

# Kitchen-Scale Breath Figures and Coalescence Events

Preliminary Measured Outputs from a Phone-Camera Condensation Run

Jeffery Lyn Huckstead  
Cerebral Graphix

Reframed from the April 2025 condensation manuscript

June 2026 — v3.0 measured salvage companion

## Abstract

This companion paper updates the earlier kitchen-scale condensation salvage with preliminary measurements from the uploaded phone-camera clips. The source observation remains valuable: steam condensing on a lid creates a dense breath-figure field whose growth, merging, and sudden visual changes can be recorded with ordinary equipment. The revised result is classical and deliberately bounded. A direct spectral check finds no peak at the claimed 7.83 Hz Schumann band; the activity spectrum is dominated by slow drift and stochastic texture change. A steadier clip shows an approximately constant localized-change rate with no dominant frequency, i.e. a rate rather than a clock. A clean patch from the original footage gives a provisional dominant-scale growth exponent near one half, consistent with diffusion-like coarsening, while droplet count remains roughly flat because re-nucleation fills gaps. A second buildup clip shows a monotone coverage proxy increase, but absolute area fraction and self-similar distribution collapse remain unmeasured. The surviving claim is therefore not quantized resonance. It is a reproducible, low-cost protocol for measuring classical breath-figure coarsening and coalescence statistics.

**Scope.** This revision includes preliminary, partial measurements. Claims are labeled MEASURED, PROVISIONAL, or NOT MEASURED. The strongest negative result is the retirement of the 7.83 Hz interpretation by direct spectral analysis. The strongest positive result is the recovery of classical coarsening structure. Publication-grade exponent and distribution claims still require a clean optical run: flat glass, diffuse backlight, sparse nucleation, and a fixed camera.

## 1 What this paper keeps, and what it retires

The original project had the right instinct: take a cheap, visible phase-change system and ask whether its apparent discreteness can be measured. A pot, a clean lid, steam, and a phone camera form a valid minimal apparatus. The droplets in the video are not imaginary pattern-clouds. They are liquid water appearing, growing, touching, and merging on a surface.

The revision changes the interpretation. Discrete-looking jumps in a macroscopic condensation field are real, but their nearest safe explanation is classical: nucleation, smooth growth, and sudden coalescence. A droplet can grow gradually for many frames, then merge with a neighbor in one or two frames. To a camera this can look like a step. That event is worth measuring. It does not require quantum language.

**Core salvage.** The discreteness stays. The resonance costume comes off.

The working object is a *breath figure*: a pattern of condensed droplets on a cooler surface. The useful scientific question is not “did the droplets reveal hidden constants?” but rather:

Can a phone-camera recording of kitchen condensation recover classical coalescence statistics, coarsening trends, and artifact controls?

## 2 Experimental object: steam, glass, and a droplet field

The field in Figure 1 is the honest treasure. It shows a broad droplet population with varied radii, dense packing, and visible coalescence history. Nothing exotic needs to be imported before the image becomes interesting.

