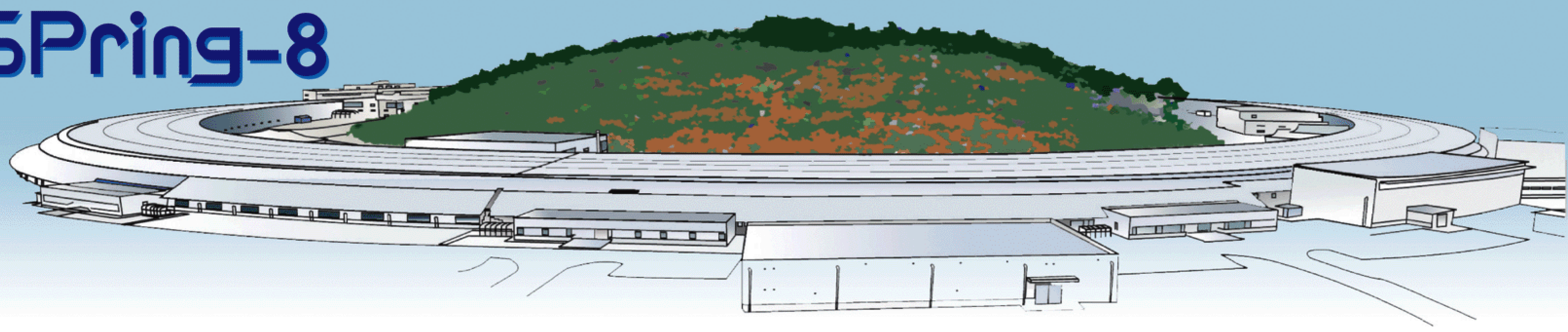

Stereo-atomscope and atomic resolution photoelectron holography

The measurement system for a stereo-atomscope and photoelectron holography has been developed at the Soft X-ray Spectroscopy of Solid Beamline (BL25SU) in SPring-8. The three-dimensional local atomic structure around a target atomic site at the surface is observable using both the stereo-atomscope and photoelectron holography, since they are both based on photoelectron diffraction. In the case of photoelectron holography, a reconstruction calculation is required to obtain the atomic image. An improved reconstruction algorithm (SPEA-MEM) [1] has been developed at SPring-8. Recently, clear atomic images of surfaces have been obtained using this algorithm.

On the other hand, we can directly obtain a stereoscopic atomic image using the stereo-atomscope [2] without a numerical process. The principle is as follows: the two-dimensional photoelectron diffraction pattern can be regarded as a projection of the atomic arrangement. When circularly polarized light is utilized, the projected atomic image is shifted. The magnitude of the shift is inversely proportional to the atomic distance between an emitter atom and a scatterer atom. The magnitude of the shift is nearly equal to parallactic angle. Therefore, the two images observed using right- and left-circularly polarized light form a stereo image of the atomic arrangement. Figure 1 shows a stereoscopic atomic image of boron-doped diamond [3]. Not only the carbon emitter but also the boron emitter can be clearly observed, and the atomic sites of the boron dopant have been determined.

These two methods have complementary features: the stereo-atomscope reveals the atomic structure directly but its accuracy is rather poor, whereas SPEA-MEM holography does not allow direct observation but has high accuracy. These methods can be appropriately used depending on the situation. This research was awarded the Best Paper Award (Materia Japan) by the Japan Institute of Metals. Photoelectron holography and the stereo-atomscope are expected to be powerful tools for analyzing the surface structure of crystals and the local structure around the impurities in a crystal.

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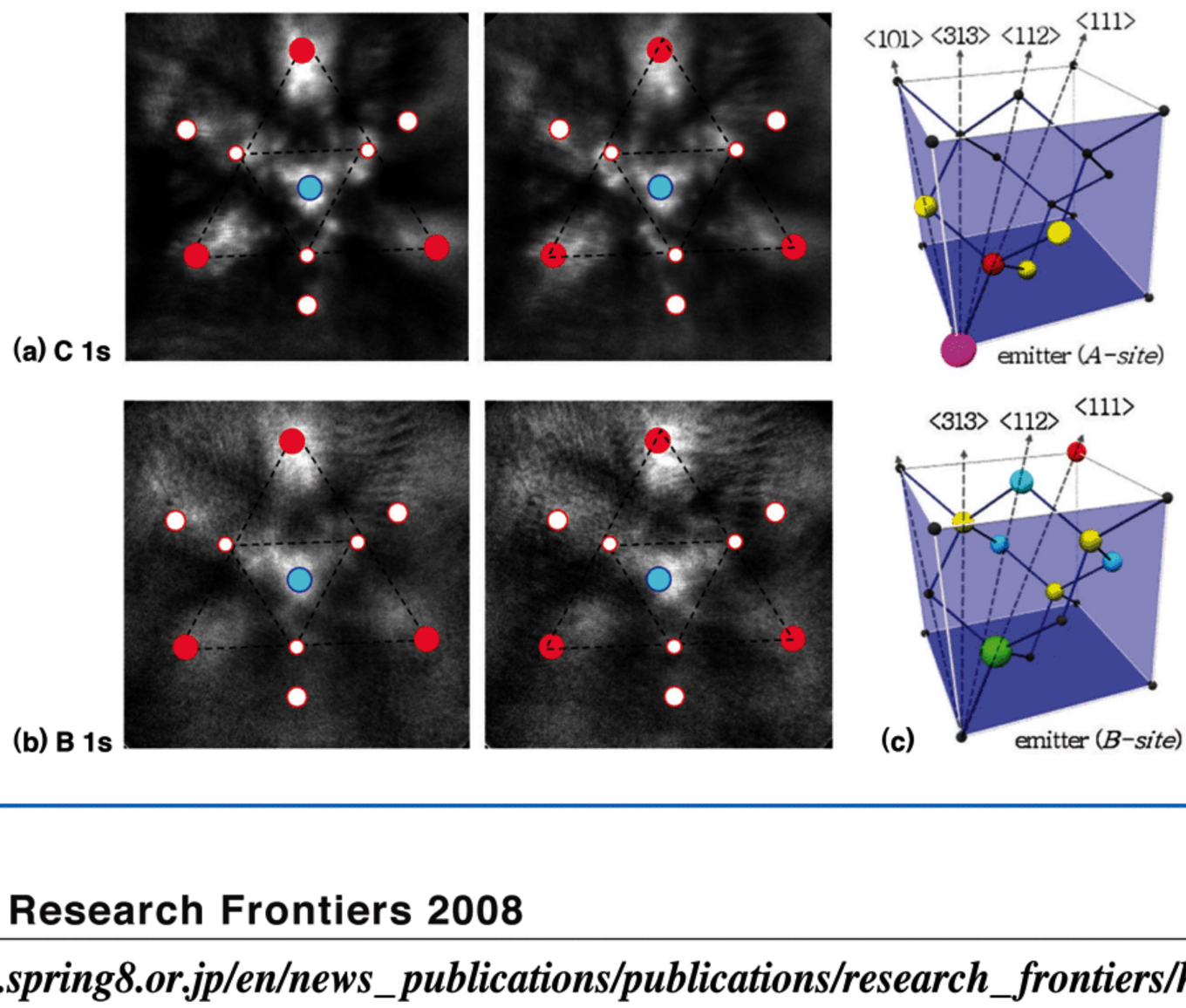

Figure 1
(a) Stereo image of the local atomic structure of diamond around a carbon atom. The center of the image (blue circle) corresponds to the <111> direction. (b) Stereo image of the local atomic structure of diamond around a boron dopant. (c) Crystal structure of the diamond.