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Erratum to: Extinction cross-section for elastic wave scattering in energy-absorbing media: revisited

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Errors in the asymptotic evaluation of integrals in the original manuscript [1] are corrected here. The extinction power detected on the detector area A_D is obtained as

$$P^{\text{ext}} = \omega \text{Im} \left[i(\lambda + 2\mu)k_p \text{Re} \int_{A_D} \hat{r}_1 A_k^{(p)} a_k^{(p)} h_p(r) e^{ik_p^{(1)}(r-x) - k_p^{(2)}(r+x)} dS \right. \\ \left. + i\mu k_s \text{Re} \int_{A_D} \hat{r}_1 A_k^{(s)} a_k^{(s)} h_s(r) e^{ik_s^{(1)}(r-x) - k_s^{(2)}(r+x)} dS \right]. \quad (1)$$

This is Eq. (23) in the original manuscript but in a corrected form. Note that since the polarization vectors $a_k^{(p)}$ and $a_k^{(s)}$ are real vectors, the conjugate signs (overbars) on them are removed. The integrals in Eq. (1) are in the following form:

$$J = \int_{A_D} \eta(y, z) e^{ikx\xi(y, z)} dS. \quad (2)$$

The asymptotic value of this integral can be obtained by applying the method of stationary phase [2, 3]. The only meaningful stationary point is located in the forward direction for both two- and three-dimensional configurations ($z_s = 0$ for the two-dimensional case and $y_s = 0, z_s = 0$, for the three-dimensional case, respectively). Then, the leading term of the integral Eq. (2) is

$$J \sim \frac{2\pi ix}{k} \eta(0, 0). \quad (3)$$

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Evaluation of the integrals in Eq. (1) yields

$$P^{\text{ext}} = \frac{\omega}{2} \text{Im} \left[i(\lambda + 2\mu)k_p e^{-2k_p^{(2)}x} \right] \cdot \frac{4\pi}{k_p^{(1)}} \text{Im} \left[A_k^{(p)}(0)a_k^{(p)} \right] + \frac{\omega}{2} \text{Im} \left[i\mu k_s e^{-2k_s^{(2)}x} \right] \cdot \frac{4\pi}{k_s^{(1)}} \text{Im} \left[A_k^{(s)}(0)a_k^{(s)} \right]. \quad (4)$$

A mistake in the old expressions in [1] is that Eq. (23) contains the complex wavenumbers k_p and k_s instead of the real wavenumbers $k_s^{(1)}$ and $k_s^{(1)}$, which are thus out of the Im operators in this equation.

The intensity of the incident wave is given by

$$I_1^{\text{inc}} = \frac{\omega}{2} \text{Im} \left[i(\lambda + 2\mu)k_p \left| a_k^{(p)} \right|^2 e^{-2k_p^{(2)}x} + i\mu k_s \left| a_k^{(s)} \right|^2 e^{-2k_s^{(2)}x} \right]. \quad (5)$$

From Eqs. (4) and (5) and the definition of the extinction cross-section [4,5], the extinction cross-sections are

$$\Sigma^{\text{ext}} = -\frac{4\pi}{k_p^{(1)} \left| a_k^{(p)} \right|^2} \text{Im} \left[A_k^{(p)}(0)a_k^{(p)} \right] \quad (6)$$

for longitudinal wave incidence, and

$$\Sigma^{\text{ext}} = -\frac{4\pi}{k_s^{(1)} \left| a_k^{(s)} \right|^2} \text{Im} \left[A_k^{(s)}(0)a_k^{(s)} \right] \quad (7)$$

for shear wave incidence.

A similar derivation for the two-dimensional case yields the extinction power at the detector

$$P^{\text{ext}} = \frac{\omega}{2} \text{Im} \left[i(\lambda + 2\mu)k_p e^{-2k_p^{(2)}x} \right] \cdot \frac{4}{k_p^{(1)}} \text{Re} \left[A_k^{(p)}(0)a_k^{(p)} \right] + \frac{\omega}{2} \text{Im} \left[i\mu k_s e^{-2k_s^{(2)}x} \right] \cdot \frac{4}{k_s^{(1)}} \text{Re} \left[A_k^{(s)}(0)a_k^{(s)} \right], \quad (8)$$

and the extinction cross-sections are

$$\Sigma^{\text{ext}} = -\frac{4}{k_p^{(1)} \left| a_k^{(p)} \right|^2} \text{Re} \left[A_k^{(p)}(0)a_k^{(p)} \right] \quad (9)$$

for longitudinal wave incidence, and

$$\Sigma^{\text{ext}} = -\frac{4}{k_s^{(1)} \left| a_k^{(s)} \right|^2} \text{Re} \left[A_k^{(s)}(0)a_k^{(s)} \right] \quad (10)$$

for in-plane vertically polarized incidence (SV wave scattering). The extinction cross-section for horizontally polarized (in the “3” direction) shear wave scattering (SH wave scattering) can also be derived in a similar manner,

$$\Sigma^{\text{ext}} = -\frac{4}{k_s^{(1)} a_3^{(s)}} \text{Re} [C(0)], \quad (11)$$

where $C(0)$ is the amplitude of the scattered SH wave amplitude in the forward direction.

Finally, note that these expressions are in the same form as the extinction cross-section for electromagnetic wave scattering in an absorbing medium [6].

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References

1. Kim, J.-Y., Lee, J.-S.: Extinction cross-section for elastic wave scattering in energy-absorbing media: revisited. *Acta Mech.* **207**, 153–161 (2009)
2. Born, M., Wolf, E.: *Principles of Optics*, 6th edn. Pergamon, Oxford (1987)
3. Erdelyi, A.: *Asymptotic Expansions*. Dover, New York (1965)
4. Kim, J.-Y.: Extinction and propagation of elastic waves in inhomogeneous. *Mech. Mater.* **35**, 877–884 (2003)
5. Kim, J.-Y.: Extinction of elastic wave energy due to scattering in a viscoelastic medium. *Int. J. Solids Struct.* **40**, 4319–4329 (2003)
6. Mishchenko, M.I.: Electromagnetic scattering by a fixed finite object embedded in an absorbing medium. *Opt. Express* **15**, 13188–13202 (2007)