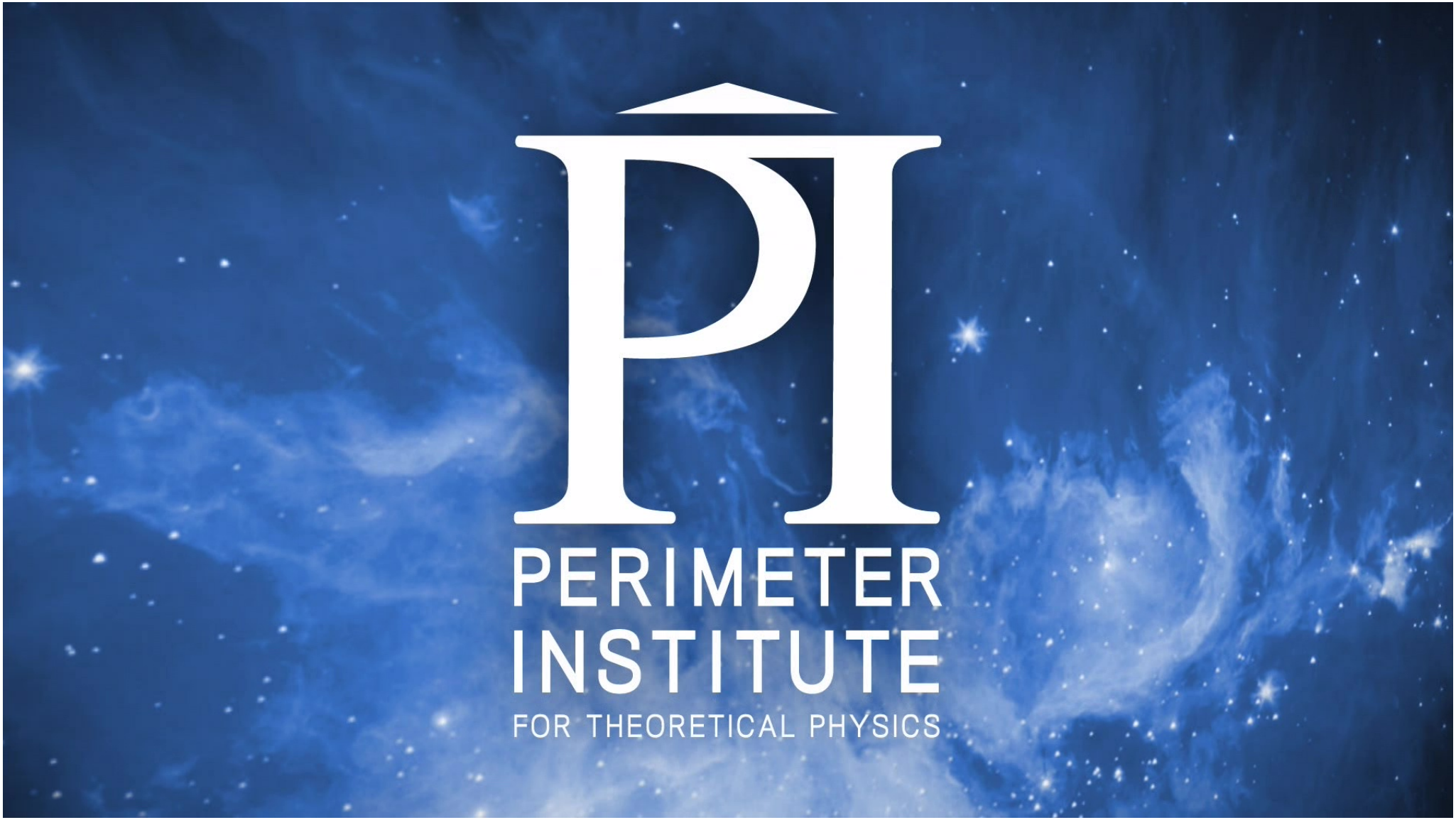
Title: WATER STRESS: SEEKING SOLUTIONS IN THE UNUSUAL PROPERTIES OF WATER

Date: Mar 04, 2015 07:00 PM

URL: http://pirsa.org/15030118

Abstract: Marcia Barbosa,<br>
Universidade Federal do Rio Grande do Sul<br>
Water Stress:<br>
Seeking Solutions in the<br>
Unusual Properties of Water<br>
Perimeter Institute Public Lecture<br>
WEDNESDAY, March 4 at 7:00 pm<br>
Mike Lazaridis Theatre of Ideas<br>
Perimeter Institute<br>
31 Caroline St. N., Waterloo

<a
href="https://prod5.agileticketing.net/WebSales/pages/info.aspx?evtinfo=36383~b872f9ab-a60c-4e69-a7ff-845da8df201e&epguid=20a1ea4d-8346-4280-93a3-1fa6988560e0&">Tickets available online</a> on Tuesday, February 17th at 9:00 am.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# Tonight's Public Lecture

## Marcia C. Barbosa

## Water Stress: Seeking Solutions in the Unusual Properties of Water

March 4, 2015

PERIMETER INSTITUTE FOR THEORETICAL PHYSICS

PUBLIC LECTURE Series

*presented by*

Sun Life Financial


Water Stress: Seeking Solutions in the unusual properties of water
Marcia C. Barbosa
PERIMETER INSTITUTE
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What is the problem?

Why should we care?

What are the clues?

