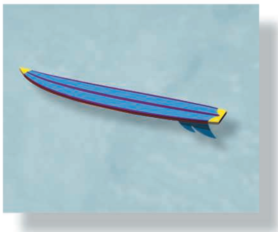
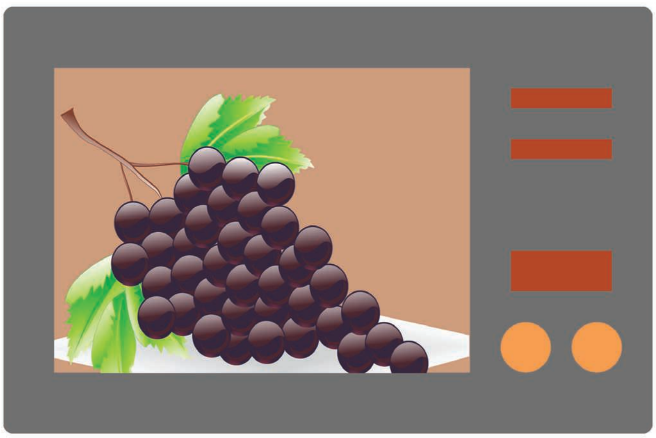


Microwave Surfing

The Wrath of Grapes?

■ **Rajeev Bansal**

There is nothing new to be discovered in physics now. All that remains is more and more precise measurement [1].



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Lord Kelvin (1824–1907) is supposed to have made this claim in 1900, obviously unaware that quantum mechanics and the theory of relativity were just around the corner. In recent years, scientists have tended to be far more cautious in delineating the scope of their collective understanding of the universe. For example, *Live Science* published a list [1] in 2012 (updated in 2017) naming some of the biggest scientific challenges today. While most of the usual suspects such as dark energy, the arrow of time, and string theory were included, one little conundrum was left off: Why do grapes spark in a microwave oven?

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As reported in *Science* [2], "YouTubers have gone grape crazy. In a plethora of Internet videos, kitchen scientists have cut a grape almost in half—leaving just a strip of skin connecting the two sides—and stuck it in the microwave. In seconds, sparks erupt." The article [2] even includes a link to an impressive video demonstration of the phenomenon, accompanied by rousing music. *Wired* [3] tells the story of physicist Stephen Bosi, who tried the experiment back in 2011 for the YouTube channel Veritasium in the physics department's break room at the University of Sydney. On camera, he and the show's host whooped in the glow of the grape. "Who needs drugs?" Bosi yells in the video, as a particularly psychedelic plume erupts. Off camera, they discovered they had burned the interior of the physics department's microwave.

Wired [3] further notes that the demonstration is "a crowd pleaser," as long as you avoid melting your kitchen appliances. But it turns out, even after millions of YouTube views and probably tens of scorched microwaves, no one knew exactly why the fireball forms. Popular online explanations usually say that the grape halves act like an antenna, and they somehow direct microwaves onto the small bridge of skin to ignite the initial spark.

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But nobody had actually done the math to prove it.

Until now, that is. Supported by several Canadian federal grants and a cadre of dedicated students, Canadian physicists Hamza K. Khattak, Pablo Bianucci, and Aaron D. Slepkov claim to have cracked the problem. In a recent paper [4] published in the *Proceedings of the National Academy of Sciences* (*PNAS*), they explain,

> This work ties the source of the plasma to microwave photonic hotspots at the junction of aqueous dielectric spherical dimers. We use a combination of thermal-imaging techniques and computer simulations to show that grape-sized fruit and hydrogel beads form resonant cavities that concentrate electromagnetic fields to extreme subwavelength regions. This is enabled by the large dielectric susceptibility of water at microwave frequencies. Furthermore, the absorptive properties of water are key to washing out complex internal modes and for allowing the evanescent hotspot build-up.

Why would this research be funded by the Canadian government? As the authors note in the "Significance" section of their *PNAS* paper, "Our approach to microwave resonances in high-dielectric materials opens a sandbox for nanocluster photonics research."

Physicist Aaron Slepkov, an author of the *PNAS* article, was interviewed on the public radio program *Science Friday* [5]. He said that he had been told not to recommend to the listeners that they try the grape experiment at home. However, if you would like to proceed anyway, he does provide tips in his interview [5]. You have been warned!

Acknowledgment

I would like to thank fellow Committee on Man and Radiation (COMAR) member Prof. Kenneth Foster of the University of Pennsylvania for bringing the topic to my attention by posting the *Science* article to the COMAR listserv.

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