

Folding a Recording onto a Fundamental: A Pitch Codex for Field Material

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August 29, 2026

Ideamorphic Studies Papers — codex

A recording of an environment contains no played note, and yet a rule can be made to assign it one. This paper states that rule completely enough to be re-executed without access to any code, and freezes it as the Pitch Codex for Field Material, version 1.0. The rule takes a recording, optionally a range within it and a transposition in whole semitones, and returns one fundamental, twelve weighted pitch classes, and a spread — the strongest class divided by the weakest. Its eight parameters are named with the reason for each. Four rules tried and withdrawn are recorded with the measurement that killed each: folding onto twelve classes before a fundamental is chosen puts a low rumble and a high resonance in one bin; scoring a candidate by the sum of its harmonics lets sub-octave ghosts survive; removing the spectral slope removes the identity along with the bias; a single harmonic-series hypothesis returns a confident figure on material that has no fundamental at all. What the instrument does not do is set out at equal length: it names no chord, produces no chromatic coordinates, and reports no melodic line for a place — the last a decision rather than a measurement, since no threshold separating a margin that names a fundamental from one that does not has been stipulated. The spread is the quantity worth attending to: in the hundreds on a manufactured tone, between 1.2 and 3.8 on field material, and it reports the latitude the rule finds rather than a hierarchy belonging to the material. Two debts to the research notes are settled. The paper's triad of strata departs from Note 04 by replacing acquired technique with the given/instituted pair legislated in Note 05; and the condition Note 05 attaches to any measurable gap — that the arrival material carry a metric — is shown to be met here and empty, no hand standing between the rule and its output.

A deterministic rule that assigns one fundamental and twelve weighted classes to any recording — and a measure of how much latitude the rule finds in the material.

Arnaud Quercy — Ideamorphic Studies Ideamorphic Studies Papers, PUB-PAP0010 — Specifies the Pitch Codex for Field Material, version 1.0

1. What This Paper Does

A fragment of sound can be made to yield three different things: a set of pitches, a rhythm, or a sequence of forms. Three rules, one material. They are specified separately, and this paper covers the first — the rule that takes a fragment and returns a pitch structure.

They are separated because three rules make three modes. That rests on a decision, declared as such in Note 01: a mode is a ruled space, individuated by its rules and not by the sensory channel ^[1]. The decision is not an established result, and what follows from it for the unity of the modes is scheduled to be reopened. Nothing in this paper depends on that reopening — three rules on one fragment remain three rules whether the modes turn out to be one or not. That they operate on the same fragment binds them no more than two games played with the same deck.

The paper states the rule in full, names its frozen parameters and where each came from, records the rules tried and withdrawn, declares the scope of the evidential protocol — with one result of its own, that the condition Note 05 attaches to any measurable gap is met here and empty — and formulates the question the device makes askable. It does not report findings. The rule has been executed on seven recordings and six works; that is not a corpus.

2. Why the Instrument Exists

The Prescribed and the Realized ^[2] specifies a device in which the measured half is operational and the prescribed half is missing. A deterministic rule assigns a chromatic structure to each of the twenty-four tonalities; 379 paintings execute it; an independent computational layer records the colours actually on each surface. What does not exist is the prescribed palette in numerical form — a pure function from harmonic structure to chromatic coordinates. The instrument has an output and no reference.

That function needs an input. In the painting practice the input is a tonality, chosen. This instrument produces one from a recording instead, and produces it by rule rather than by ear.

The asymmetry is worth stating plainly, because it is the whole reason the two devices differ. In the chromatic device the constraint is perceptual: colour is not verifiable by the practitioner, and the machine closes a loop the eye cannot close. Here there is no such deficit — harmonic relation is available to the practitioner with precision. The machine is not compensating for a missing organ. It is doing something the ear does not do at all: assigning, to a recording that contains no played note, a fundamental and a distribution.

A café terrace has no key. Traffic has no chord. The rule assigns one anyway. That is not a discovery about the recording; it is an institution, and it binds only the emitter ^[3].

3. The Rule

Stated completely, so that it can be re-executed without access to the code.

Input. One recording; optionally a time range within it; optionally a transposition in whole semitones. Everything below operates on that range and on nothing else; material outside it is never decoded, so a fragment of thirty seconds taken from an hour costs what thirty seconds cost.

Step 0 — Transposition, if there is one. A transposition is a decision of the emitter about the material, like the choice of range, and not a parameter of the codex: the rule below is unchanged, but it is applied to a shifted recording rather than to the original. The shift is performed on the range alone, duration preserved, by a phase-vocoder shift at a frequency ratio of $2^{(n/12)}$ for n between -12 and $+12$; the shifted range is re-encoded before it is read. The method is declared here rather than recorded execution by execution, so that an execution need carry only the integer. A shift by resampling and a shift by phase vocoder do not produce the same spectrum, and Step 1 reads that spectrum — so changing the method changes the codex, exactly as changing one of the eight values would.