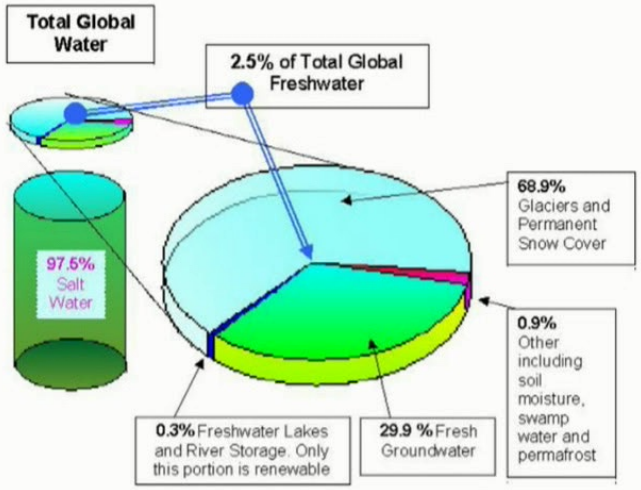
Desalination - Current Methods

Desalination - Anomalies of Water

# What is the problem?

Shiklomanov, Unesco

*http : //webworld.unesco.org/water/ihp/db/shiklomanov/summary/html/figure$_1$.html*

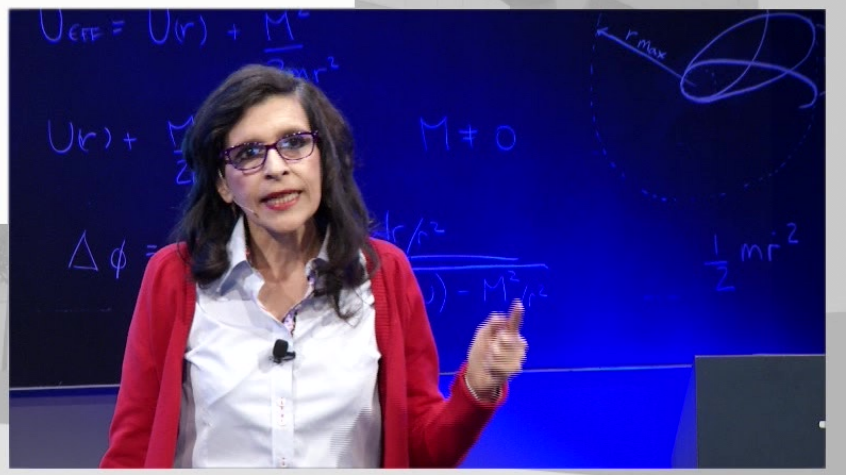



## What is the problem?

Shiklomanov, Unesco

*http : //webworld.unesco.org/water/ihp/db/shiklomanov/index.shtml*

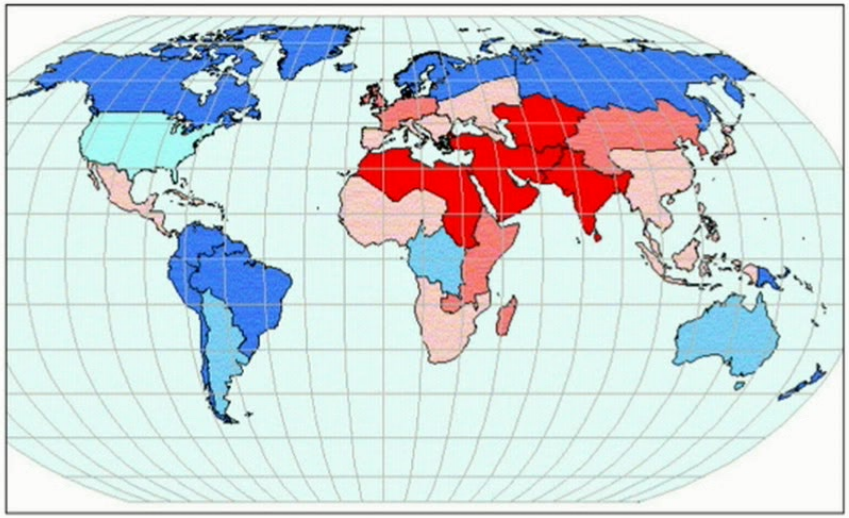
- food = 66%
- domestic households = 10%
- industry =20%
- evaporate = 4%



# 2025

Shiklomanov, Unesco

*http : //webworld.unesco.org/water/ihp/db/shiklomanov/index.shtml*



# What are the clues?

Water 3D-balls by Benjah-bmm27

*http : //commons.wikimedia.org/wiki/File : Water − 3D − balls.png*

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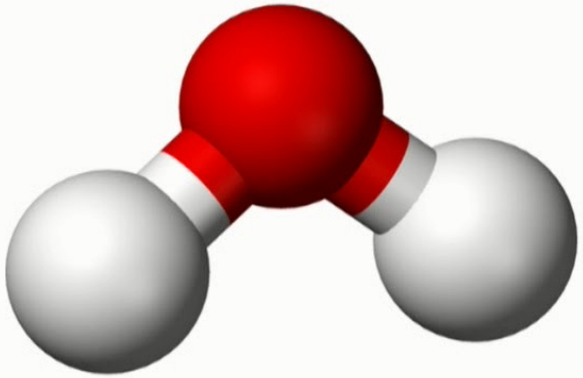

# Water H Bond

Hydrogen-bonding-in-water by Benjah-bmm27 (talk- contribs)

*http : //commons.wikimedia.org/wiki/File : Hydrogen − bonding − in − water − 2D.png*

