Grape-ling with microwaves: Why this piece of fruit ignites inside them

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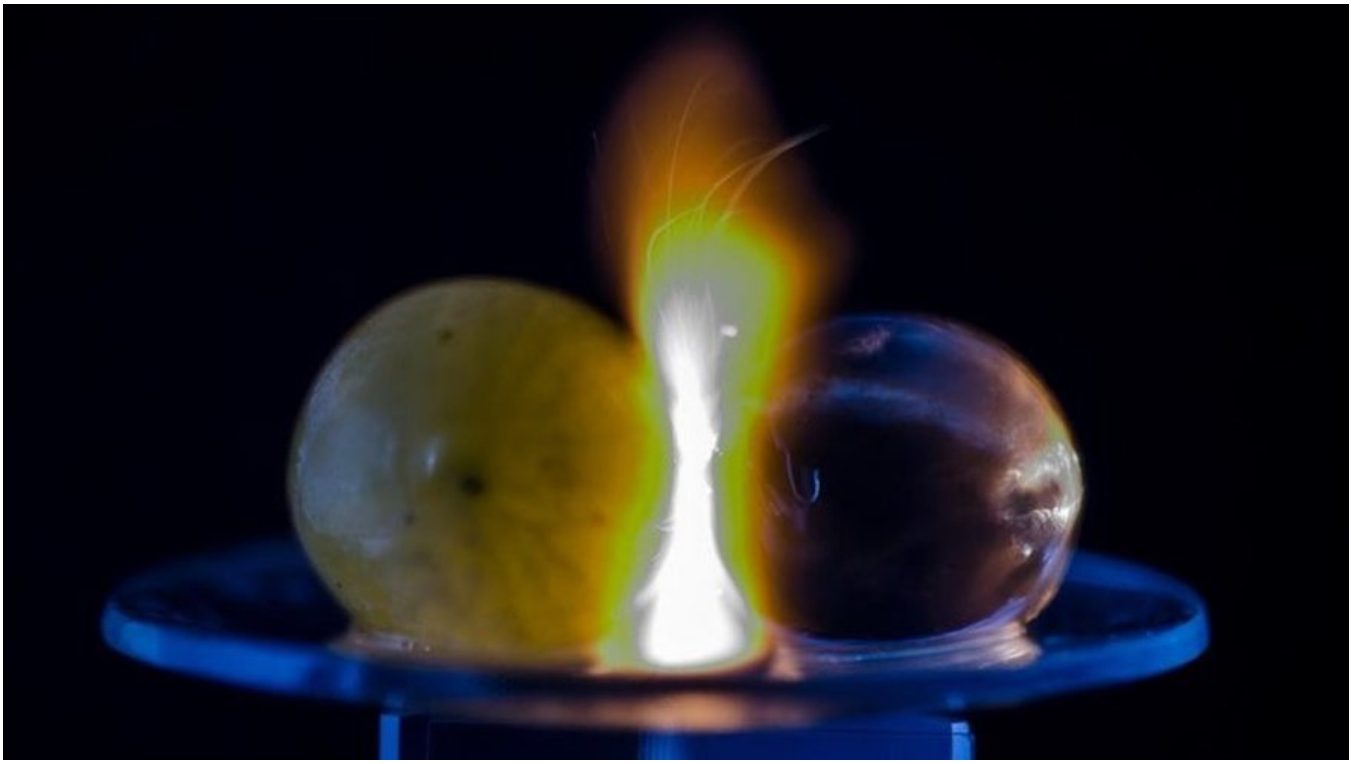


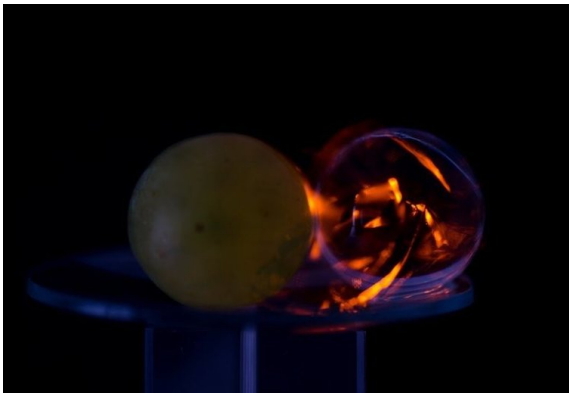
Image 1. A grape meets a hydrogel bead, and sparks fly. Photo by: Hamza Khattak/Slepkov Biophotonics Lab, Trent University

Literature fans will recognize the following quotation as a riff on the first line of Jane Austen's "Pride and Prejudice": "It is a truth universally acknowledged that a pair of grape hemispheres exposed to intense microwave radiation will spark, igniting a plasma."

Sparks may fly between Elizabeth Bennet and Mr. Darcy in Austen's book. However, that's nothing compared to the flames that come when two halves of a grape get close enough to touch while spinning inside a microwave. The above quote, in fact, is the first line of another great piece of literature, published recently by Proceedings of the National Academy of Sciences.

In the paper, "Linking plasma formation in grapes to microwave resonances of aqueous dimers," physicists Hamza K. Khattak, Pablo Bianucci and Aaron D. Slepkova deployed many grapes and several microwaves in the name of science. Microwaving a nearly halved grape to watch the middle ignite is a popular, much-documented pastime. For decades, this fiery trick has been filmed and shared on the internet where it mystified observers. The researchers set out to solve the mystery.

