15-oct-2009

Project IV - Desktop black holes - 2009/10

Organisation:

1. We will first spend a few weeks to study some of the basics of the topic. Essentially, we will need to recall (or learn) some fluid mechanics, some general relativity, and then some basics about how these two are connected (the "acoustic metric" concept). We will also need to recall some (multi-particle) quantum mechanics, because the most interesting systems in which analog black holes occur are Bose-Einstein condensates, which require quantum mechanics.

   You will all need to read about these topics, but we will structure things a bit by having three small presentations, one by each of you, taking about 30 minutes each. One will be about fluid physics material (the relevant equations, simple solutions, the rewriting in terms of a Lorentzian system), one will be about basics of black hole physics (what are horizons, how do they arise, which coordinate systems do we know; use any general relativity book you like) and one about multi-particle quantum mechanics (how do you write down a Schrödinger equation for such systems, what are the basic ideas to solve it).

2. You will then pick a particular model or phenomenon that you would like to focus on and learn more about (you are free to do things together or alone). Suggestions include: Hawking radiation, rotating black holes and ergoregions, experimental setups. We will have regular meetings to see how things progress or resolve questions.

Some literature hints to get you going:

- M. Visser, "Acoustic black holes", gr-qc/9901047 (hand-out)

  Short lecture notes with exercises. A lot of things have happened since 1999, but these notes describe the basics (which everyone will need) in simple terms.

- C. Barcelo, S. Liberati, and M. Visser, "Analogue gravity", *Living Rev. Rel.* **8** (2005) 12, gr-qc/0505065

  This is a very extensive report on the status of the field in 2005. You can read this on-line at
  http://relativity.livingreviews.org/Articles/lrr-2005-12/

- There is an annotated bibliography on analog black holes available at
  http://homepages.mcs.vuw.ac.nz/~visser/Analog/bibliography.html

- B. F. Schutz, "A first course in general relativity", Cambridge, 1985

  A simple, to-the-point introductory book on general relativity.

You will certainly want to scan around the literature to see which topic you would like to focus on. The big report listed above is a good starting point, but for all other searches you should use the Spires database,

http://durpdg.dur.ac.uk/spires/hep/

Try, as an exercise, to find the two papers above and search for all papers which cite them. Another essential ingredient is the preprint archives,

http://uk.arxiv.org/

All relevant scientific literature on desktop (or 'analog') black holes can be found there.

I will keep track of notes, links and meeting dates on
http://maths.dur.ac.uk/~dma6kp/pr4_black_holes.html