crystal. The swift ions accelerated to ~70 % of the speed of light using the heavy ion synchrotron facility are guided in the silicon single crystal, and excited by a temporally oscillating strong Coulomb field arising from the periodical atomic arrangement. When one of the frequencies corresponds to the transition energy of the ion, the oscillating field has a chance to resonantly excite the internal atomic states of the ion. This process is called "resonant coherent excitation" (RCE). Starting from the resonance by periodic field due to the arrays of the atomic strings in the crystal (2D-RCE) under the planar channeling condition, we developed the resonance technique by the periodical field by an array of the atomic planes (3D-RCE) under the non-channeling condition.

Making use of the 3D-RCE, we have made a significant progress in the selective excitation of heavy atomic ions like Ar and Fe ions accompanying one or a few electrons. Control of magnetic substate population i.e., ion alignment has been achieved by selecting polarization of the periodic field. The use of double resonance technique offered a variety of population control and probing scheme in three-level configurations, that enabled observation of 1) quantum optical phenomena like dressed atoms even in the x-ray energy domain, 2) double excitation to make two K-shell holes in an heavy ion, and 3) sequential excitation to the higher electronic states.

We also have succeeded in observing the 2s-2p transitions of Li-like U ions, which offers us a future possibility of the precision atomic spectroscopy.

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Session Classification: Session 11

Track Classification: 00 - Invited talks