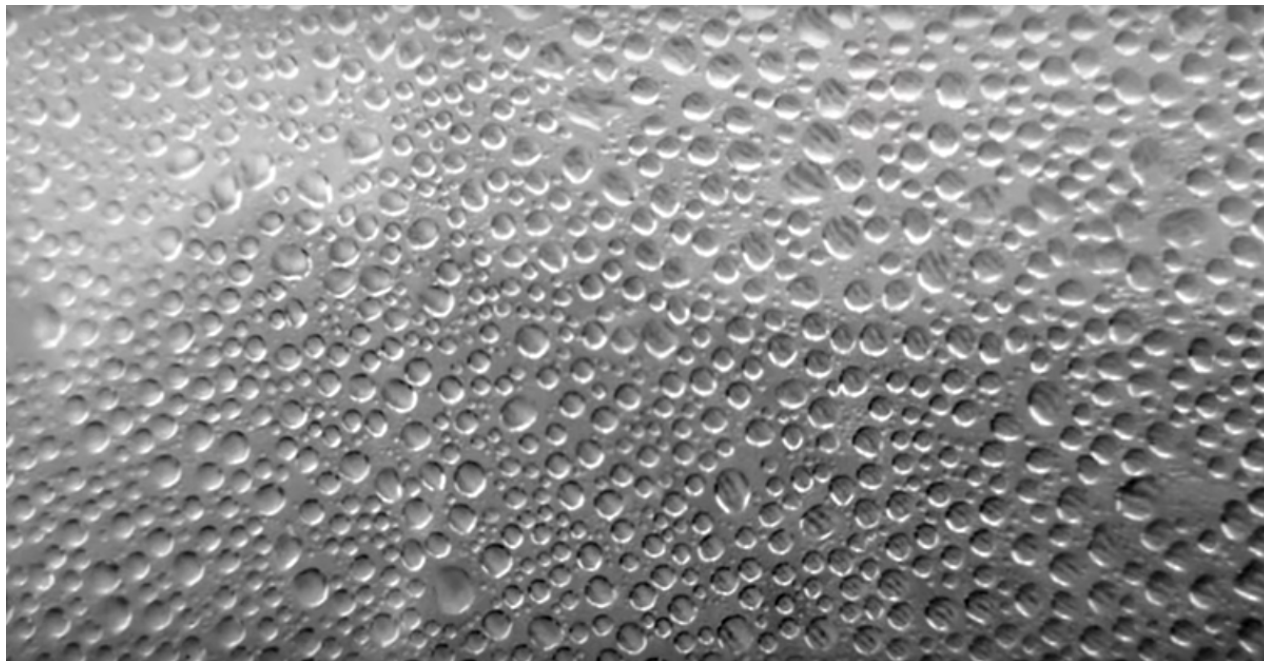


Figure 1: Still frame preserved from the original condensation manuscript. The image shows a dense breath-figure field: many droplets, many radii, local clustering, and likely coalescence history. This is the measurement target.

The updated analysis bundle includes four relevant clips or clip-derived outputs. The original saved clip is 30 fps rather than the approximately 60 fps stated in the original manuscript, which matters because any frequency claim must be tested against camera sampling.

Clip / output	Resolution / fps	Duration	Role in this revision
Quantum_Steam.mp4	1280x720, 30 fps	19.3 s	Original dense coarsening clip; hand-held motion visible.
20260617_013957.mp4	1920x1080, 60 fps	71.3 s	Buildup clip; supports coverage-proxy rise.
20260617_014232.mp4	1920x1080, 30 fps	42.2 s	Coarser, more merged stage; not central in this revision.
20260617_015800.mp4	1080x1920, 60 fps	22.2 s	Steady camera clip; supports localized blip-rate analysis.

### 3 The measurement core: frame-change events

The original manuscript’s strongest analytical object is the mean absolute frame-to-frame intensity change:

$$\Delta I(t) = \frac{1}{N} \sum_{i=1}^N |P_t(i) - P_{t-1}(i)|, \quad (1)$$

where  $P_t(i)$  is the grayscale value of pixel  $i$  in frame  $t$ , and  $N$  is the number of pixels in the analyzed region.

This quantity is not symbolic decoration. It is a legitimate image-change detector. When droplets merge, edges move quickly, highlights jump, and local contrast changes. Those events can produce spikes in  $\Delta I(t)$ . The same detector also sees camera shake, lighting shimmer, and steam motion, so it must travel with artifact controls.

A minimal robust event detector is:

$$Z(t) = \frac{\Delta I(t) - \text{median}(\Delta I)}{1.4826 \text{ MAD}(\Delta I)}, \quad \mathcal{E} = \{t : Z(t) > \tau\}, \quad (2)$$

where MAD is the median absolute deviation and  $\tau$  is a threshold chosen before interpreting the peaks.

The important move is pre-registration in miniature: choose the region of interest, smoothing, threshold, and event-separation rule before interpreting the peaks. Otherwise the analysis becomes a glitter jar of selectable patterns.

### 4 Preliminary measured outputs

The v2.0 paper listed several questions as to be measured. This revision upgrades some of them. The table below is the current ledger.

