Et bachelorprojekt om roterende vand

Et heldigt tilfælde

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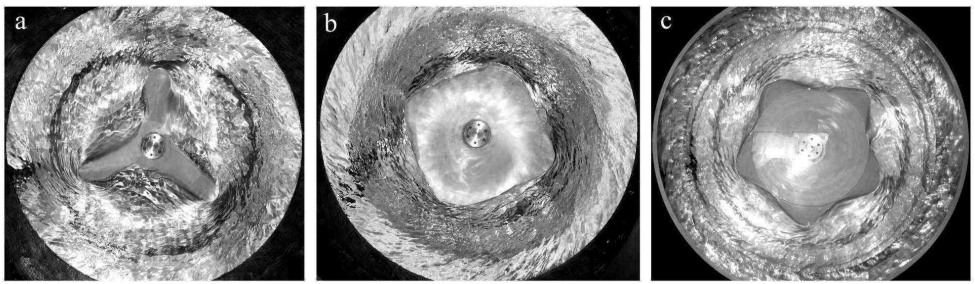
9 November 2007



Oversigt

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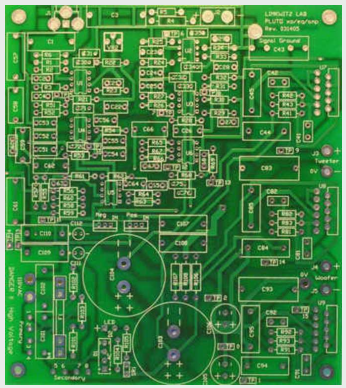
Tilfældighed

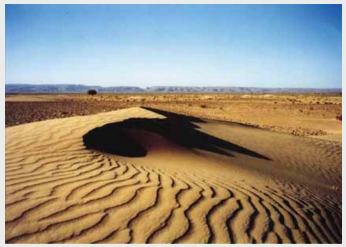
Efteråret 2004

Kryptering med kaotiske kredsløb



Mogens Høgh Jensen, NBI

Sandriller



Clive Ellegaard, NBI og *Tomas Bohr*, DTU

Roterende vand

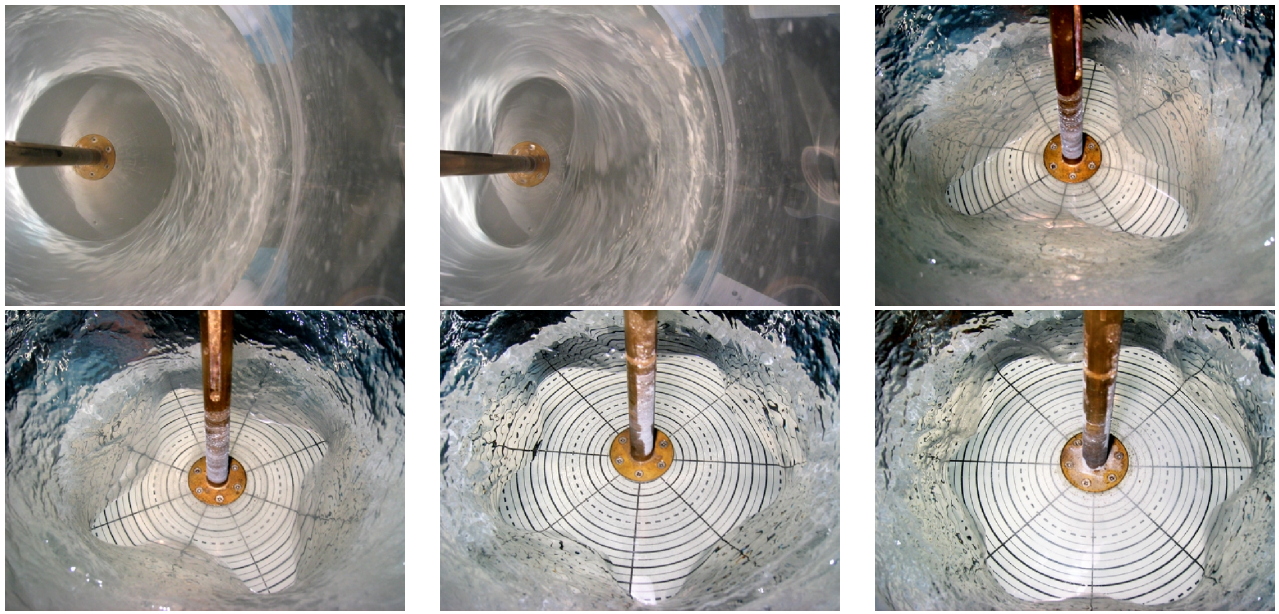
Delvist fyldt cylinder med roterende bundplade

