ÉCOLE POLYTECHNIQUE
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Addendum: Notations for dynamical scattering

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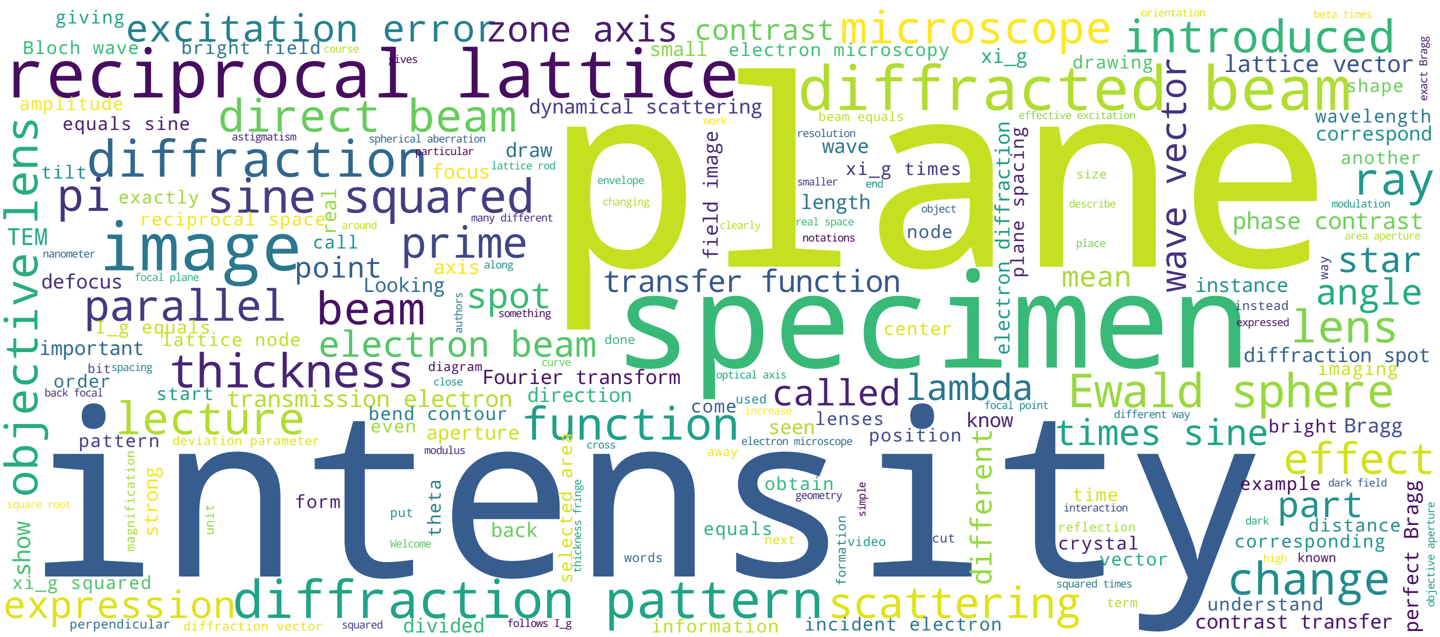

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Video

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2-beam dynamical scattering intensity

Diffracted beam intensity:

$$I_g = \frac{1}{(1+\xi_g^2 s^2)} \sin^2\left(\pi t \sqrt{\frac{1}{\xi_g^2} + s^2}\right) \qquad \left(I_0 = 1 - I_g \right)$$

"Deviation parameter" : $\omega = \xi_g s$

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If you look in the literature on dynamical scattering, you are likely to meet a variety of notations that are used to express scattering intensities and their equations. In this addendum, I describe some of these notations, in order to clarify and strengthen the connection of these lectures to references that you may read or study. Looking a bit further at this expression for the intensity in the diffracted beam, always bearing in mind that the intensity in the direct beam equals one minus the intensity in the diffracted beam, in different references, you will see that this expression is rearranged in different ways depending on the needs or purposes of the authors. For instance in some works, a parameter is introduced corresponding to xi_g times s. Since xi_g has units in real space and s has units in reciprocal space, this parameter is dimensionless, and is often called "w", as for instance by Howie and Whelan. Note that, when it is introduced, some authors call this the deviation parameter, while other authors actually use this same expression deviation parameter for s, which I have been calling the excitation error.

Notes

Summary

0m 05s

2-beam dynamical scattering intensity

Diffracted beam intensity: $$I_g = \frac{1}{(1+\xi_g^2 s^2)} \sin^2\left(\pi t \sqrt{\frac{1}{\xi_g^2} + s^2}\right) \qquad \left(I_0 = 1 - I_g \right)$$

"Deviation parameter": $w = \xi_g s$

$$I_g = \frac{1}{1+w^2} \sin^2\left(\frac{\pi t}{\xi_g}\sqrt{1+w^2}\right)$$

$$\cot\beta = w \Rightarrow \frac{1}{1+w^2} = \sin^2\beta$$

$$I_g = \sin^2\beta \sin^2\left(\frac{\pi t}{\xi_g}\sqrt{1+w^2}\right)$$

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Having introduced w, this equation can be expressed as follows: I_g, the intensity in the diffracted beam, equals one over one plus w squared times sine squared of pi t over xi_g times root root of one plus w squared. Sometimes, an additional dimensionless parameter called beta is introduced, where beta is defined as follows: cotangent beta, that is cosine beta divided by sine beta, equals w. Once this is done, you can show that one over one plus w squared equals sine squared of beta. Thus this expression now becomes I_g equals sine squared beta times sine squared of pi t over xi_g times the square root of one plus w squared.

Notes

Summary

1m 25s

2-beam dynamical scattering intensity

Diffracted beam intensity:

$$I_g = \frac{1}{(1+\xi_g^2 s^2)} \sin^2\left(\pi t \sqrt{\frac{1}{\xi_g^2} + s^2}\right)$$

$$I_0 = 1 - I_g$$

Effective excitation error : $s' = \sqrt{\frac{1}{\xi_g^2} + s^2}$

$$I_g = \left(\frac{\pi t}{\xi_g}\right)^2 \cdot \frac{\sin^2(\pi t s')}{(\pi t s')^2}$$

$$I_g = \sin^2\beta \sin^2(\pi t s')$$

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In other works, yet another parameter is introduced which we call the "effective excitation error", or s-prime, where s-prime equals the square root of the sum of 1 over xi_g squared plus s squared. Once this effective excitation error is introduced, this equation can now be expressed as follows; I_g equals pi t divided by xi_g squared times sine squared of pi t s-prime divided by the square of pi t s-prime. Expressing it this way emphasizes the sine x over x all squared type of function now related to thickness and s-prime. In other words, sinc squared pi t s-prime. Finally we can substitute s-prime into the last expression from the previous slide, giving the overall compact expression I_g equals sine squared of beta times sine squared of pi t s-prime. While we have all these different ways of expressing diffracted beam intensity, in these lectures I'm going to mainly stick to this expression here because it shows in a rather clear way the effects of thickness and s on the intensity of the diffracted beam.

Notes

Summary

2m 24s