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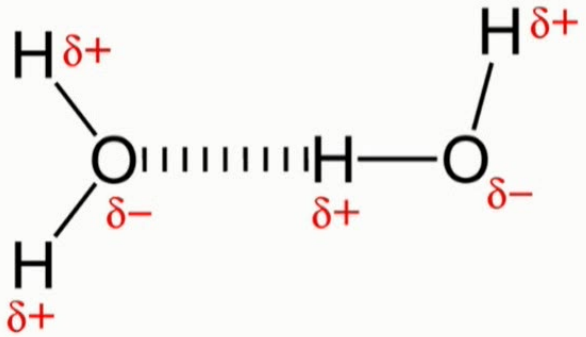
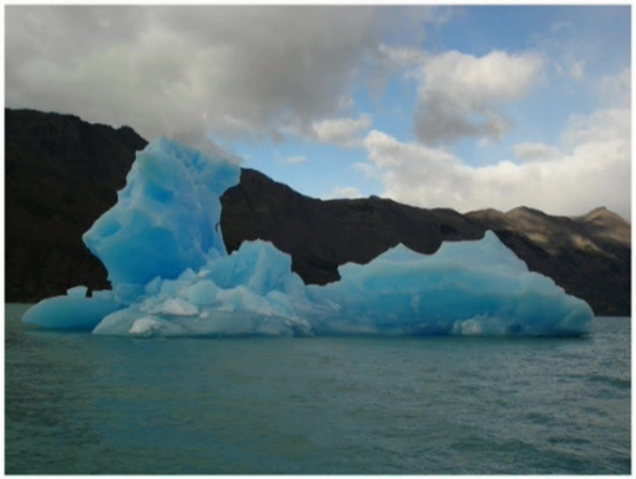



## Water Anomalies - 72 Anomalies

- Density
- Heat Capacity
- Diffusion
- Water Super Flow
- Materials that love/hate water

## Density Anomaly

Deise Costa Patagonia, Argentina



# Density Anomaly

Anomalous expansion of water Summer Winter by Klaus-Dieter Keller

*http : //commons.wikimedia.org/wiki/File : Anomalous_expansion_of_water_Summer_Winter.svg*

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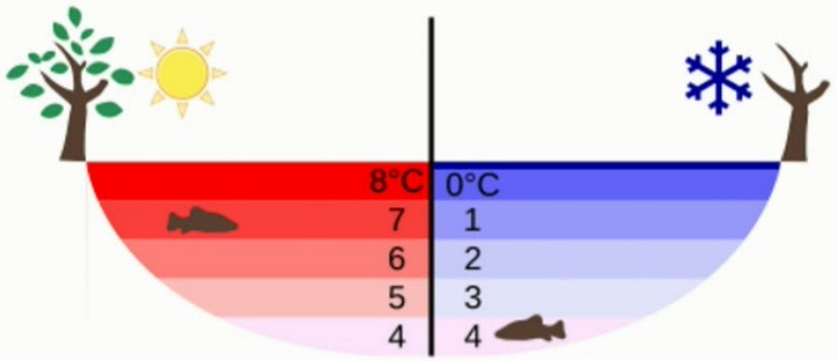
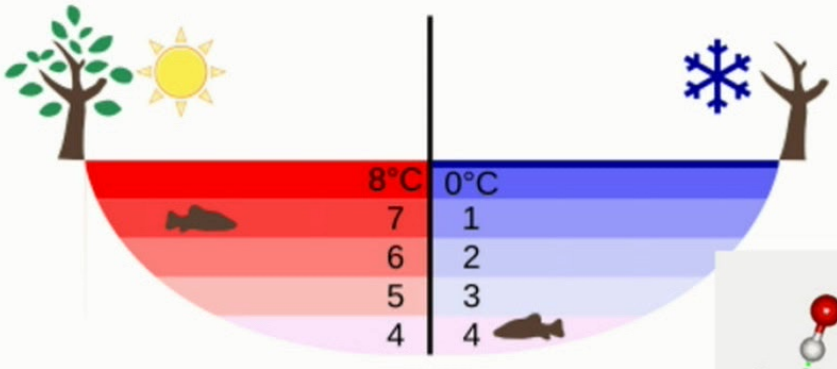


