Benchmark case: PAC-MAN

Description

The PAC-MAN geometry is the two-dimensional equivalent to the three-dimensional cat's eye geometry. As shown in Fig. 1, it is a circle of radius $r_0 = 1$ m with an angular cut-out ranging from $-\varphi_0$ to φ_0 (measured from the x-axis) and $\varphi_0 = \pi/6$. An analytical solution of the sound field inside the cut-out and outside the PAC-MAN has been derived [1]. The PAC-MAN problem is suited for radiation and scattering.

Name	PAC-MAN
Field	Linear Acoustics
Code	coded UN2-1|RF or UN2-1|SF
Categories	
Bounded or Unbounded problems	Unbounded
Dimensionality of the case	2D
Scattering or Radiation problem	Scattering and Radiation
Time-domain or Frequency-domain problem	Frequency Domain
Description	
PDE	Helmholtz equation
Geometry	Circle with radius $r_0 = 1$m. Angular cut-out ranging from $-\varphi_0$ to φ_0 (measured from the x-axis), with $\varphi_0 = \pi/6$. See Fig. 1.
Propagation medium	Air ($\rho = 1.2041$ kg/m^3 , $c = 343.21$ m/s)
BCs	$Z = \infty$ at boundaries
Sources	Four excitation types. For details see [1]. 1. Surface vibration ($V_0 = 0.1$ m/s on round surface of the PAC-MAN) 2. Line source ($r^* = 4$m, $\varphi^* = \pi/4$) of unity amplitude 3. Disk source ($r^* = 4$m, $\varphi^* = \pi/4$, $R^* = 0.01$m) of unity amplitude 4. Plane wave ($\varphi^* = \pi/4$) of unity amplitude
Receivers	72 evaluation points located on a circle ($r = 2$m, $\Delta\varphi = 5°$, $\varphi_1 = 0°$, ..., $\varphi_{72} = 355°$)
Quantity to compute	Acoustic pressure of total sound field at octave-band center frequencies from 16 Hz to 4 kHz

References

[1] H. Ziegelwanger, P. Reiter, The PAC-MAN model: Benchmark case for linear acoustics in computational physics, Journal of Computational Physics 346 (2017) 152–171. doi:10.1016/j.jcp.2017.06.018.

Geometrical details

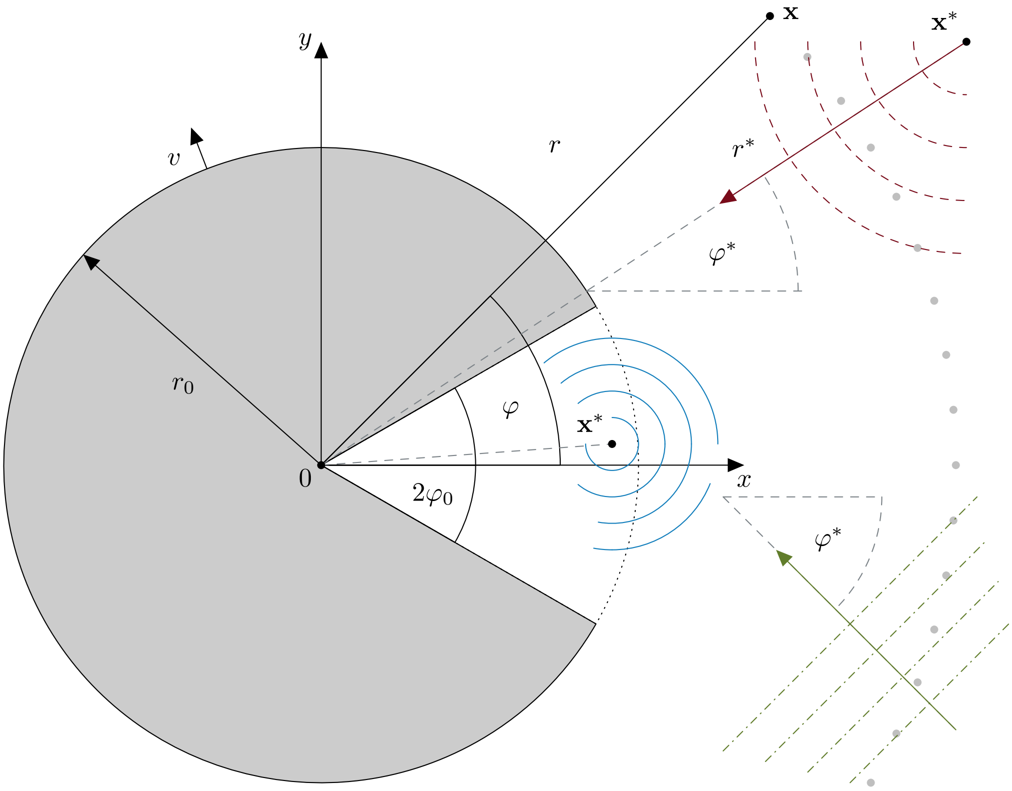

Figure 1: The PAC-MAN model consists of a circle (radius r_0) with a circular sector of angular width $2\varphi_0$ cut out. Incident sound field is schematically shown for a cylindrical wave with $r^* > r_0$ (- - -), a cylindrical wave with $r^* < r_0$ (——), and a plane wave (-·-·-). $\mathbf{x}^*$ is the position of a line or a disk source described by its distance r^* and angle φ^*. v is the velocity of a surface vibration. $\mathbf{x}$ is the position of an evaluation point.