Exploring the physics of a chocolate fountain

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Adam Townsend with the chocolate fountain. Credit: Adam Townsend/Helen Wilson

A mathematics student has worked out the secrets of how chocolate behaves in a chocolate fountain, answering the age-old question of why the falling 'curtain' of chocolate surprisingly pulls inwards rather than going straight downwards.

The results are published today, 25th November 2015, in *European Journal of Physics*.

"Chocolate fountains are just cool, aren't they!" says Adam Townsend, an author on the paper, based on his MSci project. "But it's also nice that they're models of some very important aspects of fluid dynamics."

The conundrum of the converging curtain was solved by looking at some classic work on 'water bells'.

"You can build a water bell really easily in your kitchen" says Dr Helen Wilson, the other author of the paper, and supervisor during Townsend's MSci project. "Just fix a pen vertically under a tap with a 10p coin flat on top and you'll see a beautiful bell-shaped fountain of water."

The physics of the water bell is exactly the same as the falling curtain of chocolate; and the reason the chocolate falls inwards turns out to be primarily surface tension.

They also looked at the flow up the pipe to the top of the fountain, and the flow over the plastic tiers that form the distinctive chocolate fountain shape.

"Both the chocolate fountain and water bell experiments are surprisingly simple to perform." Dr Wilson continues. "However they allow us to demonstrate several aspects of fluid dynamics, both Newtonian and non-Newtonian."

A simple water bell. Credit: Adam Townsend/Helen Wilson

The researchers were also pleased to see that their work allowed them to engage with the public.

"It's serious maths applied to a fun problem." continues Adam Townsend. "I've been talking about it at mathematics enrichment events around London for the last few years. If I can convince just one person that maths is more than Pythagoras' Theorem, I'll have succeeded. Of course, the same mathematics has a wide use in many other important industries - but none of them are quite as tasty as chocolate."

Townsend and Wilson don't consider the chocolate fountain licked; there is lots more to learn from looking at the way the curtain changes over time.

"This was only an undergraduate project - modelling the chocolate fountain completely would need a lot more detail. Thankfully, individual strands - like the screw-pump flow up the pipe - have applications well beyond chocolate, and international teams are working on them now." concludes Wilson.

Townsend is now finishing a PhD investigating suspensions of solid particles in fluids, supervised by Wilson in the Department of Mathematics at University College London.

More information: Adam K Townsend et al. The fluid dynamics of the chocolate fountain, *European Journal of Physics* (2016). DOI: 10.1088/0143-0807/37/1/015803

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