An FIO calculus for linearized marine seismic imaging

Allan Greenleaf

Abstract

The linearization of the soundspeed to surface data map, F , is a Fourier integral operator (FIO) under fairly general conditions. However, in the presence of caustics for the smooth background soundspeed, the FIO is degenerate in that the associated canonical relation has degenerate projections onto the cotangent space of the Earth and into the cotangent space of the data set. This puts the composition that goes into the formation of the normal operator, F^*F, outside of the standard clean intersection calculus for FIOs. Nolan showed that if the caustics are of the simplest type, namely folds, then for the single-source data set, F is an FIO associated with a folding canonical relation in the sense of Melrose-Taylor. We show that for the (overdetermined) marine seismic data set, F is associated with a canonical relation having a particular form, namely one projection is a submersion with folds and the other is a cross-cap. We then obtain a composition calculus for general FIOs having this structure, which shows that the resulting artifact in the normal operator is 1/2 derivative smoother than in the single source case. Sobolev estimates then show that it is reasonable to hope for removal of the artifact.This is joint work with Raluca Felea and Malabika Pramanik.