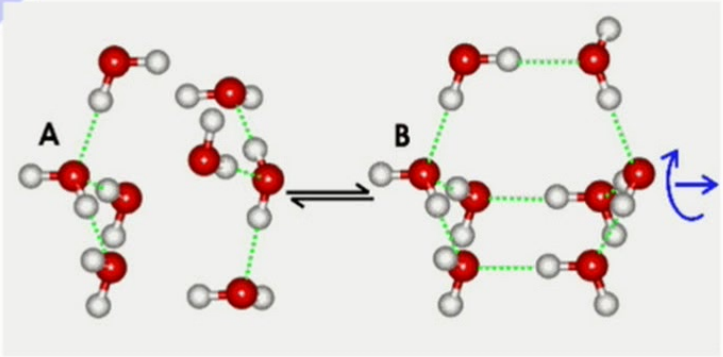
# Density Anomaly

## Water by Martin Chaplin

*http : //www1.lsbu.ac.uk/water/clusters_overview.html*





# Heat Capacity

Image:photoeverywhere.co.uk

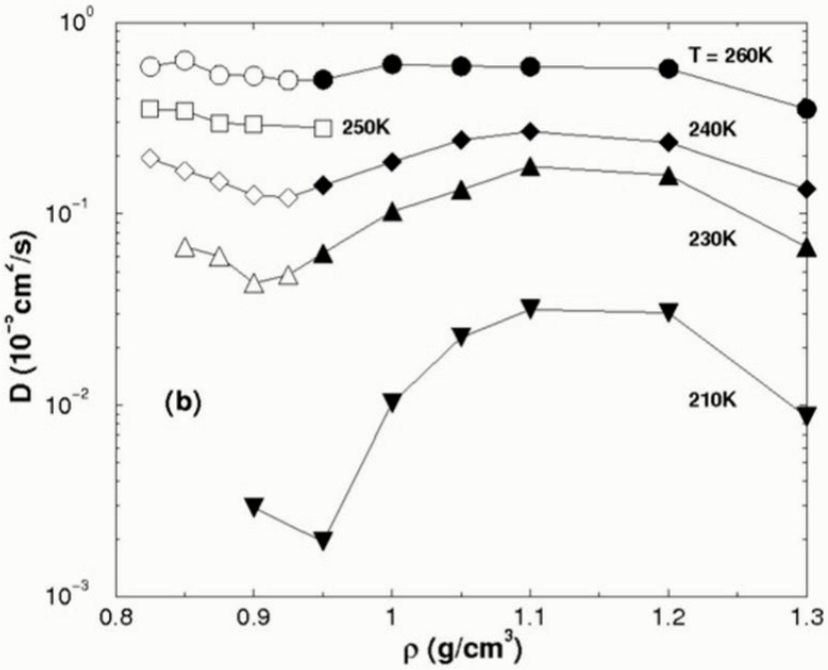
*http : //photoeverywhere.co.uk/east/fiji/slides/golden_sand.htm*



**silicon - 1.712 kJ/kgC**
**water 4.18 kJ/kgC**

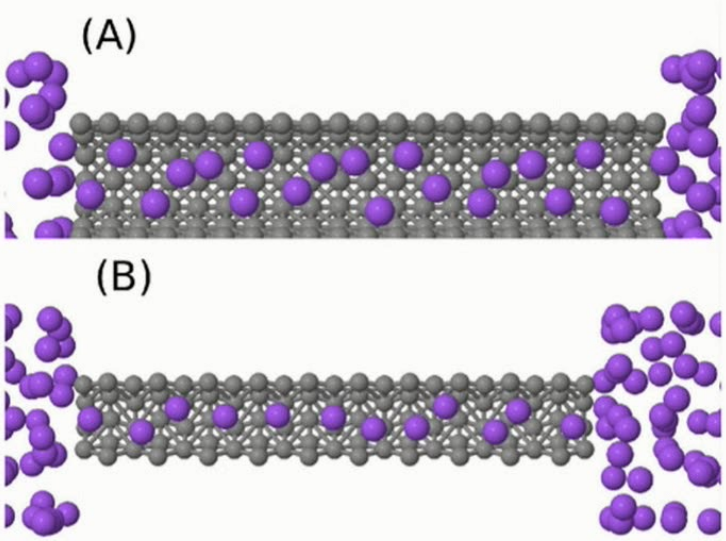
# Diffusion Anomaly

Netz, Starr, Stanley, Barbosa (2001)



