Generalized Bremmer series, uniform asymptotics, and imaging-inversion

Maarten V. de Hoop[1], Art Gautesen[2] and Jérôme Le Rousseau[1] [1]Center for Wave Phenomena, Colorado School of Mines, Golden CO 80401-1887, USA. [2]Department of Mathematics, Iowa State University, Ames IA 50011-3020, USA.

One of the open issues in seismic imaging-inversion remains a precise understanding of the transition from the high-frequency (HF) Kirchho®-style approach (Schleicher, Tygel and Hubral (1993)) to the full-wave (WE) approach. In this presentation we will address this issue. document In the HF approach, the microlocal analysis of linearized inversion has been developed (De Hoop, Spencer and Burridge (1999), De Hoop and Brandsberg-Dahl (2000), Stolk and De Hoop (2001)). We will brie°y review the processes of modeling (F(ourier) I(ntegral) O(perator)), acquisition (restriction FIO), imaging (adjoint FIO), resolution (normal (pseudodi®erential) operator) and inversion within the framework of Fourier integral operators and their composition through the clean intersection calculus.

To adapt the analysis in the HF approach to the WE approach, we invoke directional wave¯eld decomposition. Such procedure consists of three main steps: (i) decomposing the ¯eld into two constituents, propagating `one-way' upward or downward the constituents along a principal direction, (ii) computing the interaction (coupling) of the counterpropagating constituents and (iii) recomposing the constituents into observables at the positions of interest. The method allows one to `trace' wave constituents. The generalized Bremmer coupling series superimposes all the constituents to recover the full, original wave¯eld (De Hoop (1996)).

The one-way wave propagator that generates the Bremmer series can be written in the form of a sequence of Trotter products. The phase in these products (each `factor' corresponds with a Lagrangian distribution) contains the symbol of the so-called `square-root' operator occurring in the one-way wave equation. We will brie°y discuss a uniform asymptotic expansion of the propagator's kernel. The second-order term in the Bremmer coupling series will constitute the modeling. The kernel of its adjoint (the imaging operator) can be written as a sequence of Trotter products also. In fact, the adjoint is the propagator associated with Claerbout's `double-square-root' equation. We will construct the canonical relation of the imaging operator. Finally, an iterative procedure can be invoked to compute the inverse normal operator from the adjoint (De Hoop and De Hoop (2000)).

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