

The Heartbeat and the Seam

A plain-language guide to how a seam would be measured

How recurrence and oscillator methods from Dr. Charles Jorgensen (NASA Ames, ret.) give the seam papers their practical half, in everyday words

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Why this exists

The Seam was my attempt to explain, with no equations, what Norbert Schwarzer's picture of space would mean if it were right: that a seam is not a tunnel but a place where the ruler changes. It left one thing hanging. The papers kept saying that the three spheres in the footage would have to be *held* at a point that is not quite stable, and that the proof of it would be a particular kind of jitter. But nobody had said how you would actually read that jitter off a video, or how you would know a real formation from a clever animation, or what a heartbeat could have to do with any of it.

My friend Dr. Charles Jorgensen (NASA Ames, ret.) gave me two unpublished drafts that answer all three. One uses a method called recurrence analysis to read the hidden state of a pilot from nothing but the rhythm of the heartbeat. The other builds computation out of coupled oscillators, things that tick and pull on each other until they settle into patterns. I did not expect either to connect to a paper about glowing spheres. They connect so directly that I wrote a technical note, *Recurrence and the Seam*, to lay it out. This is the plain-words version of that note. It is for anyone who read *The Seam* and wants to know the practical half: how you would measure any of it, and why the heart is in the loop.

What this is. An exercise. It is not a claim that the footage is real or that the seam exists, and Jorgensen's drafts say nothing about seams; they are cited here as unpublished drafts, with his permission. Everything this guide says about a seam is a prediction, written down in advance, not a finding. Jorgensen reviewed and approved this guide and the interactive pieces that go with it. Dr. Schwarzer has not reviewed it, and any error in applying the methods to a seam is mine. The methods themselves are published and peer-reviewed (see Sources); what I have done is point them at a new question.

— Bryan M. Ingram

Before you start

Everything in this guide rests on one idea that is easy to say and surprisingly powerful: **a thing that repeats tells you what it is**. If you measure one number from a system over and over, a heartbeat, the spacing of three lights, the voltage on a wire, and you watch for the moments when the system comes back to a state it has been in before, the pattern of those returns is a fingerprint. You do not need to know the forces. You do not need a model. You need a long enough record and the patience to count. That is what recurrence analysis does, and it is what Jorgensen used to read pilots. The rest of this guide applies it in three places: to the footage, to the formation, and to a person's own heart rhythm.

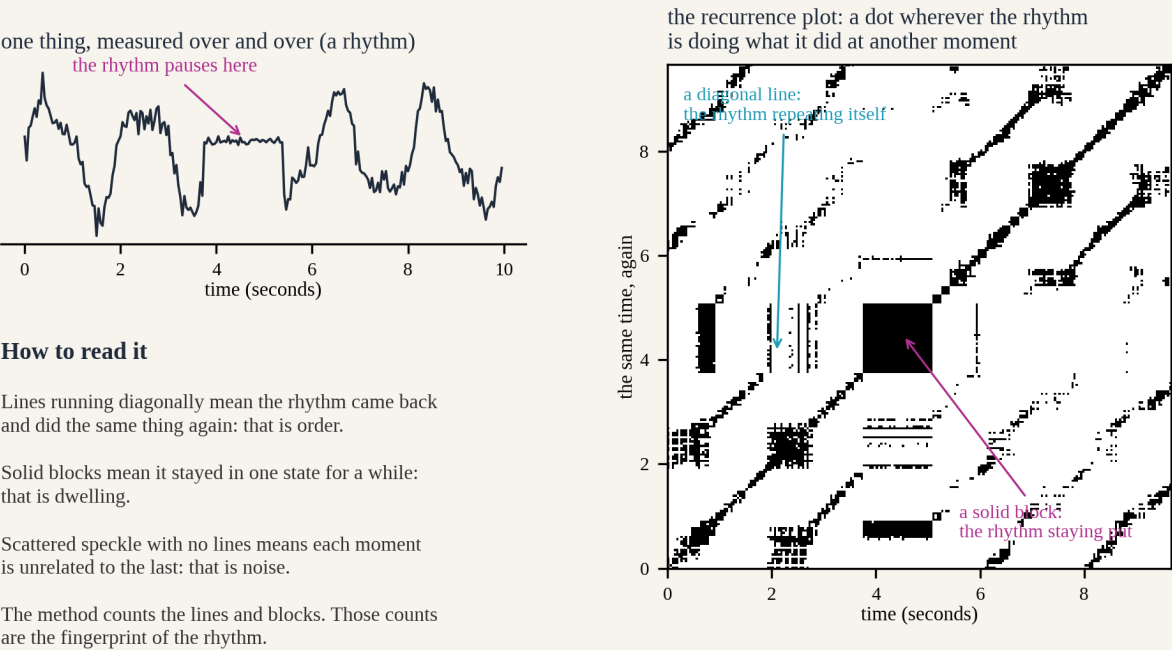
1. One number, measured over and over, is enough