Step 1 — Average spectrum. Decode to mono at 22 050 Hz. Take overlapping frames of 16 384 samples, advancing by 8 192, each multiplied by a Hann window. Take the magnitude of the real FFT of each frame. Average those magnitudes across all frames. The result is one long-term average spectrum for the whole range, with a resolution of about 1.35 Hz.

Step 2 — Candidate fundamentals. Consider every semitone from C1 to C6 inclusive — sixty-one candidates — on a grid anchored at A4 = 440 Hz.

Step 3 — Score each candidate. For a candidate of frequency f :

- *Energy at a frequency* means the maximum of the average spectrum within $\pm 2\%$ of that frequency.
- Collect the harmonics: for k from 2 to 12, take the energy at $k \cdot f$, weighted by $0.84^{(k-2)}$, stopping when $k \cdot f$ reaches the Nyquist frequency. Divide the weighted sum by the sum of the weights used.
- The score is the **product** of the energy at f itself and that weighted harmonic mean.

Step 4 — Normalise. Express the sixty-one scores as percentages of their total.

Step 5 — Read the result. The *fundamental* is the highest-scoring candidate. The *classes* are obtained by summing the sixty-one percentages onto their twelve pitch classes. The *spread* is the strongest class divided by the weakest.

Note names are written with flats throughout, by stipulation and without musical argument.

4. The Frozen Parameters

Eight values fix the rule. Changing any of them changes the codex and must produce a new version rather than a silent rewriting of past results, since a signature already attached to a work must remain replayable.

Parameter	Value	Why this value
Tuning reference	440 Hz	The whole pitch grid hangs from it. Nothing in field material is tuned to anything; the reference is imposed, not found.
Analysis rate	22 050 Hz	Covers pitch content to 11 kHz; halves the decoding cost.
Frame length	16 384 samples	1.35 Hz resolution. At C2 a semitone spans about 4 Hz, so coarser frames cannot separate low semitones.
Hop	8 192 samples	Half-overlap.
Candidate range	C1–C6	Below C1 the frame cannot resolve; above C6 a fundamental is implausible for the material.
Harmonics collected	12	Beyond the twelfth the contribution is negligible under the decay below.
Harmonic decay	0.84 per rank	Weights the series so that a high harmonic cannot outweigh the fundamental.
Band tolerance	$\pm 2\%$	Field material is not tuned; a narrower window would miss partials that sit between semitones.

The decay and the tolerance are stipulations. They were not derived and they are not optimal in any sense the instrument can establish.

One consequence of the tolerance is worth declaring rather than leaving to be found. The band is constant in cents; the transform is linear in frequency. The number of spectral bins the maximum is taken over therefore grows in proportion to the frequency — about one bin at C1, about thirty-one at C6, and several hundred for the highest harmonics collected. A maximum taken over more bins is more likely to meet a peak, so the rule does

not weigh the range evenly. This is a property of the rule, not a defect corrected inside it, and it bears on the spread: the spread reports the hierarchy the rule finds, under this unevenness, and not a hierarchy of the material independent of it.

5. What the Instrument Records

For each execution: the version of the codex; the fundamental as a note name and a frequency and its share of the total; the twelve classes with their percentages, ranked; the spread; and the eight parameters, recorded alongside the result rather than assumed. A result that does not carry the version and the parameters that produced it cannot be replayed, and an unreplayable result cannot enter a corpus.

Since 29 August 2026, every execution also carries two blocks that belong neither to the frozen parameters nor to the output. **The recording:** its path, the SHA-256 hash of the file and its duration — what tells two takes apart once a result has left its node, and what catches a long take that loops. **The execution:** the emitter's decisions on that material — the range analysed, as start and end **on the file's own timeline**, the transposition in semitones, the onset detector and the number of shape segments. None of these is a parameter of the codex and none is a result; without them a transposed or trimmed result could not be replayed. Executions made before that date carry neither block.

The pitch record also carries the **margin:** the ratio between the best-scoring candidate and the runner-up among the 61 candidates, taken before the folding into twelve classes. It cannot be recomputed from the stored classes, since the folding destroys the ranking it is taken from; every execution earlier than 29 August 2026 lacks it permanently.

Reference values, four recordings, each on the range indicated in its record:

Material	Fundamental	Spread
A three-note chime	A2, 110.0 Hz	215.8
A spoken announcement	G♭2, 92.5 Hz	1.79
A ring road, recorded from a car	C2, 65.4 Hz	1.45
A café terrace	F3, 174.6 Hz	1.24

The fundamental is reported under the same absence of threshold as the sequence refused in §6: at a spread of 1.24 nothing stipulated separates F3 from the class beneath it, and the naming is the rule's, not the recording's. The spread is therefore the quantity worth attending to. On a manufactured tone it is in the hundreds. On field material it sits between 1.2 and 3.8 — which is to say the twelve classes are nearly equal, and the ranking among them is a thin result.