Forsøgsopstillingerne

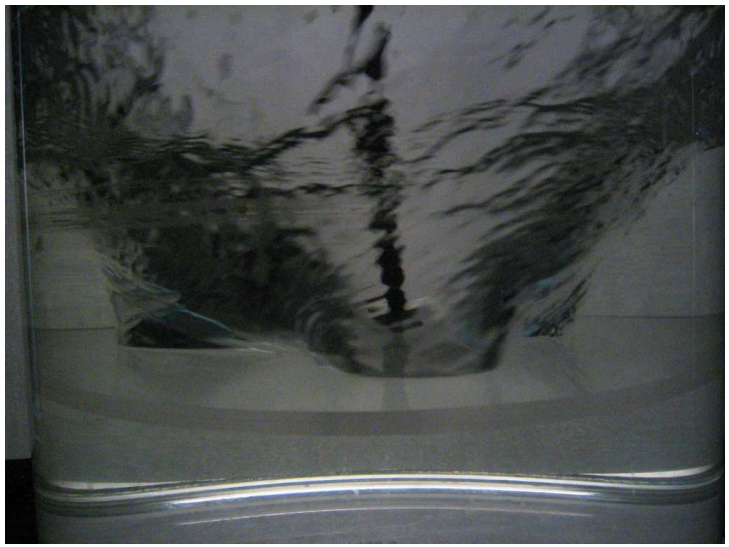
To opstillinger

131 mm - gammelt forsøg angående sandriller
194 mm - afhængighed af R og bedre billeder

