The Borrmann effect in resonant x-ray emission spectroscopy: towards quadrupolar brilliance

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The Borrmann effect is the anomalous transmission of x-rays within a crystal under diffraction conditions. It is based on the creation of a standing x-ray wavefield via the coherent superposition of incident and diffracted waves. When the nodes of the standing wave reside at absorbing atoms, dipolar absorption is drastically diminished and macroscopically thick crystals can become nearly transparent for x-rays. Furthermore, the relative weight of quadrupolar absorption can increase by orders of magnitude [1]. We show that the Borrmann effect can be utilised to enhance quadrupolar resonant emission, using the Gd 2p-4f-3d resonant excitation channel in gadolinium gallium garnet as an example [2]. This method couples in a novel way the x-ray standing wave methods and resonant x-ray emission spectroscopy, and provides a novel bulk sensitive means for studying d- and f-electron systems.

References

[1] Pettifer, Collins, and Laundy. Quadrupole transitions revealed by Borrmann spectroscopy, Nature 454, 196 (2008).

[2] Krisch et al., Evidence for a Quadrupolar Excitation Channel at the LIII Edge of Gadolinium by Resonant Inelastic X-Ray Scattering, Phys. Rev. Lett. 74, 4931 (1995).

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