# Chapter 1

# Example problem: Solving the Helmholtz equation on an unstructured mesh

In this document we revisit the solution of the Helmholtz equation and demonstrate how to simulate the scattering of a planar wave from a circular cylinder using an unstructured mesh.

## 1.1 A specific example: Scattering of an acoustic wave from a sound-hard obstacle.

We revisit the problem considered in `another tutorial`: the scattering of a planar sound wave impacting on a rigid, impermeable obstacle as shown in this sketch:
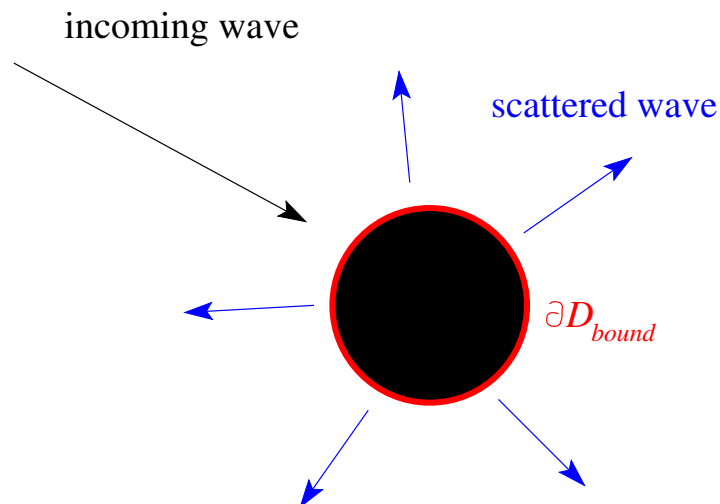


**Figure 1.1 Scattering of an incoming wave from a sound-hard obstacle -- the scatterer.**

## 1.2 Results

The figure below shows plots of the real and imaginary parts of the fluid's displacement potential $\phi$ (a measure of the fluid pressure). The red and green lines correspond to the computed and exact analytical solutions, respectively. (We refer to `another tutorial` for details.)

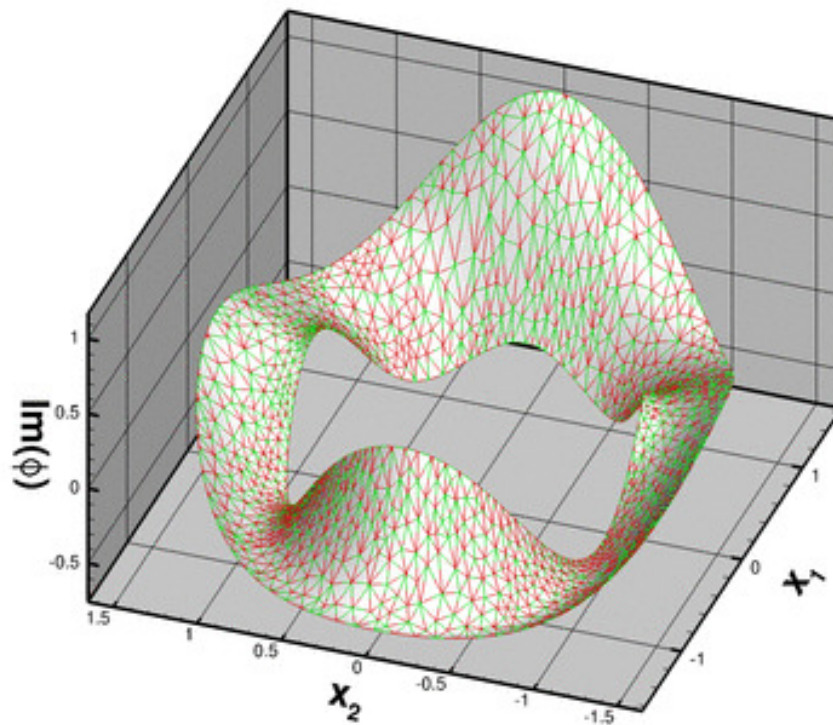**Figure 1.2 Real part of the displacement potential (red: computed; green: exact).**

**Figure 1.3 Imaginary part of the displacement potential (red: computed; green: exact).**

## 1.3  The numerical solution

The driver code for this problem is very similar to the one discussed in  `another tutorial`. Running `sdiff` on the two driver codes

  `demo_drivers/helmholtz/scattering/scattering.cc`

and

  `demo_drivers/helmholtz/scattering/unstructured_scattering.cc`

shows you the differences, the most important of which are:

- the setup of the unstructured mesh, ensuring that mesh adaptation respects the curvilinear boundaries.


- the re-assignment of element properties following any mesh adaptation – we refer to  `another tutorial` for a more detailed discussion of why this is necessary.

That's all!

## 1.4  Source files for this tutorial

- The source files for this tutorial are located in the directory:


  `demo_drivers/helmholtz/scattering/`

- The driver code is:

demo_drivers/helmholtz/scattering/unstructured_scattering.cc

## 1.5 PDF file

A pdf version of this document is available.