Mange typer polygoner



En roterende trekant fra to vinkler



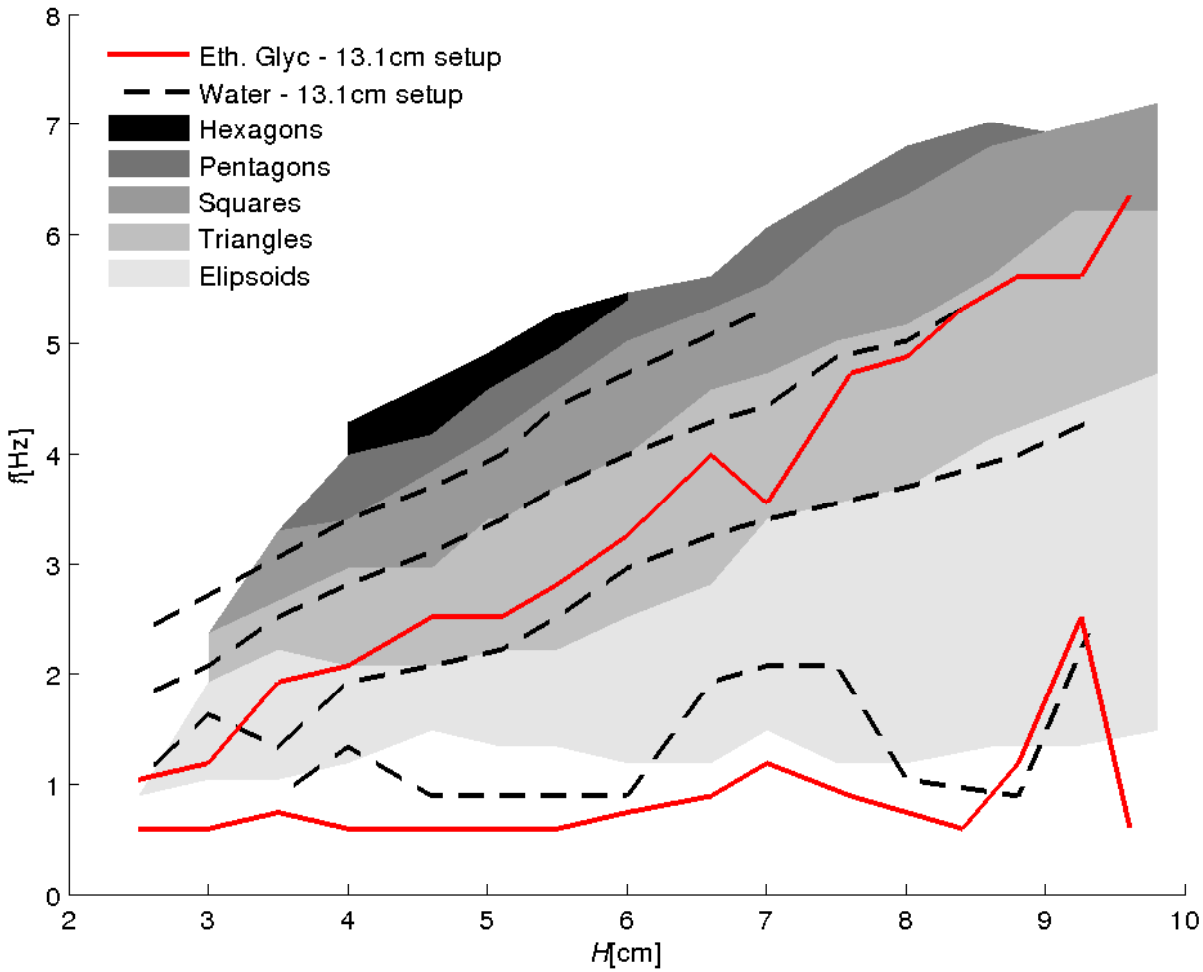
To opstillinger

Der ses ofte uregulære polygoner mellem to tilstande.

3 videoer

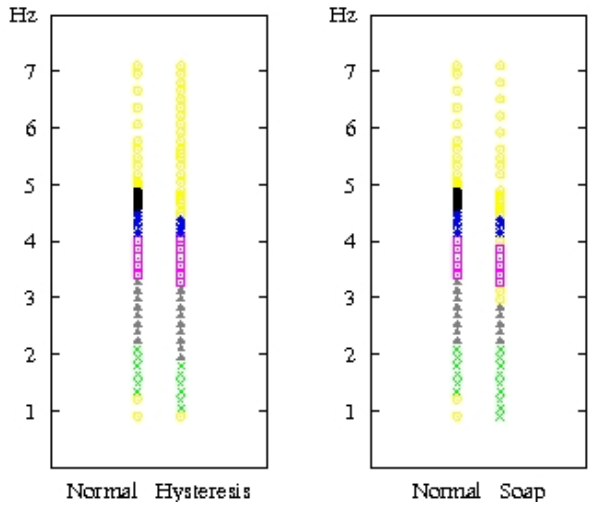
- Roterende trekant
- Opbygning af en polygon
- Roterende trekant med farve

Fasediagram



Undersøgelse af styrende egenskaber

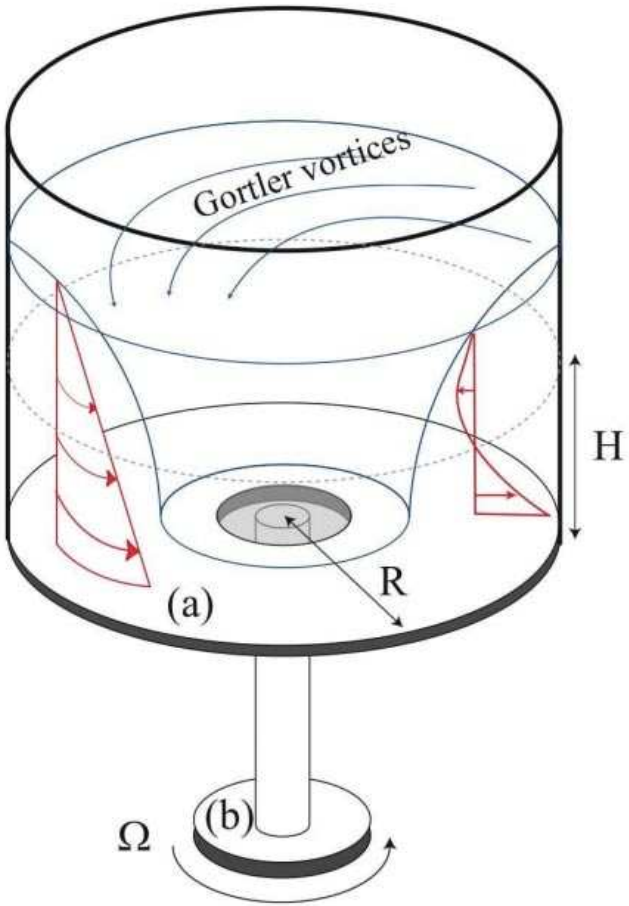
- Højden af vand over den roterende plade.
- Ethylen glycol i stedet for vand.
- 2 beholder 13,1 cm og 19,4 cm.
- Overfladespænding - opvaskemiddel
- Tilte hele forsøget.

