1. Introduction

Since the pioneering work of Lighthill[1,2], there have been numerous attempts to develop a jet noise prediction theory. In the literature, one finds many proposed theories and semi-empirical theories. The main difficulty in predicting jet noise is our lack of understanding of the turbulence in jet flows. This is true even today. However, many of the fundamental physics of jet flows that affect the propagation and radiation of jet noise were recognized very early. They have been incorporated into some of the theories. These effects include mean flow refraction[3,4] and source motion[5]. An excellent review on jet noise theories up to the late 1980's can be found in Ref. [6]. Ref. [7] to [9] provide reviews on the same subject. However, they include some of the more recent works and the emphasis and perspectives are quite different.

Recently, Tam, Golebiowski and Seiner[10] suggested that, because there is no intrinsic characteristic length and time scales in the mixing layer of a high Reynolds number jet (up to the end of the core region), not only the mean flow and the turbulence statistics must exhibit self-similarity, the same must be true for the radiated noise. By examining the entire data bank (1900 spectra in all) of the Jet Noise Laboratory of the NASA Langley Research Center, they found that turbulent mixing noise of high-speed jets consisted of two distinct components (see also Ref. [9]). Each component exhibits self-similarity of its own. One component radiates principally in the downstream direction. This is consistent with Mach wave radiation from the large turbulence structures/instability waves of the jet flow[11−13]. The other component that has a relatively uniform directivity is dominant in the sideline and upstream directions. These characteristics suggest that it is the noise from the fine scale turbulence of the jet flow. Tam *et al.*[10] succeeded in identifying two similarity spectra from the data. They demonstrated that one of the spectra they found fitted the noise from the large turbulence structures and the other the noise from the fine scale turbulence regardless of the jet velocity, temperature and direction of radiation. More recently, Tam[14] showed that even the noise spectra of non-axisymmetric jets including jets from rectangular, elliptic, plug and suppressor nozzles fitted the same two empirically found similarity spectra. This indicates that the noise sources of these jets are similar to