# Water Super Flow

Bordin,Diehl, Barbosa 2014

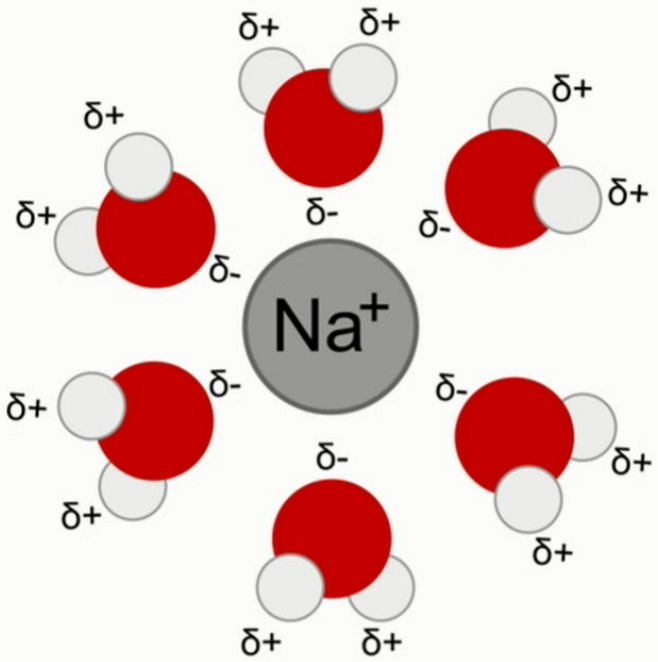


# Hydration - The materials that love water

Na+H2O by Taxman

*http : //commons.wikimedia.org/wiki/File : Na2BH2O.svg*



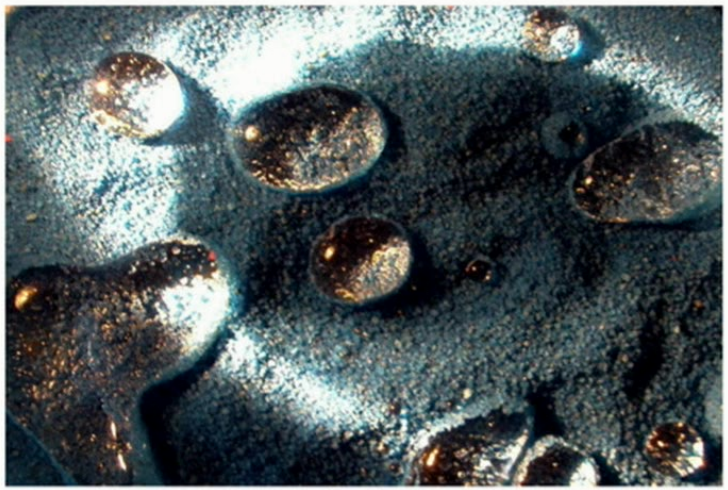


# Hydration - The materials that hate water

## Hydrophobic Sand by Steve Jurvetson

*http : //commons.wikimedia.org/wiki/File : Hydrophobic_Sand.jpg*



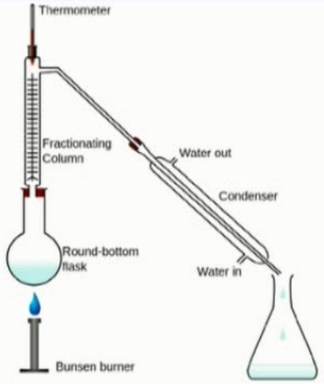


# Desalination - Thermal Distillation

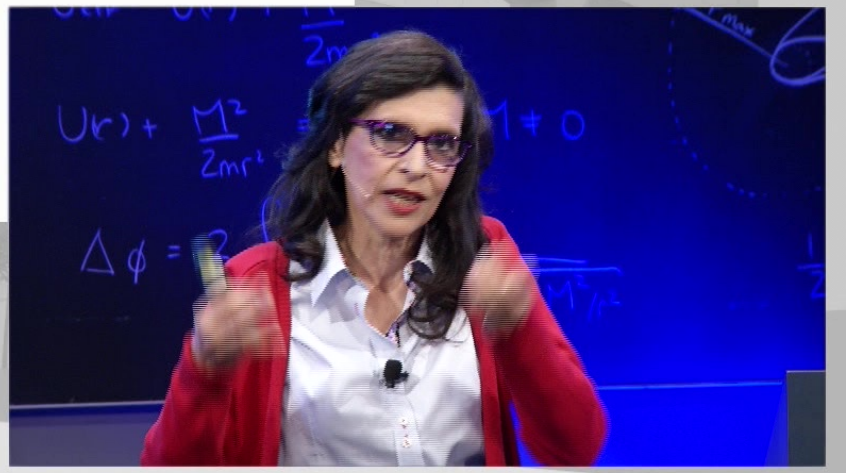
## Fractional Distillation lab apparatus by John Kershaw (talk)

*http : //commons.wikimedia.org/wiki/File : Fractional_distillation_lab_apparatus.svg*



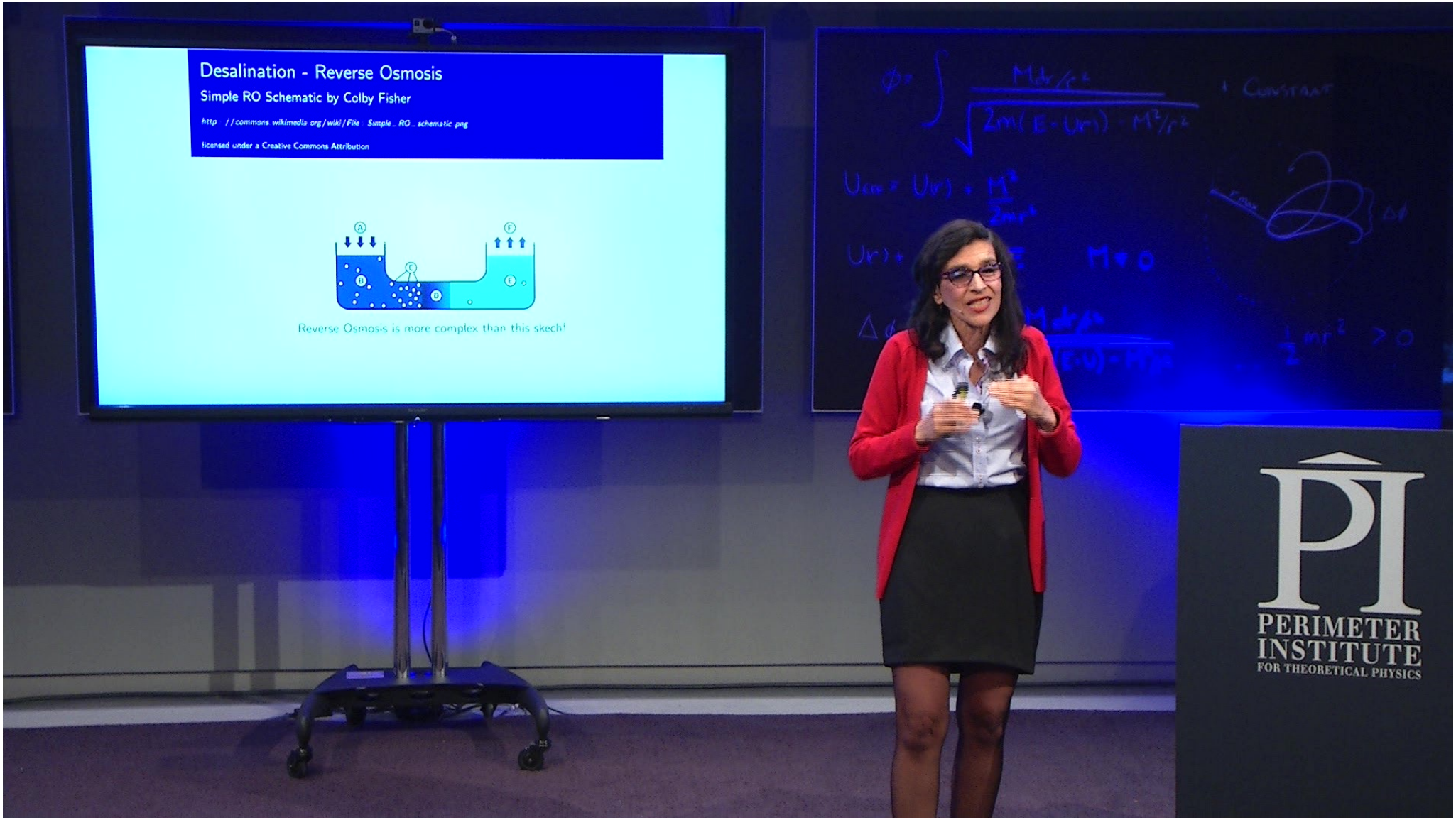



Thermal Distillation is more complex than this sketch!



