

**Whitehead Prize 2019**  
**Citation for Professor William Parnell**

Professor William Parnell of the University of Manchester is awarded a Whitehead Prize for highly novel and extensive research contributions in the fields of acoustic and elastodynamic metamaterials and theoretical solid mechanics, as well as excellence in the promotion of mathematics in industry.

Over the past decade, huge interest has centred on the topic of metamaterials, especially with regard to passive cloaking of electromagnetic waves (e.g. light and radar). However, it has been difficult to make progress in the theory of elastic wave cloaking using elastodynamic metamaterials, predominantly due to a severe bottleneck in the theory: a requirement that materials must lack a certain (physical) symmetry. Parnell solved this problem by employing ideas from nonlinear elasticity. When constructed correctly, the properties of pre-stressed nonlinear materials take exactly the required form and thus provide “natural metamaterials”, without the need for esoteric construction. In undertaking the above, Parnell developed a theory of hyperelastic invariance – of the PDEs governing small amplitude displacements to imposed nonlinear pre-stress. As well as having great mathematical elegance, the ramifications of this theory to areas such as seismology, non-destructive evaluation and advanced materials have the potential to be very significant. Indeed, a number of researchers have recently employed this theory to create materials that control and manipulate elastic waves.

Whilst noting specific theoretical achievements, it is important to recognise that Parnell’s research interests have wide application. He is active in knowledge transfer of fundamental mathematics, working actively with industry as well as material scientists, physicists, biologists and engineers to assist in novel developments for the prediction of constitutive behaviour of complex or advanced materials including composites, metamaterials, soft tissue and bone. In particular, one of his recent projects with industry has coupled transformation acoustics and his research developments in homogenisation theory to develop and fabricate a novel acoustic metamaterial that has the potential to be of significant practical use. He has also worked extensively with industrial collaborators to develop mathematical models of syntactic foams, informed by experiments, which are extremely valuable for future materials design purposes in a range of applications.