This is not a defect of the measurement. It is the measurement. Where the twelve classes stand within a point of one another, the rule has found almost nothing to rank, and what is posed on the recording is posed by the emitter alone. Where it finds 3.8, it has found something, and departing from it is a decision rather than an accident. The instrument does not adjudicate the decision; it reports how much room the rule left.

6. What the Instrument Does Not Record

No chord. The rule returns a fundamental and a distribution. Naming a chord from them is not part of the rule and is performed by no procedure. The reading belongs to the work.

No chromatic coordinates. The function from this output to a palette, which *The Prescribed and the Realized* declares missing, remains missing. This instrument supplies its input and nothing further.

No melodic line for a place. Running the rule across successive short windows returns a sequence of fundamentals, but on field material the margins are thin — measured at 1.04 to 1.45 between the winner and the runner-up, median 1.21 — and the sequence is the argmax of a near-tie changing hands. It is not reported. That is a decision and not a measurement: no threshold has been stipulated separating a margin that names a funda-

mental from a margin that does not, and until one is, no figure in that range refutes the sequence or licenses it. What can be said without a threshold is comparative — the same procedure on a chime gives a margin no near-tie could produce — and a comparison of two materials is not a criterion for one.

No verdict on aptness. A stipulated rule is neither true nor false ^[2]. What is available is the extent of its execution.

7. Rules Tried and Withdrawn

These are recorded because they justify the rule that stands, and because each looks reasonable enough to be tried again.

Folding onto twelve classes alone. The obvious first rule sums the spectrum onto twelve pitch classes, discarding the octave. It fails on this material for a structural reason: a 60 Hz rumble and a 1900 Hz resonance land in the same bin. Two recordings whose energy sits two octaves apart returned the same three leading classes. Octaves must not be folded before a fundamental has been chosen.

Scoring a candidate by the sum of its harmonics. A comb placed on $f/2$ falls on every harmonic of a true f , so each real fundamental manufactures ghosts an octave and a fifth below it. Under a sum these ghosts survive: on the chime the procedure returned thirty candidates for eighty per cent of the mass where the unfolded spectrum needed twenty-three. The folding increased the data instead of reducing it. The product used in Step 3 removes them, because a ghost has no energy at its own fundamental.

Removing the spectral slope before searching. Field recordings differ enormously in how their energy distributes with frequency, and normalising that slope seems a way to stop the lowest candidate winning by default. It removes the identity along with the bias: the procedure returned a fundamental of E4 for a recording with 55 % of its mass below C3 and a maximum at C2. Withdrawn.

A single harmonic-series hypothesis for a whole recording. Testing whether one fundamental explains an entire spectrum returns a confident figure on any material. Against a control — the same measurement at non-integer multiples — a chime beats the control by 3.0 dB, a spoken announcement by 1.2, a ring road by 0.5, a café terrace by −0.1. On an environment there is no fundamental for anything to be a harmonic of, and the procedure must not be read as finding one.

8. Three Strata, and the Scope of the Protocol

Three distinct things accumulate around one fragment, and only the first is evidence.

The division into strata is Note 04's — acquired technique, stipulated codex, enacted idea of the work ^[4]. The first term is replaced here, and the replacement is a debt. *The given* and *the instituted* are the pair legislated in Note 05, on an axis of mode of existence rather than of substance: the given is what a sensor measures at the surface **without the codex**, and the instituted is the rule that elects relations within that surface, which only the divulged codex deciphers ^[5]. Acquired technique plays no part in what follows — the rule needs no hand — which is why the triad below is not Note 04's unchanged.

The given — what a sensor records without the codex: the average spectrum of the file. Measurable because it is a fact of the file.

The stipulated codex — the rule above, frozen and versioned. It produces the fundamental, the twelve classes and their spread, which exist only once the rule has folded the spectrum. It produces no chord.

The idea of this particular work — the chord read from the classes, its voicing, the practitioner's notes on the fragment. Note 04 describes this stratum as an act tracing a curve across the parameters the codex fixes, and that curve is not deduced.

Note 05 attaches a condition to any gap between a rule and its realization: it is a measurable magnitude only where the **arrival** material carries a metric — colour does, and the regressed word of the Feigned Tongue does not, its criterion being an audible curve and not a number ^[5]. Here the arrival material is numeric and carries one by construction, so the condition is met trivially rather than instructively. It is met and empty: no hand stands between the rule and its output, and the gap Note 05 measures — between a rule prescribed and a surface realized — does not arise here at all. The gaps that do arise lie upstream of the rule, in the capture, and §9 lists them.

