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The energy flow for a spherical acoustic lens: ray vs. wave methods

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A simple classroom demonstration consists of a weather balloon filled with carbon dioxide, a sound source, and a microphone. Since the speed of sound is slower in carbon dioxide than in air at room temperature and pressure, the balloon acts as a positive spherical acoustic lens. The accuracy of ray methods in locating the acoustic focus versus a full blown wave solution approach is probed. This problem presents particular difficulties if the sound source lies in the near field region. The sound emitter is treated as a dipole source equivalent to a rigid oscillating sphere of small size and amplitude of motion relative to the scatterer. The energy flux around the balloon is visualized by both ray methods and by the acoustic Poynting vector field. The geometrical ray results and the acoustic Poynting vector field resulting from the wave solution are compared.