Orbiting Frog

Astronomy, Space, Science

Measure the Speed of Light Using Your Microwave

May 13, 2008 — Leave a comment

Astronomers studying star formation, like myself, use telescopes that can see though the pretty, optical exteriors of nebulae into the dark interiors where very cold dust radiates in the submillimetre and microwave regimes.

Microwaves, fall on the electromagnetic spectrum, between radio waves and infrared waves. They are usually around the size of a few centimetres and you may well be very familiar with them as they are produced by the microwave oven that might just be sitting in your kitchen.

Microwave ovens use a particular microwave frequency to excite molecules of water. Since water is present in lots of food and drink, this means that microwaves heat up lots of useful stuff – and they do it quickly. The fact that microwaves are now readily available to most of us in the western world and they are only a few centimetres in length, means that you can measure the speed of light in your very own home.

What You Need:

The quickest and tastiest way to perform this little experiment is with marshmallows, but chocolate chips also work. You'll obviously need a microwave oven as well, and a large, microwaveable dish.

I'm Robert Simpson and I work at the Zooniverse, a world-leading Citizen Science platform. I am also the creator of .Astronomy. I am an astrophysicist and my research involves understanding how stars form. I also love the web! You can hear me on the Recycled Electrons podcast.

Recent Popular Tags

The Rabbit Has Landed: China is on the Moon
December 14, 2013

A Brand New Milky Way Project
December 12, 2013

Male and female brains: the REAL differences
December 4, 2013

Comet ISON Dives In
November 28, 2013

So… I'm a TED Fellow
November 19, 2013

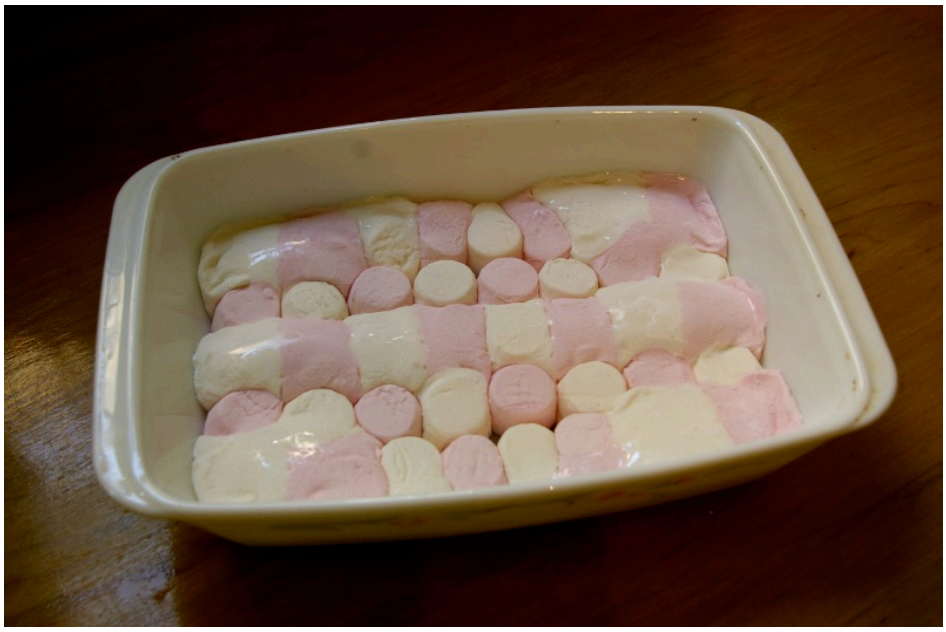
The View from Saturn
November 18, 2013

You will need a ruler, too.

What to Do:

Get your large, microwaveable dish and place a layer of marshmallows at the bottom of it.Remove the turntable from the bottom of the microwave oven. If you don't, then this experiment will not work at all. If your microwave doesn't have a turntable, it means that the turning mechanism is elsewhere and you'll need to find a regular microwave oven to try this experiment.

Cook the marshmallows on a low heat for a couple of minutes, or until you see parts of the marshmallows starting to bubble. When you do, remove the dish and take a look at the marshmallows.



You ought to see that they have not melted evenly. In fact you should be able to see a regular pattern has formed, drawn out in melted-mallow. It depends on your microwave oven, but you should see a melted/unmelted pattern across the dish in some direction. When I tried it at home, my oven created long melted strips next to long unmelted strips (see above).

This regularity is caused by the same mechanism that heats up the food you place into your microwave oven. The appliance generates microwaves which very quickly form standing waves (see animation above) inside the cavity inside, where you put food. As the food rotates around, it passes through the standing wave nodes and this excites the water molecules, heating the food.