The evidential protocol reads the first stratum only. The chord and the notes are not excluded for impurity — they reconcile nothing and consume no measurement — but they belong to a different stratum, and an objection granted on one does not carry to the others.

This is a matter of scope and not the exclusion declared in *The Prescribed and the Realized* ^[2] against an editorial layer that began from the prescription, observed its variance with the surface, and resolved that variance into plausible prose — thereby consuming the quantity the device exists to record. Nothing here does that. The distinction is worth keeping sharp: one is a contamination, the other a boundary.

9. The Chain of Gaps

The distance between a rule and its result is a composite here as it is for colour, and is not decomposable with what exists:

- from the recording to the range chosen within it, and to the transposition applied to that range if there is one — the two links that are entirely the practitioner's, and the two the rule takes as given;
- from the event in the room to the microphone;
- from the microphone to the encoded file, with its lossy compression;
- from the file to the decoded range;
- from the range to its shifted re-encoding, when a transposition is applied — a resynthesis, and a second lossy generation;
- from the range to the averaged spectrum, with its window and its resolution;
- from the spectrum to the score, with its decay and its band tolerance — the latter constant in cents and therefore uneven in resolution across the range;
- from the score to the fundamental, when the margin is thin.

Each link displaces. None can be isolated without an apparatus that does not exist. The instrument measures the output of the chain.

10. What the Device Contributes, and the Question It Makes Askable

Note 02 holds the unity of the modes to be instituted — an effect of the codex and not its ground — and attaches a falsification condition to it: **comparative executability**. If an equation between two unlike domains exhausts itself where the chromatic equation holds four hundred canvases, a weak common space regains its rights ^[3].

That condition is not testable, and the block is declared rather than incidental: it holds until the **chromatic** codex exists in machine-executable form — the form in which a rule runs rather than is described. §2 has already said what is missing there: the prescribed palette in numerical form.

This device does not lift it. Nor does it measure the resistance the condition looks for; the spread measures nothing of the kind. What it supplies is narrower, and can be stated exactly: an equation between a different pair of domains, stipulated with the same rigour, executed without exception — and executable by machine, which is the form comparative executability requires of what it compares. The practice institutes many codices, the Feigned Tongue and the duration-to-surface rule of *Solabi Vare* among them; what the condition can compare is the subset that runs without its author, and this one runs without its author. That does not make the condition testable, since the term it needs most is still the chromatic one. It adds a term where the inventory was thin.

The question that remains open here is separate, correlational, and does not falsify anything. The spread states, per recording, how much hierarchy the rule finds in the material before anything is posed on it. A corpus of executions carrying their spreads would show whether readings taken on flat material behave differently from readings taken on structured material — whether the latitude the instrument reports has any consequence downstream. Seven recordings cannot show it. The instrument records the quantity so that a corpus can.

11. What This Paper Does Not Claim

The instrument assigns a fundamental and a distribution to a recording under a stipulated rule. It establishes nothing about the recording's musical content, nothing about how any work made from it is received, and nothing about whether the rule is apt.

It does not claim that the fundamental it returns is present in the material. On a chime it is; on a café terrace it is a region where uncorrelated sources accumulate, and the paper says so in §6 rather than leaving it to be discovered.

The rule changed repeatedly while it was being built. Publication ends that, on the precedent of the Codex of the Feigned Tongue: what was a proto-codex is stabilised here as the **Pitch Codex for Field Material, version 1.0**. The version number is not a claim that the rule is right — a stipulated rule is neither — but that it is fixed. Any change to the eight values, or to Steps 0 to 5, produces a new version; a result stays attached to the version that produced it, and nothing already executed is rewritten.

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Quercy, A. (2026). *Folding a Recording onto a Fundamental: A Pitch Codex for Field Material*. Art Quam Anima Publishing New York. <https://doi.org/10.5281/zenodo.22774915>

DOI (this version)	10.5281/zenodo.22774916
DOI (all versions)	10.5281/zenodo.22774915
Deposited	Version 1.0 · 2026-09-15
License	CC BY 4.0

ISSN: applied for — U.S. ISSN Center, Library of Congress

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Published by Art Quam Anima Publishing New York,
an assumed name of AQA Publishing LLC

c/o Northwest Registered Agent, 418 Broadway Ste N
Albany, NY 12207, USA
+1 917-764-5470

NY DOS ID 7624376 · Assumed Name ID 7658709

publishing.artquamanima.com

Last updated: 2026-09-15

Persistent URI: <https://publishing.artquamanima.com/en/papers/2026/08/folding-a-recording-onto-a-fundamental-a-pitch-codex-for-field-material-5e6l.pdf>