Artifacts that appear in inverse problems of seismic waves

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Conventional analysis of seismic wave forms and travel times as tomography is based on the ray theory or the assumption of high frequency approximation. However, serious questions have been raised for this assumption and intensively investigated. Indeed, distinct artifacts can be produced by diffraction effects (e.g., Huang, et al.,2004). In addition to the above problem, various other effects that have never been recognized correctly before might introduce spurious results in the analysis of seismic waves. For example: (1) Dispersion effects of seismic waves that are attributed to heterogeneity of the medium contaminate the original information. At least, we must distinguish concepts of arrivals of signal onsets and wave packets, which was first investigated by Sommerfeld and Brillouin. Saito (1973) found significant difference between their arrival times. (2) Diffraction limits are also important since seismic waves suffer from various limitations of frequency bands due to attenuation during propagation and instrumental restrictions of observations. The numerical experiment by Rosny and Fink (2002) that shows time-reversed waves do not converge to the original point due to diffraction limits posed a serious question on the validity of wave form inversion. Further, (3) tunneling of evanescence waves (Deng,1994) and (4) existence of various guided waves like high frequency Pn/Sn and Po/So phases (Morozov,2004) as well as many crustal phases will disturb the analysis of seismic wave forms and travel times. Most of these effects have never been recognized suitably but have much larger influences than we have expected before. If we miss to evaluate these influences appropriately for observed waves, we may fail to obtain appropriate images for real structures.