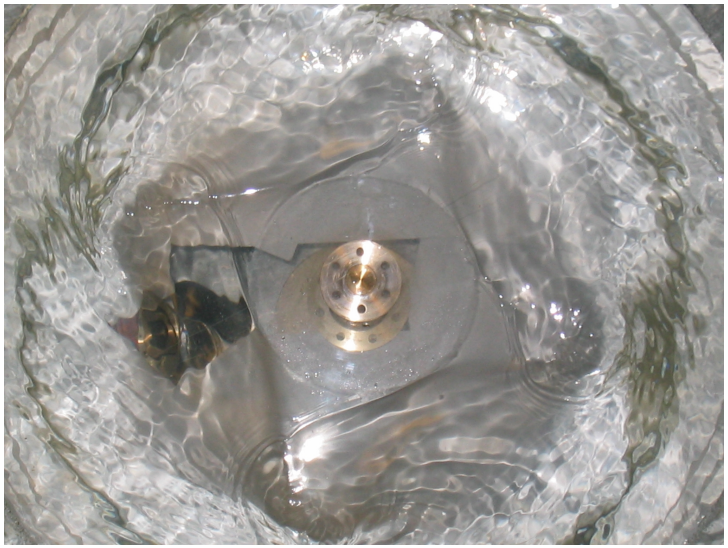


Forklaring

- Ændring i viskositeten på 15 gange ændre Reynolds tallet meget $Re = \frac{\Omega R^2}{\nu}$, men påvirker ikke fænomenet. Vores forsøg $Re = 1 \cdot 10^5 \rightarrow 1.5 \cdot 10^6$. Nummeriske forsøg ~ 5000
- Meget komplekst system p.g.a. den høje hastighed. Artikler om lignende emner handler om langsommere systemer
- Væggene i opstillingerne giver meget stor gnidning, hvilket kan være en del af forklaringen.

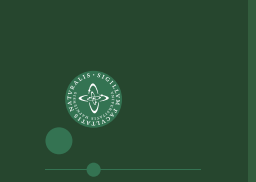
Billeder





Flow og mode-locking

- Rotationshastigheden af polygonerne er betydeligt mindre en pladens og sammenhængen er ret kompliceret.
- Observere mode-locking - at polygonerne drejer et hjørne for hver omgang af pladen.
- Von Karman flow - uendelig flade. Vores har endelig udstrækning og der er væske der bliver drevet op lang siderne og ned igen.



Anvendelser

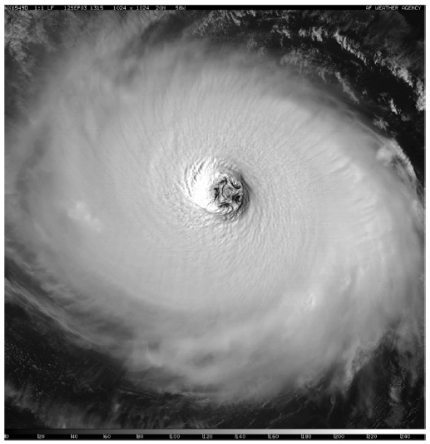
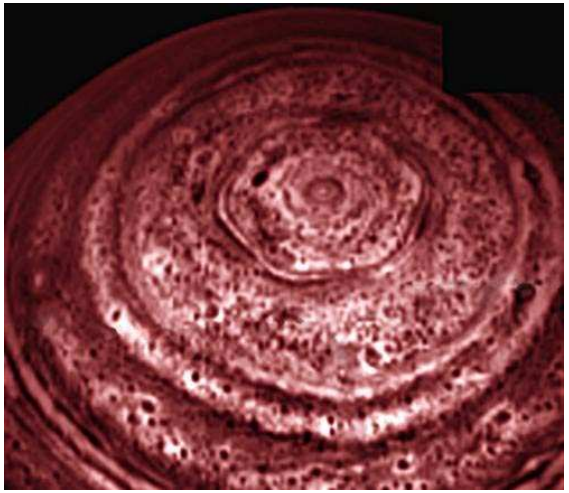


FIG. 1. Defense Meteorological Satellite Program (DMSP) image of Hurricane Isabel at 1315 UTC 12 Sep 2003. The starfish pattern is caused by the presence of six mesovortices in the eye—one at the eye center and five surrounding it.



