Abstract:

- Laboratory experiments with general relativity black holes are basically impossible.

- Because of this limitation, there is now a lot of interest in simulating black holes by using condensed matter analogues.

- Simulating the kinematics of Einstein gravity (how fields and particles react to curved spacetime) is relatively easy.

- Simulating the dynamics of Einstein gravity (the relation between spacetime curvature and matter) is much more difficult.

- I will discuss the prospects for building analogue black holes in the laboratory, and the extremely exciting possibility of observing the analogue of Hawking radiation.

Acoustic black holes:

Basic Idea:

Consider sound waves in a flowing fluid.

If the fluid is moving faster than the speed of sound, then the sound waves are swept along with the flow, and cannot escape from that region.

This sounds awfully similar to a black hole in general relativity — is there any connection?

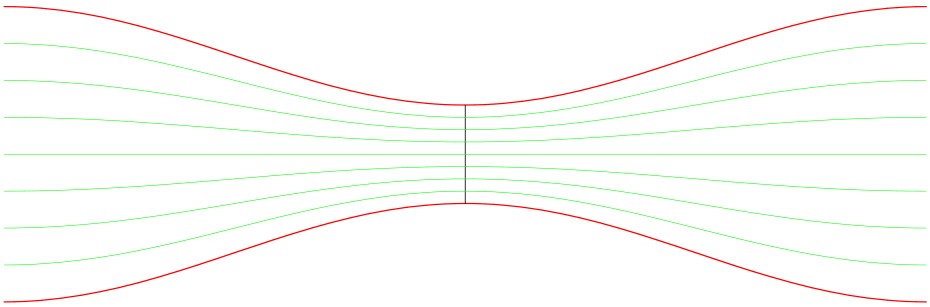
— # # # YES! # # # —

(Otherwise I would not be giving this talk.)

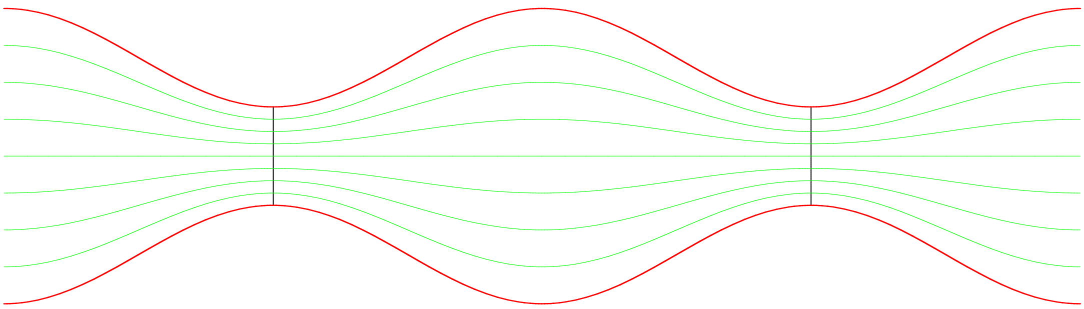
Details (sophisticated mathematics and physics):
Rio workshop on Analog models
http://www.mcs.vuw.ac.nz/~visser/Analog
Book:
"Artificial Black Holes" (Novello, Visser, Volovik)

Supersonic wind tunnels:

Aerodynamic engineers build acoustic black holes all the time — they call them supersonic wind tunnels.



A Laval nozzle can be used to induce supersonic fluid flow. The acoustic horizon forms at the narrowest point of the nozzle.



A second Laval nozzle is needed to bring the fluid flow back to subsonic speed [breakdown shock].

Hawking radiation:

- Hawking radiation is a subtle quantum effect was predicted by Stephen Hawking in 1972.
- The Hawking effect implies that black holes are not completely black once quantum physics is taken into account.
- The effect is too small to be seen in the real general relativity black holes that show up in astrophysics. (Collapsed stars, black-hole galactic cores.)
- The numbers may work out better for these analogue "artificial black holes".
- What are the hopes are for laboratory tests?

Acoustics in Bose-Einstein condensates:

- The specific interest in BEC's is technological; not fundamental.

- First: c_s can be as low as a few millimeters per second.

- Second: the temperature of the condensate is already a few nano-Kelvin.

- Tech note: 1 nano-Kelvin = 0.000,000,001 Celsius degrees above the absolute zero of temperature; near -273.15 degrees Celsius.

Most favourable estimates:

$$T_H \approx 70 \text{ nK}$$

$$T_{condensation} \approx 90 \text{ nK}$$

$$T_{condensate} \approx 5 \text{ nK?}$$

Conclusions:

- Analog models should allow us to experimentally test some features of GR that would be completely unattainable with physical gravity.