# Desalination - Thermal Distillation

- Multi-Effect distillation
- Multistage Flash
- Vapor Compression


Desalination - Reverse Osmosis
Simple RO Schematic by Colby Fisher
http://commons.wikimedia.org/wiki/File:Simple_RO_schematic.png
licensed under a Creative Commons Attribution
Reverse Osmosis is more complex than this sketch!
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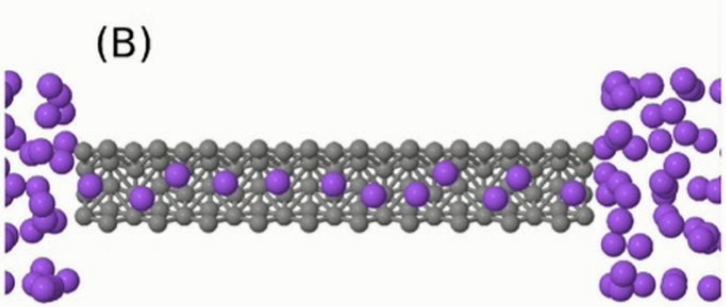
## Desalination - Anomalies of Water

- Nanotubes
- Biomimetics
- Membrane Distillation
- Hydrophobic-hydrophilic

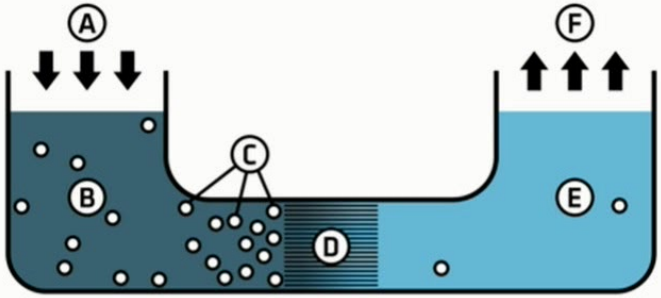
# Desalination - Carbon Nanotubes

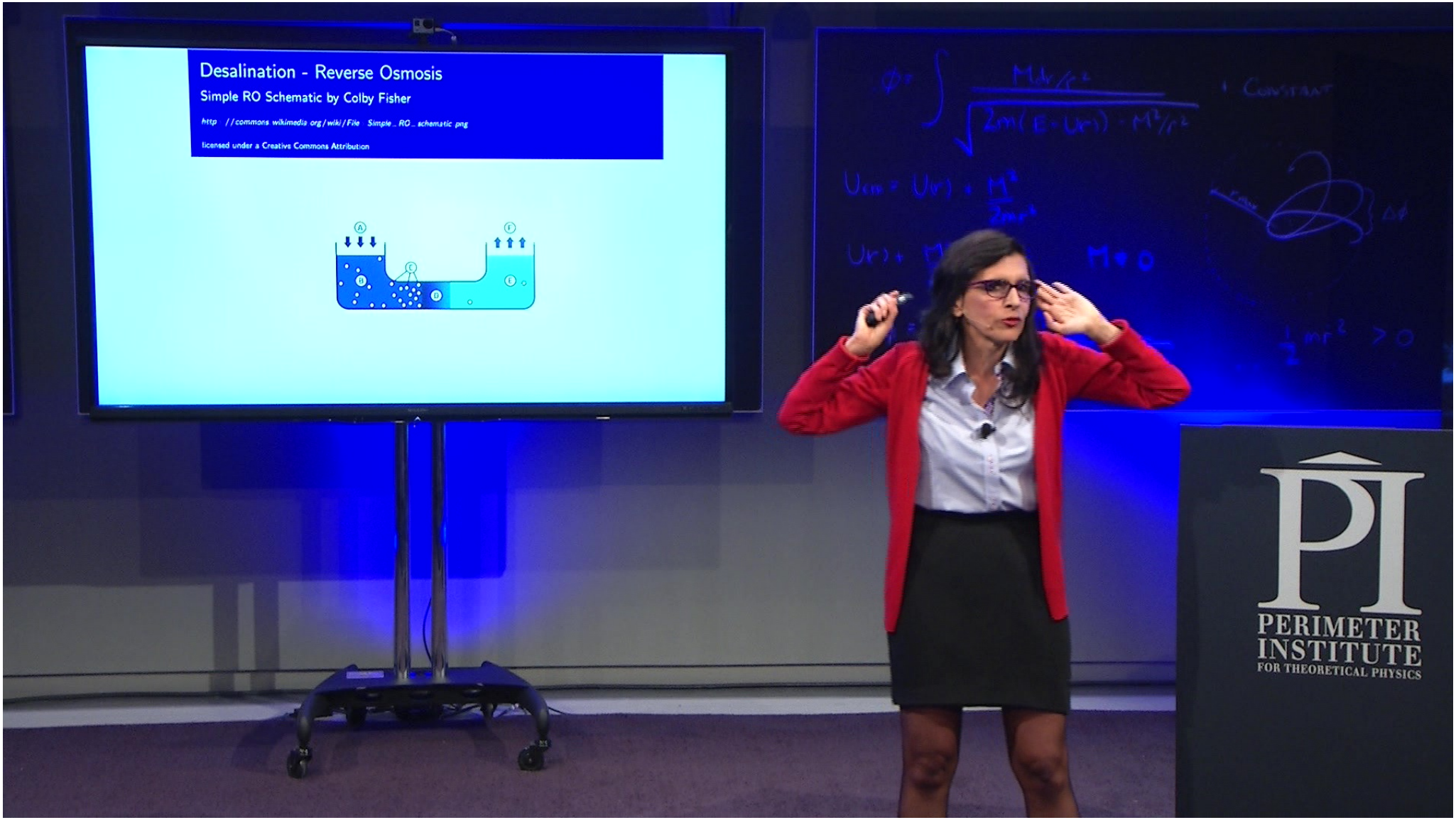
Hinds et al, 2004, Fornsiero et al, 2008, Corry et al, 2011,Bordin et al, 2013, 2014,...