Imagine you are standing outside a house at night and all you can see is one window. Someone inside is walking around, and every second you note how bright the window is. You cannot see the room. But if you write down the brightness for long enough, you can tell a great deal: whether the person is pacing in a loop, whether they stopped, whether a second person came in, whether the lamp is on a timer. The brightness is one number. The room is a whole hidden world. The trick, worked out by the mathematician Floris Takens in 1981, is that a single measured number, taken at a string of moments, can be unfolded into a picture of the hidden world that made it. You take today's value, the value a moment ago, and the value a moment before that, and treat the three together as one point. String the points together and the shape they trace is, under conditions Takens stated, a faithful copy of the shape the hidden system was tracing.

Two settings go into the unfolding: how far apart "a moment ago" is, and how many past values to carry. Jorgensen's first draft takes both from the record itself, by standard recipes, so that the person doing the reading cannot tune the answer. The second setting matters more than it sounds. The number of past values you need before the picture stops folding over on itself is a count of how many independent things the hidden system is doing. For the three spheres, that count is the natural candidate for what Schwarzer's equations call the dimension number, which the papers had been treating as a free choice. Whether the two are the same is an open question. Jorgensen's method is how you would measure the first one off the footage.

2. The recurrence plot: a picture of a rhythm meeting itself

Once you have the unfolded shape, you ask a simple question of every pair of moments: was the system in nearly the same state at these two times? Draw a square. Time runs along the bottom and up the side. Put a dot wherever the answer is yes. That square is a recurrence plot, and after looking at a few you can read them at a glance.



A rhythm and its recurrence plot. Diagonal lines are the rhythm repeating itself; solid blocks are the rhythm staying in one state; speckle is noise. Counting the lines and blocks turns the picture into numbers.

Diagonal lines mean the system is repeating itself: whatever it did from here, it did again from there. Solid blocks mean it stayed put for a while. Speckle with no lines means each moment is unrelated to the last, which is what noise looks like. The method then counts: what fraction of the dots sit on diagonal lines (order), what fraction sit in blocks (dwelling), how long the longest line is, how long the blocks last, and how varied the line lengths are. Five or six numbers. Together they are the fingerprint, and the same fingerprint can be taken from a heartbeat, from a sphere’s position, or from the reading of a reference instrument.

3. Real formation, control loop, or animation: three fingerprints

This is the first practical payoff, and it is the one the three-orb paper needed most. The paper said that if the spheres are real and are being held in a triangle by the medium, they should sit at a point that is not quite balanced, and should jitter in a particular way. If instead they are three machines flown by a controller, the jitter should be driven down to the noise of the sensors. And if the whole thing is a computer animation, the spheres move along smooth curves drawn between keyframes, with almost no jitter at all. Three hypotheses, three very different fingerprints.

If the spheres are...	The spacing between them should...	The recurrence plot looks like...	The tell
a formation held by the medium	wander in a structured way around a slightly off-center point, with two natural wobbles	short diagonal lines inside blocks: order and dwelling together	both order and dwelling are high; the plot has texture
three machines on a control loop	be driven to the noise floor of the sensors; each moment unrelated to the last	speckle with no lines	order and dwelling sit at the level a shuffled record would give
a computer animation	follow smooth curves between keyframes, almost perfectly repeating	one unbroken family of diagonal lines across the whole square	the longest line runs the whole length of the record

The three readings of the footage. They were drawn as synthetic examples in the technical note; the real test is the tracked footage against shuffled copies of itself.

