

Laboratory Demonstrations in Fluid Dynamics

Michaelmas 2011

Non-examinable

4 sessions

Fluid dynamics is about understanding a *real* physical system, not just solving equations. But the equations are *impossible* to solve analytically in most circumstances, so we make use of *approximate equations* or numerical solutions. When using approximate equations we should ask *questions* such as:

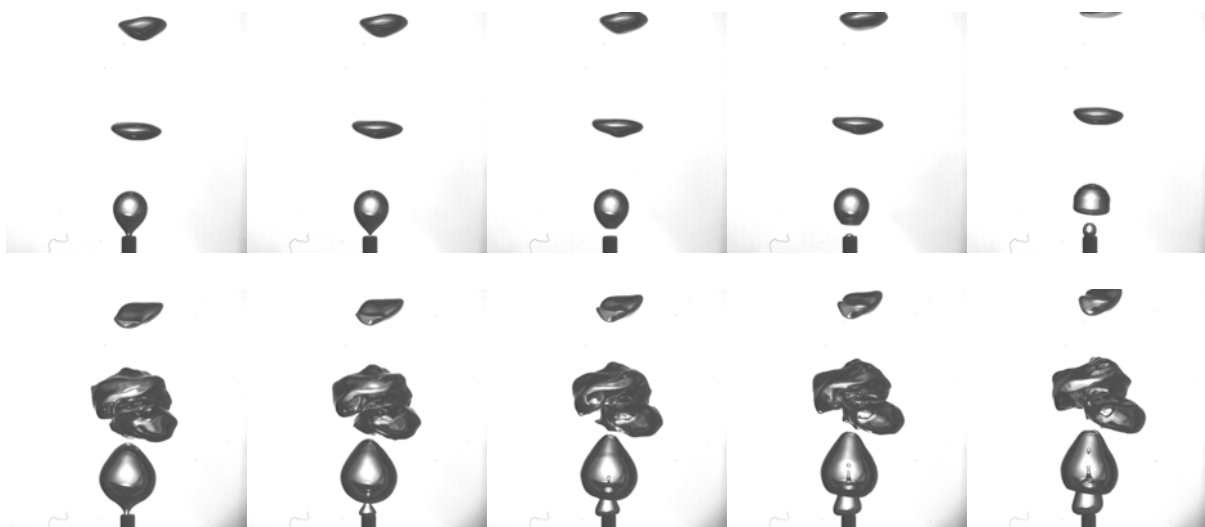
- ◇ Do these equations work?
- ◇ What important physics have we missed out on?
- ◇ Can we simplify the equations even further?
- ◇ How do I know if the answer is reasonable?

This demonstration complements the Part II(D) Fluid Dynamics lecture course through a series of laboratory experiments that illustrate key elements of the lectured material (along with some material you will have met in the Part IB fluids course). The demonstrations will help you develop your physical intuition, an invaluable tool when deriving simplified equations and assessing their performance. The course does not simply repeat what you have in lectures, but rather looks at related material from a different angle, and reinforces how real flows can sometimes be far more complex, while other times even the simplest approaches can yield surprisingly accurate answers.

There are four distinct demonstrations during the course. Depending on numbers attending, each demonstration will be run either two or three times on different afternoons. All demonstrations start at 2:00 in the Pavilion A laboratory beneath the Common Room and last approximately one hour. The first demonstration is scheduled for Thursday 20 October, and is repeated on Tuesday 25 October (and possibly Wednesday 26 October).

Participation in performing the experiments is encouraged, but not mandatory.

There will be a brief meeting towards the end of the Fluid Dynamics lecture on Friday 14 October to assess and balance numbers between each of the two (or three) streams.



What shape are bubbles? Spheres (or parts of spheres) may be theoretically attractive, but the shape can be far more complex!

Part IID Fluid Dynamics Laboratory Demonstrations¹

Each demonstration will be given at least twice. Once on a Thursday afternoon, and then repeated later on a Tuesday afternoon (and possibly a third time on a Wednesday afternoon). Demonstrations start at 2:00 and typically last about one hour, but you are welcome to stay longer to explore further aspects of the flows considered. Please keep with the same session wherever possible. Note that the sessions may be merged if numbers decline.

Session 1: Thursday 20, Tuesday 25 (and Wednesday 26) October

- Surface waves
- Belly flops
- Reynolds experiment

Session 2: Thursday 3, Tuesday 8 (and Wednesday 9) November

- Low Re drag on a sphere
- Reversibility
- Minimum dissipation: low Re drag for arbitrary shapes
- Interacting particles

Session 3: Thursday 17, Tuesday 22 (and Wednesday 23) November

- Kelvin's circulation theorem
- Plug-hole vortices
- Spin-up
- Bluff bodies and aerofoils
- Boundary layers

Session 4: Thursday 24, Tuesday 29 (and Wednesday 30 December) November

- Bubbles in Hele-Shaw cell
- Spherical bubbles
- Spherical cap bubbles
- Slug flow
- Low Re bubbles
- Non-Newtonian bubbles

Note: The Wednesday sessions will cease if the numbers fall significantly.

All demonstrations begin in the Pavilion A Laboratory beneath the serving area of the Common Room in CMS. Enter through corridor on northern side of MR2.

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¹ A much more extensive array of demonstrations will be available next year if you take Part III.