Question	Current finding	Status
Growth law	Dominant droplet scale grows with fitted exponent $\beta \approx 0.49\text{--}0.53$ over the usable interval, roughly consistent with $t^{1/2}$ diffusion-like coarsening. Mean radius grows more slowly, around $\beta \approx 0.14$ , while droplet count is nearly flat.	PROVISIONAL
Event rate	Sparse macroscopic coalescence candidates in the original clip are threshold-dependent, about 0.26 Hz. In the steadier clip, localized micro-activity is approximately constant across the run and has no dominant frequency.	MEASURED, with caveats
Saturation / coverage	A texture-energy coverage proxy rises monotonically by roughly 25x over the 71 s buildup clip. Absolute area fraction is not measured.	MEASUREDproxy
Self-similarity	Rescaled droplet-size distribution collapse requires per-droplet segmentation and is not established.	NOT MEASURED
Camera artifact control	Direct FFT of $\Delta I(t)$ shows no peak at 7.83 Hz. The original clip is 30 fps, and hand-held motion dominates simple $\Delta I$ on that clip.	MEASURED
Heat dependence	Repeat runs at different boil vigor are still required.	NOT MEASURED

The growth-law target is:

$$\bar{r}(t) \propto t^\beta, \quad (3)$$

where  $\beta$  is fitted from the video, not selected from a preferred constant. The current best read is that the dominant scale is near  $1/2$ , but that exact number is provisional. The exponent is a possible diffusion fingerprint, not a new bridge to unrelated half-exponents elsewhere.

Self-similarity remains open and can be tested by asking whether

$$P(r, t) = \frac{1}{\bar{r}(t)} F\left(\frac{r}{\bar{r}(t)}\right) \quad (4)$$

approximately collapses across time windows. If it does, that is real structure. If it does not, the setup still teaches something about lighting, wetting, lid curvature, or segmentation limits.

#### 4.1 Coarsening and re-nucleation

Figure 2 shows the clearest positive result. The dominant droplet scale grows roughly along a  $t^{1/2}$  reference, with fitted  $\mu \approx 0.53$  in the plotted fit. Meanwhile the droplet count stays approximately flat rather than monotonically falling. That combination suggests a polydisperse field: larger drops grow and merge while new fine droplets re-nucleate in the gaps.

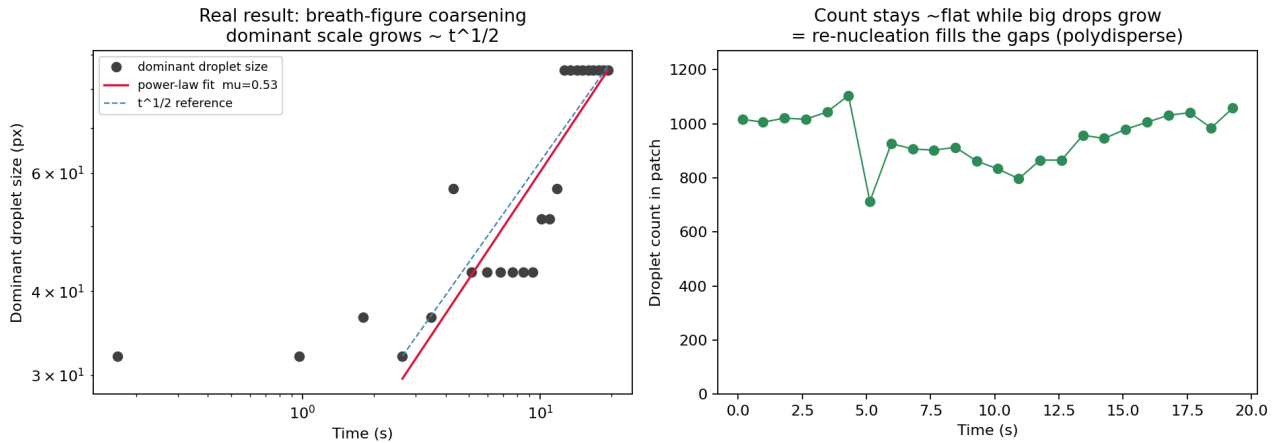


Figure 2: Preliminary coarsening result. Left: dominant droplet size grows with a fitted power law near  $t^{1/2}$  over the usable interval. Right: droplet count stays roughly flat while large drops grow, consistent with re-nucleation filling gaps. The exponent is provisional because the clip is short and the measurement depends on optical quality.