The honest part of the method is the comparison. The numbers on their own say only that three records differ. To say which hypothesis a *real* record fits, you take the record, shuffle it a hundred times so that any structure is destroyed, and ask whether the real fingerprint sits inside the band the shuffles give. If it does, the record is noise, which is the control-loop reading. If it stands clear above the band, there is structure, which is the formation reading. And if the longest diagonal line runs the whole record, you are looking at an animation. All of this can be done today, with free software, on footage that already exists. It is the cheapest experiment proposed in this release.

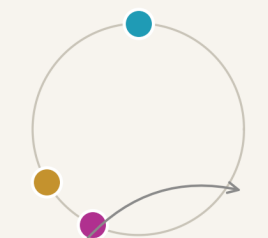
4. Why three things on a shelf settle at 120 degrees

The second of Jorgensen's drafts is about something different: how you could compute with things that tick. It builds on models of nerve cells, which fire in rhythms. Ticking things that pull on each other are familiar from everyday life too: pendulum clocks on a shared wall drift into step, and fireflies in a tree can come to flash in unison. When ticking things are coupled, even weakly, they fall into patterns, and the patterns are stable in the way a marble at the bottom of a bowl is stable: push it and it rolls back. Jorgensen's architecture proposes using those patterns as memory and as logic.

Here is why that matters for a triangle of three lights. Take three ticking things and couple them so that each one pushes the others a little. If the push pulls them together, they end up ticking in unison: three dots collapsing to one. If the push drives them apart, they end up as far from each other as they can get on a circle, which for three things is exactly 120 degrees apart. That second pattern is called the splay state. It is not a shape someone drew. It is a resting state the system falls into on its own, and if you knock one of the three out of place, it slides back, in a time set by how strongly they push.

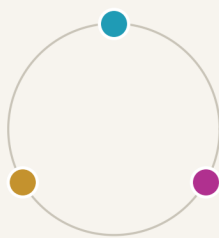
Three ticking things coupled on one shelf settle into one of two patterns

one is knocked out of place



the third has slipped round by 34°

they push each other apart: 120°



a resting state; a kick is undone in seconds

they pull each other together: one point



the other resting state; the triangle vanishes

Three ticking things coupled on one shelf. Pushing apart gives 120° (the splay state); pulling together gives one point. A kick to the splay state is undone in a few seconds, and the time it takes measures the coupling.

So the papers' 120-degree triangle gets a candidate mechanism. If the three spheres were three oscillators coupled through the medium, they would sit at 120 degrees because that is where three mutually repelling oscillators rest. The paper had already said that the formation stiffening as it tightened would be the signature of the medium. Jorgensen's model adds a second, more specific prediction: if one sphere is disturbed, it should return along a particular curve, and the time it takes is a direct reading of the coupling strength. Give the three different natural rates and there is a threshold: below a certain coupling the triangle leans, then one pair breaks loose. On the console you can turn the dial and watch it happen.

5. The heart: a clock you carry

Now the person. The reference instrument in the design study reads the medium against a stored reference. A heart can be read the same way: not against anyone else’s heart, but against a record of the same person’s own rhythm, taken earlier under known, quiet conditions. Call that record the person’s reference band.

The question is what “your reference band” means in numbers. An average heart rate is not it: two very different states can have the same average. This is the problem Jorgensen’s first draft takes up for pilots, and the method carries straight across. Take a two-minute record. Unfold it. Draw the recurrence plot. Count the five numbers. Do it on six quiet mornings, and the spread of those six is the band. From then on, any new record is the same count, compared against that band.

This is not a new idea of mine. Jorgensen holds patents on the same principle used for a different purpose: confirming who a person is from the person’s own heartbeat. One builds a reference from the beats in a recording that most resemble each other and checks a later recording against it [8]; another compares as many as 192 statistics of the heartbeat’s shape with the same person’s stored statistics [9]. Here the logic is turned from identity to state: not who you are, but whether your rhythm is still behaving like your own.

The heart earns its place here for a reason worth saying plainly. The reference instrument reads the medium against a stored reference. This reads a person against a stored reference. In both cases what is being read is an oscillator, something that ticks, compared with a record of how it ticked before. The heart does not open the seam and does not steer it, and nothing in this guide proposes that the body carries information about the seam. The heart is the clock you carry, and recurrence analysis is how you read it without needing to know what made it tick.