- J. P. Kossin & W. P. Schubert, Bull. Amer. Met. Soc. (2004)
- Billeder fra Nasas Cassini mission viser en roterende hexagon over nordpolen på Saturn. Hexagonet er 25000km bredt i diameter og er kendt fra Voyager 1 og 2 missionerne i for 26 år siden, men er nu blevet optaget igen. Store temperatur forskelle og vind hastigheder kunne eventuelt give anledning til samme gnidning som væggene i vores forsøg viser.
- Hardiske

Artikel

I slutningen af vores Bachelor projekt mente Tomas Bohr at vi skulle skrive en artikel og et år efter i December 2005 sendte vi den afsted til Physcial Review Letters:

PRL 96, 174502 (2006) PHYSICAL REVIEW LETTERS week ending 5 MAY 2006

Polygons on a Rotating Fluid Surface

Thomas R. N. Jansson,[1,2] Martin P. Haspang,[1,2] Kåre H. Jensen,[1,2] Pascal Hersen,[1] and Tomas Bohr[1]

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[2]*The Niels Bohr Institute, Blegdamsvej 17, 2100 Copenhagen Ø, Denmark*

(Received 1 December 2005; published 3 May 2006)

We report a novel and spectacular instability of a fluid surface in a rotating system. In a flow driven by rotating the bottom plate of a partially filled, stationary cylindrical container, the shape of the free surface can spontaneously break the axial symmetry and assume the form of a polygon rotating rigidly with a speed different from that of the plate. With water, we have observed polygons with up to 6 corners. It has been known for many years that such flows are prone to symmetry breaking, but apparently the polygonal surface shapes have never been observed. The creation of rotating internal waves in a similar setup was observed for much lower rotation rates, where the free surface remains essentially flat [J. M. Lopez *et al.*, J. Fluid Mech. **502**, 99 (2004).]. We speculate that the instability is caused by the strong azimuthal shear due to the stationary walls and that it is triggered by minute wobbling of the rotating plate.

DOI: 10.1103/PhysRevLett.96.174502 PACS numbers: 47.20.Ky, 47.32.C−, 47.32.Ef

Endnu en overaskelse

I april 2006 møder Tomas Bohr Vatistas til en konference.

Experiments in Fluids 13, 377–385 (1992)

Experiments in Fluids

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Experiments on waves induced in the hollow core of vortices

G. H. Vatistas, J. Wang and **S. Lin**

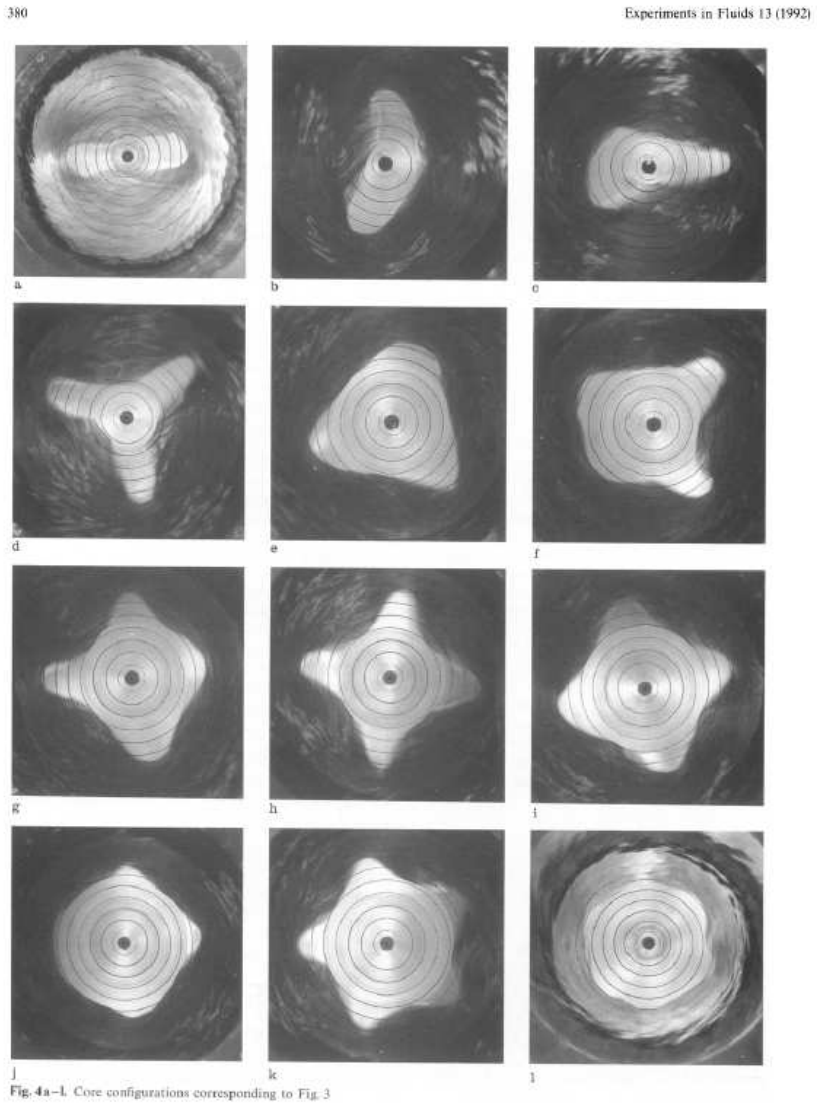
Department of Mechanical Engineering, Concordia University, 1455 DeMaisonneuve Blvd. West., Montreal, Canada