Measure the Microwaves:

Take your ruler and measure the distance between the melted parts of the marshmallows. You should find that there is an even pattern of melting and that the distance between them is something like 5 or 6cm. Why? Because that is the distance between the nodes of the standing waves.

Zooniverse Jobs – Come Work with Us in Oxford
November 11, 2013

1.6 Tonnes of Rubbish Burning Up in the Atmosphere
November 7, 2013

Astronomy in Everyday Life
November 6, 2013

Kepler-90: An Amazing, Tiny Solar System Where Internet Rumours Come True
November 4, 2013

Categories

.Astronomy (8)

Fun (20)

Hacks (5)

Interesting (22)

Literature Hacking (7)

News (31)

Open Science (3)

Oxford (8)

Podcast (2)

Research (17)

Satellite Tracking (7)

Schools (6)

Science at Home (7)

TED (1)

Travel (2)

Uncategorized (495)

Zooniverse (9)

Twitter

"Worst People In The World" - on Big Tobacco and genocide buff.ly/1klmBIZ 4 hours ago

British Library uploads one million public domain images to the net for remix and reuse buff.ly/1fd4gSZ 7 hours ago

Without the rotating mechanism, the food does not move around and cook evenly, instead it just heats at the nodal points. **Using your marshmallows you have created a 'map' of the microwaves in your microwave oven!**

Find the Frequency:

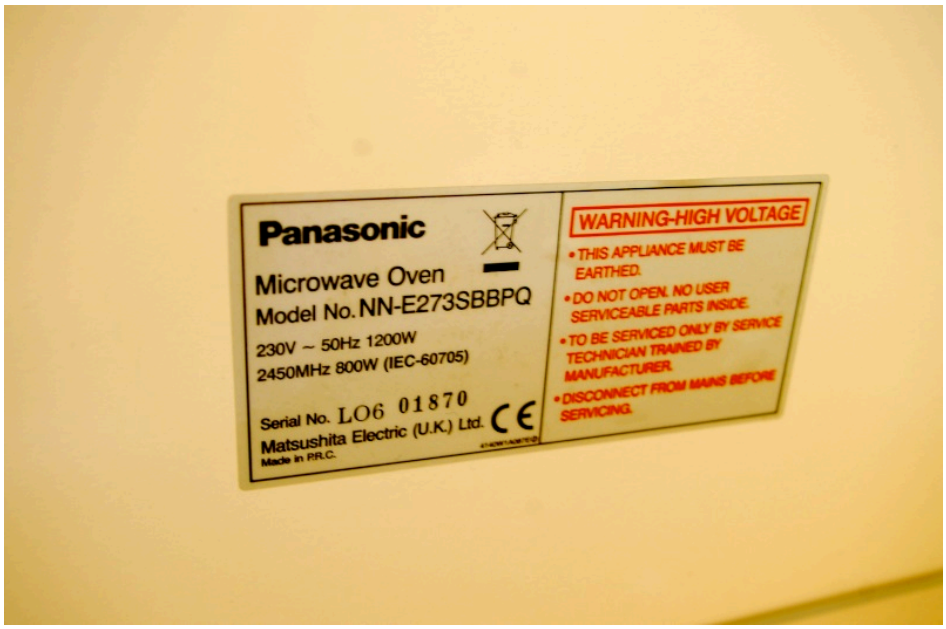
Finally you need to know the frequency at which your microwave oven operates. It is usually written on the back somewhere in small writing. Most standard microwave ovens operate at 2450 MHz. If you cannot find the value on the back of the oven, you can take it for granted that 2450 MHz is about correct.

Measure the Speed of Light:

Now you have what you need to measure the speed of light. You just need to know a very fundamental equation of physics:

Speed of a Wave (c) = Frequency (f) x Wavelength (L)

The distance between the melted sections of the marshmallow is in fact L/2, because there are two nodes for each wave (see animation). So if you have measured 6cm and your oven operates at 2450 MHz, then your measured speed of light is (0.12 x 2450,000,000) 294,000,000 metres per second.



The agreed value of the speed of light through a vacuum is 299,792,458 metres per second. See how accurately you can measure it? what could you do to make the experiment better, and thus get a closer answer?

Now You Can Eat the Gooey Melted Marshmallows:

…and make yourself sick. Yay!

Related

Explore Planck Data in Chro…
In "News"

Supercooled Water and Tow…
In "Fun"

How to Make Glowing Jelly
In "Fun"

In Fun, Hacks, Schools, Science at Home

No Comments

Be the first to start the conversation!

Leave a Reply

Enter your comment here...

Previous Next