Overture to Acoustics: Overview of Research Programme

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- PhD in theoretical acoustics and solid mechanics at Cambridge
- Interested in acoustic scattering, elastic waves in structures, and their interactions
- Aeroacoustics, metamaterials, electromagnetics, seismology
- Want physical insight into problems from mathematical understanding rather than simply number-crunching (*cf.* 'shut up and calculate')

Applications include:

- non-destructive evaluation of manufactured and in-situ objects
- improving the efficiency of filters in vacuum cleaners, or reducing noise from domestic fans
- optimisation of hulls of underwater vehicles to reduce noise emissions
- design of acoustic ‘metamaterials’ with cloaking applications

- I use both analytic and numerical approaches
- Key tools used in my research are Wiener–Hopf technique and asymptotic methods
- Former invented to solve problem posed by Milne of radiative equilibrium in stellar atmosphere (1926) – reduced to integral equation:

$$B(\tau) = \frac{1}{4} S \mathrm{e}^{-\tau \sec \alpha} + \frac{1}{2} \int_0^\infty B(t) \mathrm{Ei}(|t - \tau|) \, \mathrm{d}t$$

- Wiener–Hopf technique offers explicit analytical solution which gives great physical insight
- Combined with asymptotic analysis, Wiener–Hopf method can be extended and applied to many thousands of different problems in physical sciences and beyond