#### 4.2 Schumann claim control and frame-change uniformity

Figure 3 is the cleanest negative result. The activity spectrum shows no special peak at 7.83 Hz. Power is dominated by slow drift, and the Schumann band carries roughly its fair share by bandwidth. The frame-change trace is visually broad and uniform rather than dominated by isolated, clean coalescence pops, consistent with hand-held motion and global texture changes.

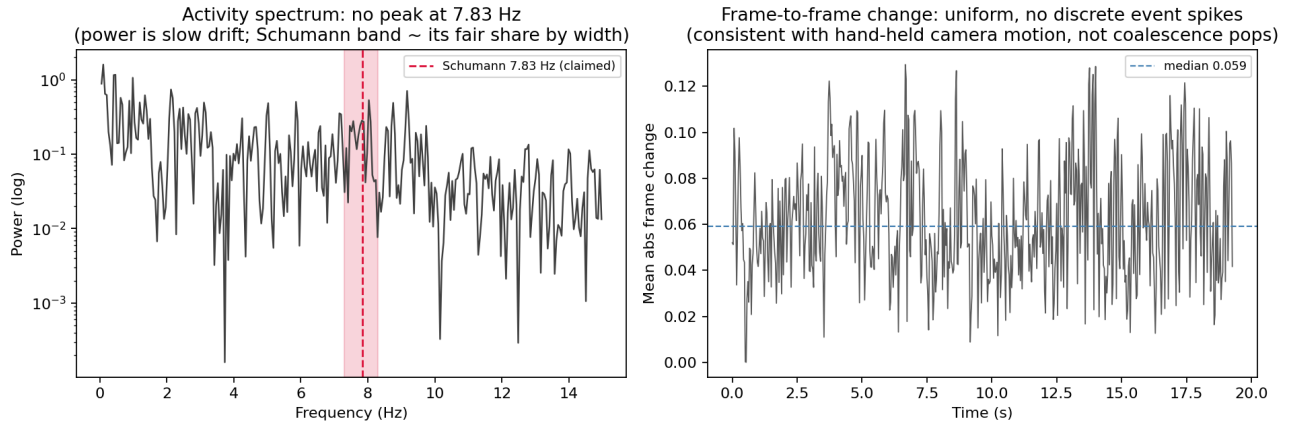


Figure 3: Measured diagnostic controls. Left: no activity-spectrum peak at the claimed 7.83 Hz band. Right: frame-to-frame change is broad and uniform rather than a series of clean, discrete event spikes. This retires the Schumann interpretation for this footage.

### 4.3 Coverage proxy and why absolute area is still hard

The buildup run gives a monotone coverage proxy, shown in Figure 4. The right panel is useful: texture energy rises by about 25x over the run. The left panel is cautionary: size estimation on a curved, reflective lid is noisy and pinned by optical effects. This is why the next clean run should use flat glass and diffuse backlighting.