Question	What answers it	What it cannot do
Is this rhythm inside this person’s own band?	the heart’s recurrence fingerprint against the person’s reference band	identify the person; a stranger could have a tidy rhythm
Which stored record does today’s rhythm match?	cross-recurrence against each stored record (Section 6)	say why the stored records differ
Did a stay across a seam run at the stated clock-rate ratio?	the stretch in the heart’s recurrence periods, compared with the reference instrument (Section 7)	replace the instrument; it is a second witness, not a first

Three questions, three different witnesses. Each answers only its own question.

6. Two calm records: which one does today match?

A single fingerprint has a blind spot. Suppose a person has two stored records, both settled and calm, taken under different conditions. A new record can sit inside the band of either one, because both are calm, and the fingerprint alone cannot say which it matches.

Recurrence analysis has a tool for it. Instead of asking when a record meets itself, you ask when one record meets another: lay today’s rhythm along the bottom of the square and a stored rhythm up the side, and dot the moments where the two are in the same state. That is a cross-recurrence plot. Today’s rhythm should meet the record it came from more than it meets the other. On a synthetic example in the technical note the difference is large: a rate of 0.09 against the matching record versus 0.02 against the other, and the reverse for a sample drawn from the other condition. Whether real records separate that cleanly is not known. It is the kind of thing you find out by enrolling a few volunteers.

7. A prediction: the rhythm should stretch

One prediction follows from putting Schwarzer's physics and Jorgensen's method in the same room, and it is specific enough to be wrong. In the scaled-metric picture a seam does not move anything along the calendar, but time spent on the far side runs at a different clock rate than time at home, by a ratio the seam sets. A heart is one of those clocks. As a thought experiment: if a rhythm were recorded through such a stay, then in home time every one of its recurrence periods should be longer or shorter by exactly that ratio. Not changed in shape; stretched, like a recording played at a different speed.

That would give a second witness. The reference instrument says the stay ran at a certain rate. The heart record, read by recurrence, says what rate it actually ran at. The two must agree. If they did not, one of the two clocks would be wrong, and the exercise would have failed in a way that can be seen.

Seeing it at a glance. Numbers are not the only way to show this. Jorgensen also worked on how signals should be drawn for the people who must act on them: two 2009 papers with Shivanjli Sharma on visual coding of signals for advanced displays [10], and a NASA method for visualizing analog signals to spot changes or faults [11]. In that spirit, the Unfolding Bench draws each stretch of a record as its own small closed loop, shaded by how strongly it shows the warning signs. A steady rhythm gives a patchwork; a rhythm whose recovery is slowing gives loops that grow and close into rings, darkening from one end of the strip to the other.

8. What can be done now, and what cannot

Three things can be done this month, with equipment that already exists. The tracked footage can be read for its fingerprint against shuffled copies, which decides formation, control loop or animation at a stated confidence; that is the first paper's open question, and it is now a procedure. The 120-degree lock can be tested on any three coupled oscillators on a bench, electronic or mechanical, to confirm the return time and the breaking threshold the model gives. And a within-person heart band can be built for a handful of volunteers with an ordinary chest-strap monitor, to learn whether real people's fingerprints are stable enough from day to day for such a band to be usable at all. None of these needs a seam.

What cannot be done is anything that needs the seam itself: the stretch after a stay across a seam, and the clock-rate comparison it would allow. Those are predictions, written down in advance so that if a seam is ever made the checks are already waiting, and so that if the method is wrong, it is wrong in a way that can be seen.

Where to go next

The Scaling Field Console at bryaningram.com/toe-lab has two instruments for this guide: a recurrence bench, where you can paste any record, or use the three readings above, and watch the fingerprint computed live; and a splay-state lock, where three oscillators sit on a circle and you can kick one, change the coupling, and break the lock. The technical note, *Recurrence and the Seam*, carries the procedure, figures and sources. The main paper is *Geometry of a Three-Orb Metastructure*, Revision 10.2, the reissue that incorporates N. J. Bocker's review. Jorgensen's two drafts are cited as unpublished drafts, with his permission; he reviewed and approved this guide and the interactive pieces. Norbert Schwarzer's own account of the medium is his book *Fluid Universe: The Way of Structured Water and its Mathematical Foundations* (Jenny Stanford Publishing, 2026, ISBN 9789815352153). He has not reviewed this guide, and any error in applying the methods to a seam is mine.

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