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Prediction and tailoring of steady-state broadband sound fields in enclosures using absorption scaling and energy-intensity boundary elements

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Enclosures with diffuse reflection boundaries are modeled with an energy-intensity boundary element method using uncorrelated broadband directional sources. An absorption-based perturbation analysis shows the spatial variation of the acoustic field obeys certain scaling laws. A series expansion in terms of average absorption gives separate boundary integral problems at each order. The lowest-order solution has a uniform level proportional to the reciprocal of the average absorption. The next-order solution is independent of average absorption and primarily responsible for spatial variation of the acoustic field. This solution depends on the spatial distribution of absorption and input power sources, but not their overall level. For the primary spatial variation, the effects of the relative distributions of absorption and input power are linear and uncoupled. These distributions can be expressed in terms of constituent spatial modes corresponding to the ways absorption and input power can be distributed. Solved numerically once for each mode, the acoustic field can be expressed in terms of the modal amplitudes in closed form. These amplitudes can be adjusted to tailor the spatial variation. Examples include how to distribute absorption to minimize sound levels in one location, or how to achieve a uniform interior field. (Sponsor: NSF)