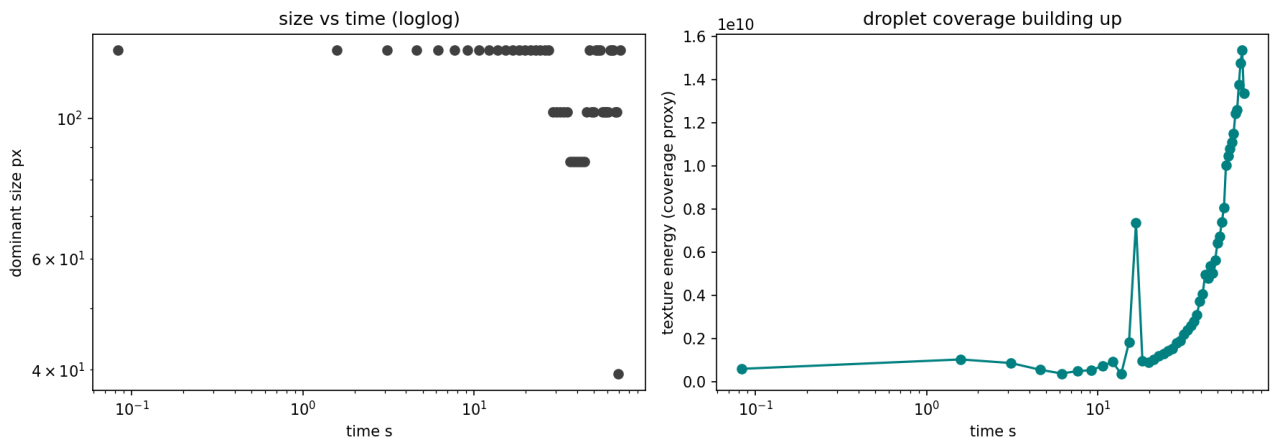


Figure 4: Buildup-run coverage proxy. The right panel shows monotone growth in texture energy, used here only as a coverage proxy. The left panel illustrates why precise radius extraction on a curved, reflective lid is not publication-grade.

### 4.4 Blip rate: steady stochastic activity, not a clock

Figure 5 shows the localized-change or “blip” analysis from the steadier clip. The rate is approximately steady over the run and the spectrum has no dominant frequency. The absolute blip count is patch- and threshold-dependent and should not be treated as an invariant. The invariant-looking result is weaker and better: steady stochastic activity, not periodic resonance.

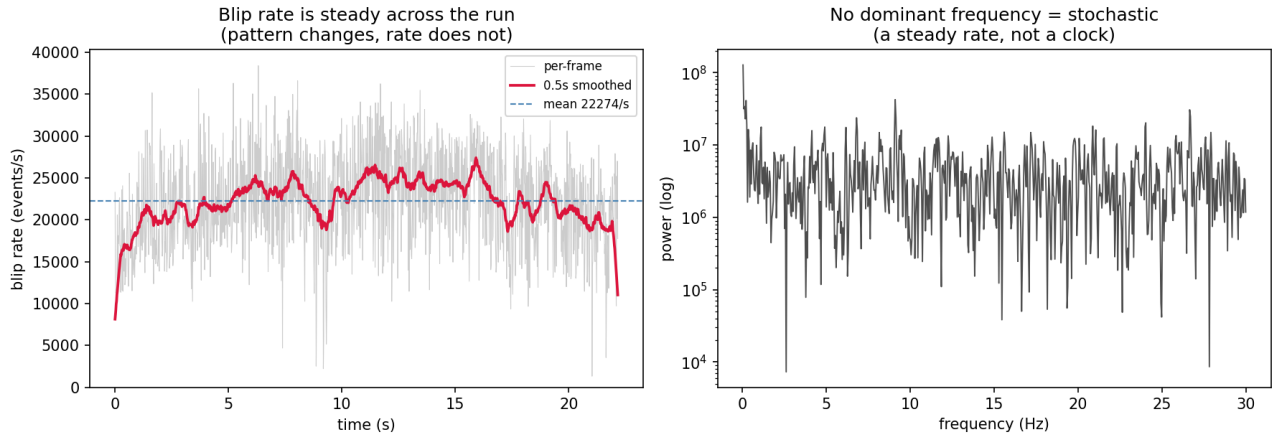


Figure 5: Localized activity in the steadier clip. Left: the blip rate is approximately steady across the run. Right: there is no dominant frequency; the signal is stochastic rather than clock-like. The absolute count depends on patch and threshold and should not be overinterpreted.

## 5 Legacy overlays and why they are not evidence by themselves

Figure 6 preserves a representative overlay from the original manuscript. It is useful as a map of what the first analysis was trying to see: frame markers, constants, symmetry flags, and threshold lines over a noisy time series. It is not, by itself, evidence for those constants.