Abstract. Recent experimental findings with respect to wave activity in the core of a hollow disk-shaped vortex generated in a cylindrical container with a flat disk rotating at the bottom are reported herein. For relatively low viscosity fluid, several stationary states of the core exist within a certain range of disk speeds. This range becomes narrow as the wave number grows. Between the stationary states, mixed, time dependent states were found to occur. Their interval of endurance decrease with the wave number. The disk speed at which the static state first appears and ends increases linearly with the original height. The phase velocity of the stationary waves rises with the angular velocity of the disk. For a liquid with an intermediate value of viscosity, abrupt transitions from one equilibrium state to the other is taking place. Steady vortex core patterns with wave numbers from one to eleven are observed. States were the basic pattern is subharmonically modulated and states where a wave packet encircles periodically the core are also encountered. Hysterisis is clearly evident. The core of a highly viscous liquid is stable. A suppressed form of instability appears at very large liquid heights and disk speeds.

though the latter case might be more involved from the mathematical modeling point of view (complex boundary conditions and processes involved), than the above mentioned classical problems, it is relatively simple in construction. Futhermore, as it will be shown, it can provide the reseacher with a wide window into the study of flow transition.

In 1880 Lord Kelvin (Thomson, 1880) investigated theoretically the stability of culumnar vortices. One of the case studies involved the behavior of a hollow irrotational vortex in a fixed cylindrical tube under the influence of three-dimensional harmonic disturbances. His analysis showed that vortex cores perturbed by waves with different number, were consistent with the inviscid equations of motion. Recently, Vatistas (1990) was able to experimentally disclose the existence of a similar core behavior in a liquid forced into rotation by a disk in a stationary container. In the past the

Billeder fra Vatistas artikel



Erfaringerne ved at skrive sammen

- Arbejdsdeling - teori, eksperimenter og IT
- Møde med vejleder og præsentation af resultater
- Afleverede klokken 6 om morgen - printer på NBI og DTU
- At skrive en artikel efter bachelorprojekt tager tid.

Nature

Published online 19 May 2006 | Nature | doi:10.1038/news060515-17

News

Geometric whirlpools revealed

Recipe for making symmetrical holes in water is easy.

Philip Ball

Bizarre geometric shapes that appear at the centre of swirling vortices in planetary atmospheres might be explained by a simple experiment with a bucket of water.