The Igniting Grape Phenomenon



The leading theory was that when two halves of a grape are microwaved, the fruit's skin connecting them acts as an antenna. The current that runs through the antenna heats up until a plasma forms. Plasma is an ionized gas that occurs when atoms are heated to the point that they release their electrons. Lightning is plasma, as is the sun.

Ionization is the process of turning an atom or molecule into an ion by adding or removing charged particles such as electrons or other ions. An ion is an electrically charged atom or group of atoms.

The antenna theory turned out not to be the case, says study author Bianucci. A physicist at Concordia University in Montreal, Quebec, Canada, he's been fielding many calls from journalists interested in their findings. His fellow researcher, Slepkova, first learned about the grape phenomenon on the internet in 1995, and they began studying it together as a side project in 2015. However, it was only when undergraduate Khattak joined the team in 2017, says Bianucci, that the research "pushed forward very quickly."

Ionized Sodium And Potassium

Using modified microwave ovens that allowed them to take photos, Slepkova and Khattak began microwaving grapes. The paper says the team used "thermal-imaging techniques and computer simulations" to examine what was happening.

It turned out that cutting the grapes wasn't necessary, and neither was the connecting skin. Even two whole peeled grapes side-by-side could bring fireworks. In fact, any grape-like objects, including blueberries, cherry tomatoes, quail eggs and hydrogel water beads, do the same — a fact the researchers carefully proved by microwaving each in turn.

This insight led the team to a new theory. In what Bianucci calls a "lucky coincidence," grapes are mostly made of water, which reduces the wavelengths of microwaves significantly. The lengths of microwaves average about 4.7 inches in the air, but in water the length drops to around .4 to .8 inches, which is a bit smaller than an average grape.

"Microwaves can get trapped inside the grape," says Bianucci. If a grape is microwaved by itself, a hotspot forms in its center from the trapped microwaves. Then when two grapes are close enough, the waves can "hop" from one to the other. "This hopping results in a very strong electromagnetic field in between the grapes," he says. When the field is strong enough to ionize the sodium and potassium ions in the grapes, it results in a tiny fireball.

The team's discovery took several years and resulted in the deaths of 12 microwave ovens. Even heavily modified microwaves "don't like to run empty" except for two grapes. This might seem like lighthearted research, and the paper acknowledges that "observing a piece of fruit burst into flames in a microwave oven is exciting and memorable."

However, there are also real-world implications. As Bianucci explained to Physics World, these findings could come in handy in the field of nanophotonics, which is the study of light on a very small scale. Meanwhile, anyone interested in a free light show can microwave away, carefully, secure in the knowledge that we have a better idea of what's happening in there.

Quiz

1 Read the following statement.

The study linking plasma formation to the microwaving of grapes might have useful applications in the future.

Which sentence from the article BEST supports the statement above?

(A) The paper says the team used "thermal-imaging techniques and computer simulations" to examine what was happening.

(B) This might seem like lighthearted research, and the paper acknowledges that "observing a piece of fruit burst into flames in a microwave oven is exciting and memorable."

(C) Bianucci explained to Physics World, these findings could come in handy in the field of nanophotonics, which is the study of light on a very small scale.

(D) Meanwhile, anyone interested in a free light show can microwave away, carefully, secure in the knowledge that we have a better idea of what's happening in there.

2 Is the author of the article suggesting that microwaving grape-like objects was a waste of time? Which detail from the text BEST supports your answer?

(A) No: Microwaving the grape-like objects led the researchers to come up with a new theory about what happens in the microwave oven.

(B) No: Microwaving the grape-like objects showed the researchers how important it was for the grapes to have skin during the experiment.

(C) Yes: Microwaving the grape-like objects led the researchers to destroy 12 modified microwave ovens without finding out anything new.

(D) Yes: Microwaving the grape-like objects showed the researchers nothing that they did not already know from microwaving the grapes.

3 What are the reasons why flames ignite between two grapes in a microwave?

1. *The thermal-imaging techniques used by the researchers allowed the wavelengths in microwaves to change from 4.7 inches to .4 or .8 inches.*
2. *The skin on the grapes becomes some type of antenna, which allows currents to run through the grapes until a plasma is formed.*
3. *The grapes are made of mostly water, which causes the wavelengths of microwaves to decrease in size and become trapped in the grapes.*
4. *Waves will jump from one grape to another and create an electromagnetic field which ionizes sodium and potassium ions in the grapes.*

(A) 1 and 2 only

(B) 3 and 4 only

(C) 1, 2, and 3

(D) 2, 3 and 4

4 Why did the author begin the article by mentioning Jane Austen's "Pride and Prejudice"?

(A) because Jane Austen delved into the topic of grape hemispheres, microwaving radiation and plasma formation in her book "Pride and Prejudice"

(B) because the writers of the scientific paper modeled a statement in their paper after the well-known first line of Jane Austen's book

(C) because Jane Austen inspired Hamza K. Khattak, Pablo Bianucci and Aaron D. Slepkova to do the study on the grape phenomenon

(D) because the grape experiment paper has become just as popular as Jane Austen's "Pride and Prejudice" was many years ago