ACOUSTICS2008/541
Green's theorem as the foundation of interferometry

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A prerequisite for applying full wavefield theory to marine exploration is the completeness and proper sampling of recorded data, which can be satisfied with data extrapolation/interpolation techniques. Green's theorem can be applied to acoustic measurements of the Earth's subsurface to obtain exact equations that incorporate boundary conditions for the retrieval of the Earth's Green's function in positions where it was not measured. Recently, a number of papers on seismic interferometry have shown methods to reconstruct the Green's function between a pair of receivers by using data cross correlations. Current interferometry methods require dual measurements (pressure field and its normal derivative) which are not always available. The lack of dual measurements has encouraged the arrival of algorithms using high frequency and one-way wave approximations to the normal field derivative. The approximations are compromises to the exact theory and, hence, produce artifacts. We present a unifying framework for a broad class of interferometry techniques using Green's theorem. This framework and foundation allows errors and artifacts to be anticipated and fully explained as a consequence of approximations made within Green's theorem. We also develop a set of more effective interferometry methods, where fewer (or none) approximations are made and the result is improved.