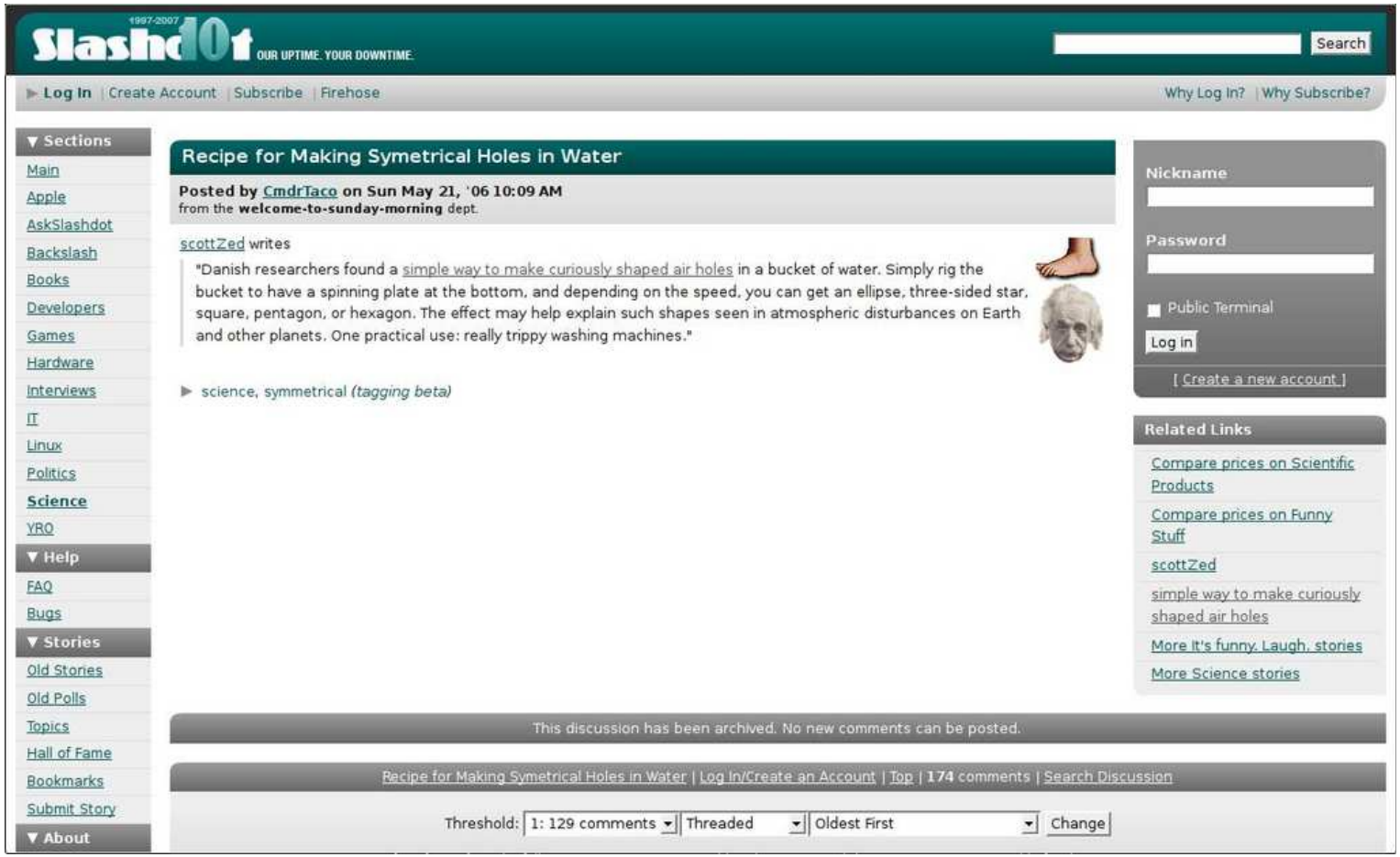
Researchers at the Technical University of Denmark in Lyngby have created similar geometric shapes (holes in the form of stars, squares, pentagons and hexagons) in whirlpools of water in a cylindrical bucket[1]. The shapes appear easily enough once the bucket is spinning at a rate of one to seven revolutions per second, they say.

Tomas Bohr and colleagues made plexiglass buckets, 13 and 20 centimetres across, with metal bottoms that could be rotated at high speed by a motor. They filled the bucket with water and spun the bottom to whip up the liquid into a whirlpool that rose up the sides of the container.

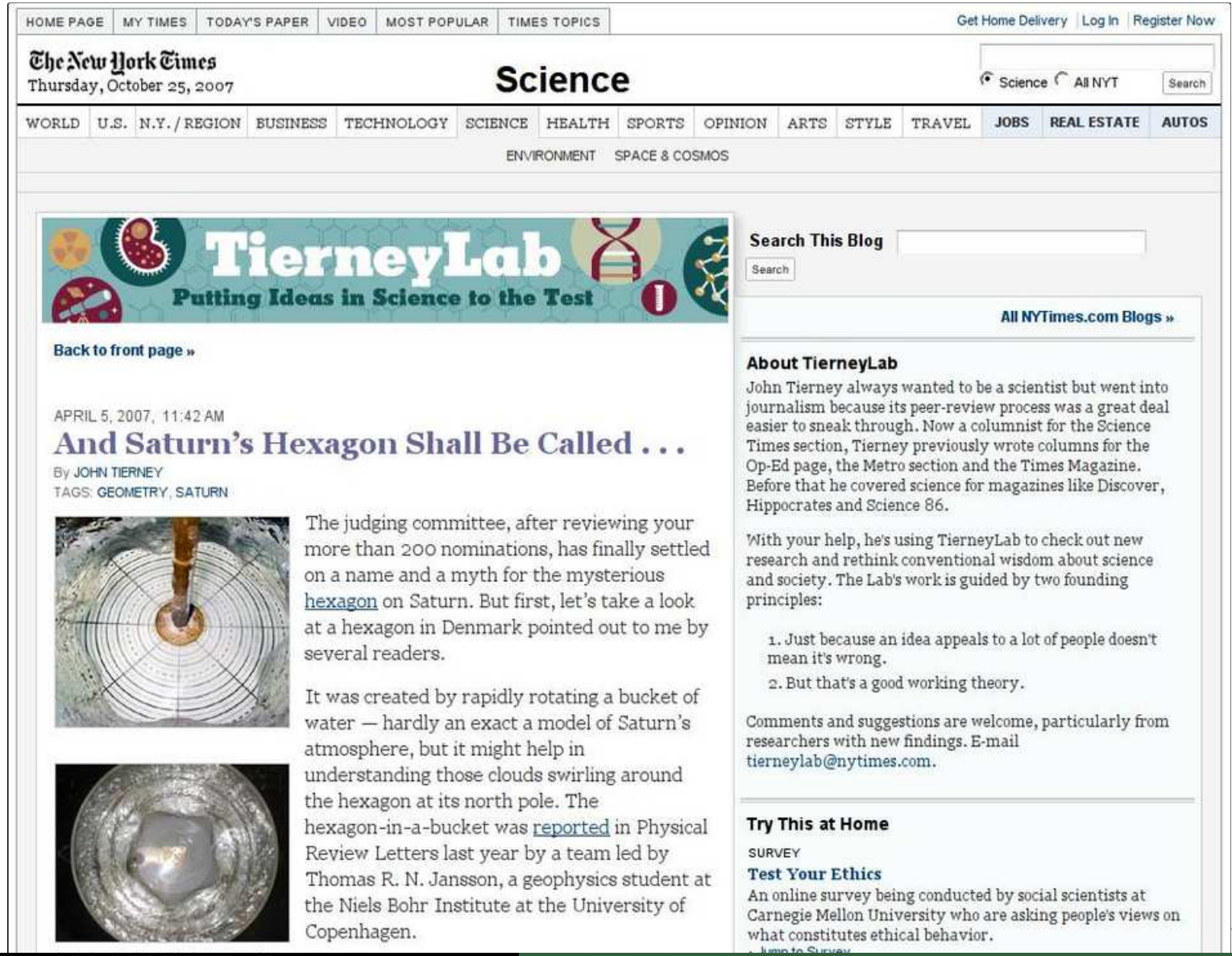
This set-up is very similar to the rotating bucket that Isaac Newton used in the