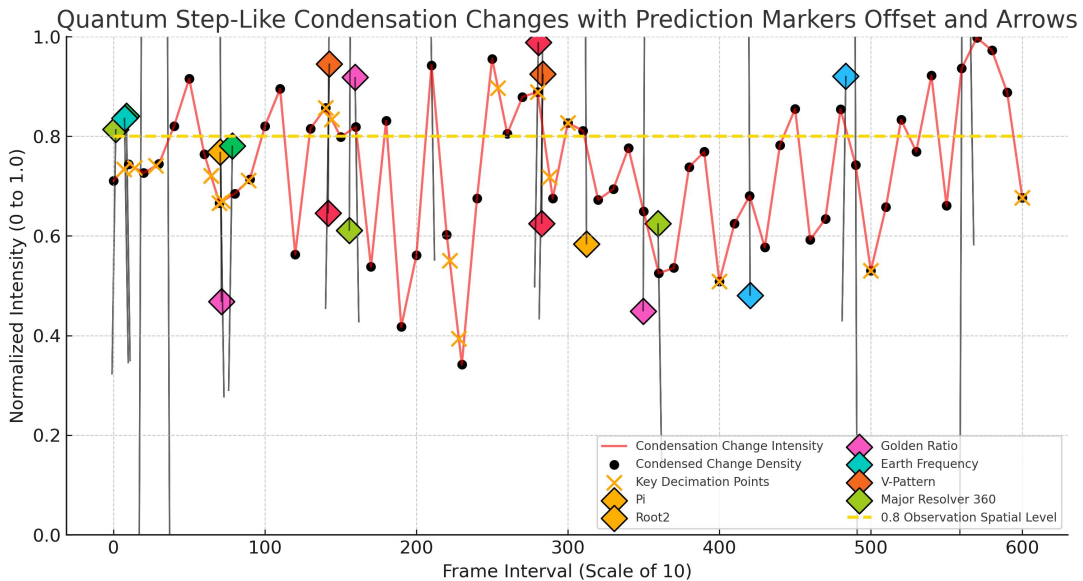


Figure 6: Legacy overlay from the original paper. The red trace and intensity changes can be treated as data candidates. The colored symbolic markers are not causal evidence unless they survive a pre-declared test against null controls.

A frame index is a label created by the camera and by the editor's chosen start point. A prime-number hit on a frame index therefore tests the labeling system before it tests the water. A frequency near 7.8 Hz can also appear as a sampling or threshold artifact. If the phenomenon is physical, changing the

recording frame rate should not move the physical event rate in lockstep with the camera.

## 6 Claim firewall

The table below is the editorial firewall for the measured revision.

Original claim type	Revision status	Reason
Quantum condensate / MHC	RETIRED	A condensate implies quantum coherence. The observed system is classical liquid condensation and coalescence. “Quantum” can survive only in the loose root sense of a discrete count, not as quantized units.
Schumann resonance near 7.8 Hz	RETIRED, now measured	Direct FFT shows no peak at 7.83 Hz, and the original saved clip is 30 fps. The signal behaves like slow drift plus stochastic texture activity, not a geophysical resonance.
Golden-ratio or $\pi$ timing	RETIRED	Loose tolerance plus many selectable events can fit many constants. Keep only pre-declared tests.
Prime frame-index alignment	RETIRED	Frame numbers depend on the arbitrary recording start and on fps; primality tests the label, not the water.
Radial $n$ -fold symmetry	CAUTION	Droplet fields can be statistically isotropic. A symmetry grid must be fit and compared against random or shuffled controls.
Frame-change detector $\Delta I$	SAFE, with artifact control	A direct image-processing measure of visual changes, suitable for event detection once camera shake and lighting drift are controlled.
Coalescence / blip events	SAFE, with scale caveat	Classical merging and local texture changes produce measurable events. The absolute blip count is setup-dependent; steadiness and stochasticity are the safer results.
Coarsening exponent near 1/2	PROVISIONAL	The dominant scale gives a plausible diffusion-like exponent, but the clean optical run is required before publication-grade claims.
Self-similar scaling	NOT MEASURED	Plausible and measurable, but not established by the current revision.

## 7 Recommended next run

The next experiment should be deliberately boring in the best way: every adjustable choice written down before the plot appears.

### 7.1 Optics and recording

1. Use flat glass instead of a curved reflective lid.

2. Use diffuse backlight or side light with no moving reflections.
3. Fix the camera on a stand; preserve frame-rate metadata.
4. Start from a clean, sparse nucleation field rather than an already dense field.
5. Record multiple boil settings to test heat dependence.