# Desalination - Membrane Distillation

Gerhard, Sae-Khow, Mitra, 2011




Desalination - Reverse Osmosis
Simple RO Schematic by Colby Fisher
http //commons.wikimedia.org/wiki/File Simple_RO_schematic.png
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## Namibia Beatle

Stenocara dentata Herbst, 1799 by Hans Hillewaert

*http : //commons.wikimedia.org/wiki/File : Stenocara_dentata.jpg*

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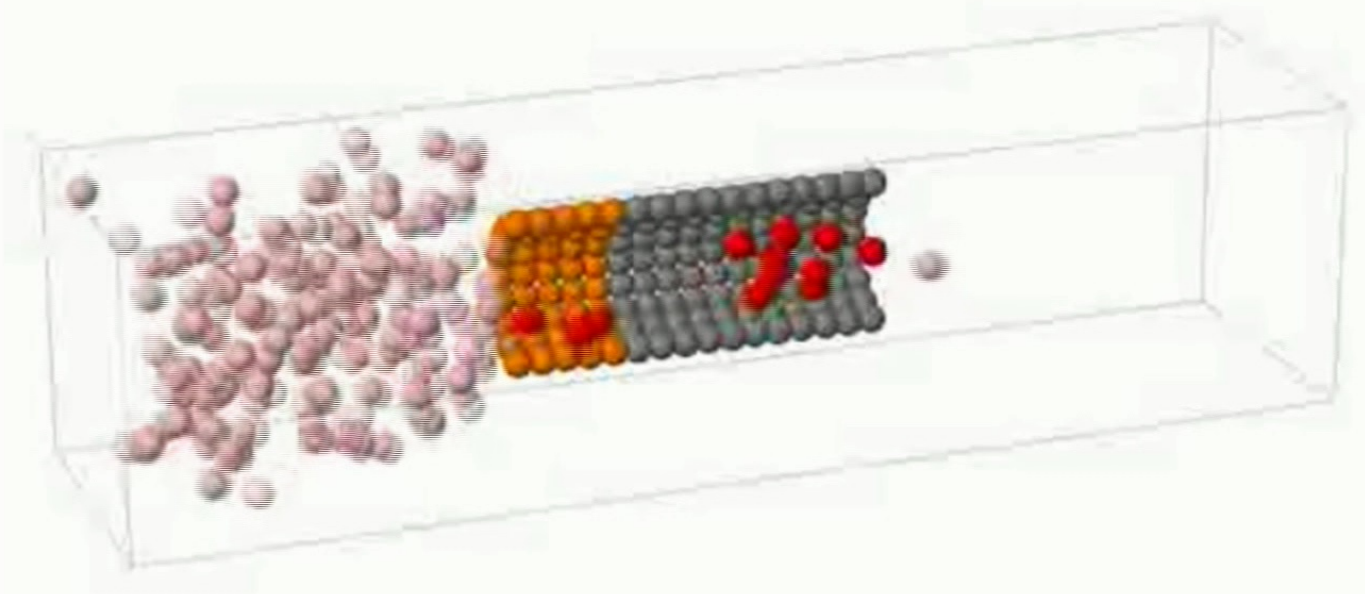