As a bucket of water speeds up, the hole changes shape from a three-sided star to a

Slashdot



New York Times



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APRIL 5, 2007, 11:42 AM

And Saturn's Hexagon Shall Be Called . . .

By JOHN TIERNEY
TAGS: GEOMETRY, SATURN

The judging committee, after reviewing your more than 200 nominations, has finally settled on a name and a myth for the mysterious hexagon on Saturn. But first, let's take a look at a hexagon in Denmark pointed out to me by several readers.

It was created by rapidly rotating a bucket of water — hardly an exact a model of Saturn's atmosphere, but it might help in understanding those clouds swirling around the hexagon at its north pole. The hexagon-in-a-bucket was reported in Physical Review Letters last year by a team led by Thomas R. N. Jansson, a geophysics student at the Niels Bohr Institute at the University of Copenhagen.

About TierneyLab

John Tierney always wanted to be a scientist but went into journalism because its peer-review process was a great deal easier to sneak through. Now a columnist for the Science Times section, Tierney previously wrote columns for the Op-Ed page, the Metro section and the Times Magazine. Before that he covered science for magazines like Discover, Hippocrates and Science 86.

With your help, he's using TierneyLab to check out new research and rethink conventional wisdom about science and society. The Lab's work is guided by two founding principles:

1. Just because an idea appeals to a lot of people doesn't mean it's wrong.
2. But that's a good working theory.

Comments and suggestions are welcome, particularly from researchers with new findings. E-mail tierneylab@nytimes.com.

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SURVEY

Test Your Ethics

An online survey being conducted by social scientists at Carnegie Mellon University who are asking people's views on what constitutes ethical behavior.

Link til videre læsning

tjansson.dk

Dette slideshow inklusiv videoer og links til andre sider kan findes på www.tjansson.dk

Referencer

- Thomas R. N. Jansson, Martin P. Haspang, Kåre H. Jensen, Pascal Hersen, and Tomas Bohr, *Polygons on a Rotating Fluid Surface*, Physical Review Letters **96**, 174502 (2006)
- Vatistas, G.H., "A Note on Liquid Vortex Sloshing and Kelvin's Equilibria", JFM, vol. 217, 1990, p. 241.
- Vatistas, G. H., Wang, J., and Lin, S. "Experiments on Waves Induced in the Hollow Core of Vortices". J. Exp. Fluids, vol 13, 1992, p.377.
- Vatistas, G. H., Wang, J., and Lin, S. "Recent Findings on Kelvin's Equilibria", Acta Mechanica, vol. 103, 1994, p. 89.
- Vatistas, G.H., Esmail, N., and Ravanis, C. "Wave Development in Disk-Like Nearly Inviscid Liquid Vortices", 39th AIAA Aerospace Sciences Meeting and Exhibit. Paper no. AIAA 2001-0168, 8-11 January 2001, Reno, NV.