Microphone array technology has been widely used for the localization of sound sources. In particular, beamforming is a well-established signal processing method that maps the position of acoustic sources by steering the array transducers toward different directions electronically. The present PhD study aims at enhancing the performance of uniform circular arrays, and to a lesser extent, spherical arrays, for two- and three-dimensional localization problems, respectively. These array geometries allow to perform eigenbeamforming, beamforming based on the decomposition of the sound field in a series of orthogonal functions. In this work, eigenbeamforming is particularly developed to improve the performance of circular arrays at low frequencies. Compared to conventional delay-and-sum beamforming, the proposed technique, named circular harmonics beamforming, provides a better resolution at the expense of being more vulnerable to noise. A simple way to further improve the array performance is to flush-mount the transducers on a rigid scatterer. For a circular array, an ideal solution is a rigid cylindrical scatterer of infinite length. Due to its impracticality, the use of a rigid spherical scatterer is recommended instead. A better visualization in the entire frequency range can be achieved with deconvolution methods, as they allow the recovery of the sound source distribution from a given beamformed map. Three efficient methods based on spectral procedures, originally conceived for planar-sparse arrays, are adapted to circular arrays. They rely on the fact that uniform circular arrays present an azimuthal response that is rather independent on the focusing direction. Finally, a method based on the combination of beamforming and acoustic holography is introduced for both circular and spherical arrays. This new approach, also expressible in terms of eigenbeamforming, extends the frequency range of operation of conventional delay-and-sum beamforming toward the low frequencies.