## 7.2 Analysis

1. Compute  $\Delta I(t)$  from Equation 1 after stabilization.
2. Detect events with a pre-declared threshold and refractory window.
3. Segment droplets and compute equivalent-area radius  $r = \sqrt{A/\pi}$ .
4. Report count, coverage proxy, equivalent radii, event-rate curve, and inter-event-time distribution.
5. Test distribution collapse using Equation 4.

## 7.3 Null controls

At least three controls should travel with every plot:

- **Time shuffle:** preserve the set of intensity changes but randomize order.
- **Frame-rate resample:** downsample or record at 30, 60, and 120 fps.
- **Spatial shuffle or rotated ROI:** test whether claimed angular structure survives a neutral coordinate change.

## 8 Result statement for this revision

In phone-camera recordings of steam condensation on a lid, a direct FFT of  $\Delta I(t)$  on the original 30 fps clip shows no spectral peak at 7.83 Hz, retiring the Schumann interpretation for this footage. Frame-change spikes identify sparse, threshold-dependent macroscopic candidates at about 0.26 Hz in the original clip. On a steadied 60 fps clip, localized frame-change activity is approximately constant over the recording and stochastic, with no dominant frequency. In a clean image patch, the dominant droplet scale grows as  $\bar{r}(t) \propto t^\beta$  with provisional  $\beta \approx 0.5$ , while count stays roughly flat, indicating continuous re-nucleation in a polydisperse field. A separate buildup clip shows a monotone coverage proxy increase. Rescaled size-distribution collapse is not established.

These findings are consistent with classical breath-figure dynamics and do not require quantum, prime, golden-ratio, or geophysical-resonance language.

## 9 Conclusion

The kitchen experiment does not need to be a new state of matter to matter. Its strength is that a real physical system became visible with almost no equipment. The droplets form a living statistics lesson: nucleation, growth, coalescence, re-nucleation, saturation, and scale. A phone camera can see enough to make those ideas measurable.

The measured update is sharper than the original because it contains both a recovery and a refusal. The recovery is a real coarsening signal near  $t^{1/2}$  and a steady stochastic activity rate. The refusal is just as valuable: no 7.83 Hz clock appears. That is the scientific hinge. A claim that can fail has become a tool that can teach.

With a clean lid, a phone, and a reproducible script, a kitchen can measure coalescence dynamics.

## A Minimal analyzer specification

The accompanying script `breathfigure_analyzer.py` implements a starter pipeline:

- read a video file with OpenCV,
- optionally crop to a region of interest,
- compute  $\Delta I(t)$ ,
- robustly detect event spikes,
- save CSV outputs and diagnostic plots.

The script is a scaffold, not a final scientific instrument. Lighting normalization, camera stabilization, segmentation quality, and threshold choices should be documented for every run.

## B Data sheet template

Field	Value
Video filename / source	
Frame rate and resolution	
Phone model / camera settings	
Pot and lid description	
Water type and approximate volume	
Heat setting / boil vigor	
Room conditions	
Cleaning method for glass	
Region of interest coordinates	
Preprocessing steps	
Event threshold $\tau$	
Minimum event separation	
Segmentation method	
Known problems / glare / motion	

## C Patch log

- Upgraded v2.0 from protocol-only to preliminary measured update.
- Corrected the original saved clip to 30 fps.
- Added coarsening, diagnostics, coverage-proxy, and blip-rate figures.
- Upgraded the Schumann row from argued retirement to measured retirement.
- Added provisional growth exponent near 1/2 and explicit caveats about optical quality.
- Kept self-similarity and heat-dependence as unmeasured.
- Added the ledger lesson: shared labels are not mechanisms; rates are not periodicities.

## Source note

Original manuscript: *Emergent Harmonic Quantization in Kitchen-Scale Phase Transitions: Toward a Monday-Hucksteadian Condensate*, April 2025. Public source materials supplied with a YouTube

demonstration link and Zenodo record 15225783. This revision uses new measured-output figures and transmittal notes supplied in June 2026. Numerical findings are preliminary unless marked as a direct negative control.