

Clouds in My Coffee / Pattern Recognition
or
Wake up & Photo Your Coffee!

Abstract

We explain a technique for capturing & analyzing vapor condensation bubble patterns from freshly brewed coffee, and consider the mathematical & physical laws they follow. Close-up photos of the experiment reveal surprising results.

This nine-month research project spans several disciplines:

Mathematics (statistics / constraints / packing), pattern recognition, psychology, photography.

Mathematics:

Statistics – the expected distribution of bubble events

similar patterns appear over many trials; very consistent.

Constraints – existing bubbles limit the boundaries of expanding bubbles.

Packing – bubbles pack themselves into the circle as tightly as possible.

Pattern recognition – what is the threshold for deciding a pattern has meaning?

Psychology – the observer's internal mental maps heavily influence specific patterns seen.

Photography – the complexity of light rays interacting with thousands of bubbles, reflecting other bubbles containing reflections, influences the visual texture of patterns.

The number **ten** underlies the four-orders-of-magnitude range of bubble sizes, & makes a cameo appearance in the grand finale.

Welcome to G4GX

It's an honor & a pleasure to address this sophisticated audience. Thank you for this wonderful opportunity to present our pioneering scientific research project. It's sort of like the contrapositive to the old Monty Python Argument routine: You can't keep arguing unless you've paid! Well, at G4GX, once you've paid, you can pretty much rant on about anything you like!

The Meta-Message, or Point, to the extent there is one

Clouds in My Coffee [divided by] Pattern Recognition . . . hmmm; ambiguity; CIA reference.

Vapor condensation patterns right above the surface of your coffee are conveying important messages. Look closely!

I noticed these intriguing bubble patterns when wrapping my second cup of coffee one morning.

Set-up / Mechanics

There's a scientific procedure & an art to it.

Use the right kind of glass cylinder coffee mug. (See Measurements at end.)

Bubble size is a direct function of coffee temperature (volatility) & distance from liquid surface to plastic wrap.

Use two small half-moon shaped ice chunks to cool the freshly brewed coffee.

Allow coffee to cool for ~ 5 minutes, lowering volatility & individual bubble size.

Use 5/8" distance from surface of liquid to plastic wrap.

Use **Kirkland Signature stretch-tite® plastic wrap**; other brands won't work well.

Must lay it atop mug evenly & gently to avoid edge wrinkles.

Stretching plastic too tightly creates a slight vacuum, causing concavity & bubble distortion.

Photography

Tricky lighting effects.

Reflections of ceiling lights are visible; also of me taking the photo.

Clear glass mug helps ambient light illuminate the surface.

White paper towel background also helps.

Set the glass mug atop a glass table, allowing ambient light illumination from below.

Each bubble acts as a lens, catching light sources & reflections; complex ray tracing.

Get a sort of fractal effect, visible in close-up view.

Still experimenting with new digital camera.

Pattern Recognition / Psychology

What is the visual pattern-matching threshold for deciding a pattern has meaning?

The observer's internal mental maps heavily influence specific patterns seen.

[Display images here]

Parameters

Volume of liquid = 19.1748 cubic inches (see Calculations at end).

Almost all photos taken > 5 hours, or > 24 hours after wrapping.

Have not experimented with tea yet; different viscosity may create other patterns.

Observations

Vapor bubbles distribute themselves uniformly over the circle's area, as you would expect.

Once surface is coated with bubbles, new ones rising hit existing ones, gobbling up neighbors, & forming larger bubbles. Continuously rising smaller bubbles fill in the new gaps.

Larger bubbles form in the center; edge bubbles remain small.

Seems to be a clear upper bound on size of the largest bubbles.

Seems to be a clear lower bound on size of the smallest bubbles.

Largest bubbles are about 4 orders of magnitude (10,000x) greater than smallest ones, I reckon.

A surprising number of nearly straight lines & continuous curves appear.

V patterns often appear.

Patterns show a remarkable general consistency over 90 trials.

Statistical Distribution

Overall effect is like looking down over a modified Poisson probability distribution that has been rotated around a vertical axis through its peak.

Bubbles pack themselves into the circle as tightly as possible.

Looking for the mathematical equations that will describe these patterns to a good first-order approximation.

Patterns / Meaning / Models

The brain operates by recognizing / manipulating patterns.

The human mind insists on seeing patterns where none exist, or are only marginal.

Well-known Rorschach test effect / psychological projections.

Look closely at 10x close-ups of bubble patterns.

Look at the astonishing resolution coming directly out of the hand-held S8200!

(I lightened some images post-FX for higher contrast.)

Note the near-holographic (or fractal) effect – each individual bubble seems to contain the entire picture.

Perhaps this models the distribution of galaxies throughout the universe.

Perhaps this models the formation of parallel multiverses.

Perhaps this is a circular / spherical form of the I Ching, giving clues to the future; sort of a 2D resolution vector mapping of our universe's present state.

Or perhaps not.

Personal Interpretations

Do you see the patterns here? I see:

All of American history

Gadsden Purchase here in the SW quadrant

Passage of Federal Reserve Act of 1913 here in the NE quadrant

Star constellations / Orion's belt / Big Zipper

Entire Bible Code + cryptography key to sacred texts

My own personal genome DNA code sequence

The next generation of aerodynamic golf-ball dimpling

Government webcam lenses tracking my every move

The last extant smallpox virus lurking in the vault at the U.S. Centers for Disease Control & Prevention, just 5 miles from here!

There must be a **10** or an **X** in here somewhere!

Ten Appears!

Adding a knife to the left of the mug gives this experiment the spirit of **10**.

Viewing

I posted a few of these photos on FB; befriend me to see them all.

Of course this is also an incentive for you to look at my other photo albums on FB.

I printed 6 of the best images; you can inspect them closely.

I will be glad to help you photo your morning coffee here at the Ritz.

Measurements / Calculations

$$\begin{aligned} \text{mug height} &= 3 \frac{5}{8} \text{ inches (outside)} \\ &= 3 \frac{1}{8} \text{ inches (inside)} \end{aligned}$$

$$\text{liquid height} = h = (3 \frac{1}{8} \text{ inches} - \frac{5}{8} \text{ inch}) = 2.5 \text{ inches}$$

$$\begin{aligned} \text{mug diameter} &= 3 \frac{3}{8} \text{ inches (outside)} \\ &= 3 \frac{1}{8} \text{ inches (inside)} \end{aligned}$$

$$\text{mug inner radius} = r = 3.125 / 2 = 1.5625$$

circular Area of bubble-covered plastic

$$A = \pi * r^2 = 3.1416 * 1.5625 * 1.5625 = 7.6699 \text{ square inches}$$

Volume of liquid

$$\begin{aligned} V &= \pi * r^2 * h = A * h \\ &= 7.67 * 2.5 = 19.17 \text{ cubic inches} \end{aligned}$$

(includes 2 half-moon shaped ice chunks)

Special Exchange Gift

I went to the trouble of ripping three hundred 8" x 8" square sheets of Kirkland Signature stretch-tite® plastic wrap, to include one for each of you in the Gift Exchange bag, so you can perform these scientific experiments in the privacy of your own kitchen.

Good Luck!

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