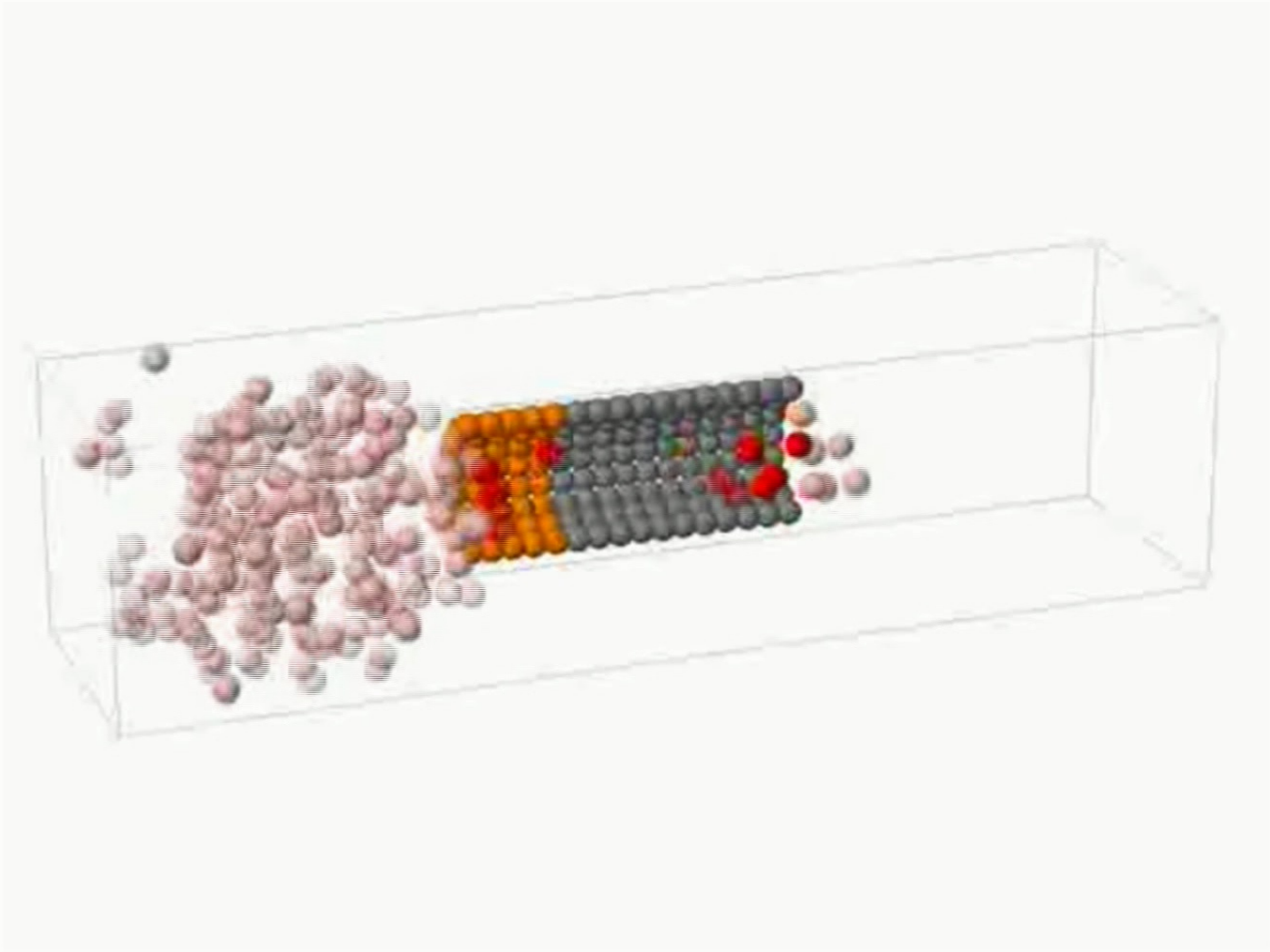

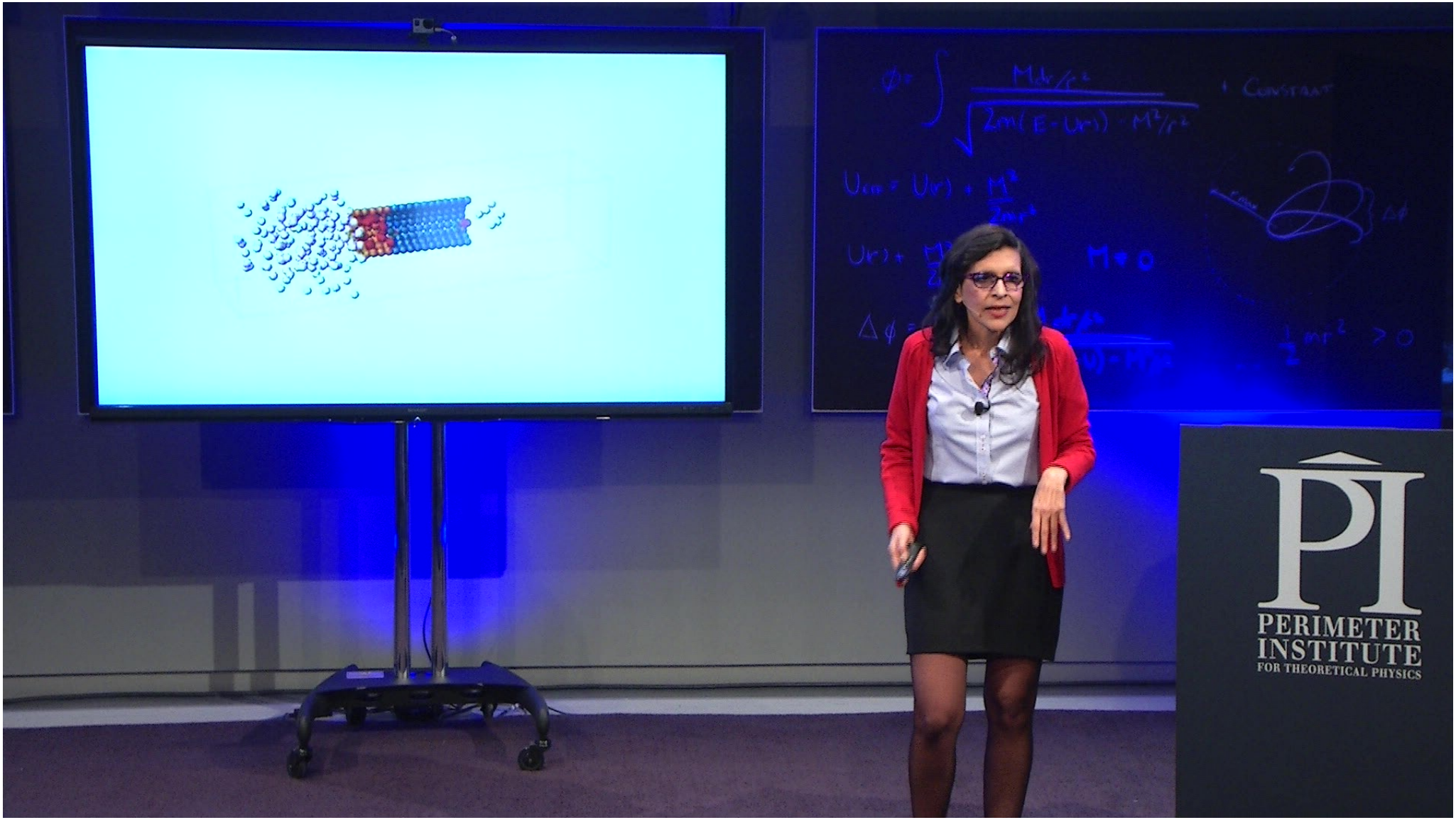
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