Direct Observation of Resonance Fringes in X-ray Cavity: A Diffraction Experiment

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The idea of using multi-plate crystals to confine incident hard X-rays in a closed loop by means of multiple reflection was proposed more than thirty years ago. The simplest two-crystal plate cavity has been mostly investigated theoretically based on the dynamical theory of X-ray diffraction. A variety of experiments in realizing x-ray cavity resonance have also been proposed and attempted. With the advent of synchrotron radiation, high resolution and time resolved experiments for this purpose has recently been conducted and experimental attempts to observe cavity resonance fringes have been pursued.

Her we report the direct observation of resonance fringes inside the energy gap and the total-reflection range of the (12 4 0) back reflection from monolithic two silicon crystal plates of 25—150um thick and a 40—150 um gap using synchrotron radiation of energy resolution Delta E=0.36 meV at 14.4388 keV. This cavity resonance results from the coherent interaction between the X-ray wavefields generated by the two plates with a gap smaller than the X-ray coherence length. This finding may open up new opportunities for high-resolution and phase-contrast X-ray studies, and lead to new developments in X-ray optics.

Keywords: x-ray cavity, multiple diffraction, temporal coherence