

Temporal–Chromatic Coherence in Rubin/LSST Light Curves

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Can temporal–chromatic coherence reveal organised multiband behaviour under irregular Rubin/LSST cadence?

PROBLEM

Single metrics overlap across coherent, natural-stochastic and noise-dominated variability.

TARGET

Slow coordinated modulation from activity, dust/coma evolution or viewing geometry.

GOAL

A high-purity survey filter for weakly active, volatile-rich or transitional small bodies.

Simulation design: 500 LSST-like synthetic light curves

Simulation Setup (N=500 synthetic curves, ~167 per class)

BASELINE: 3-year irregular observing baseline (180-day observing season followed by a 185-day gap).

CADENCE SPECIFICS: Night probability 0.55; mean 1.2 visits/within-night scatter 0.06 d.

IMBALANCE: Band fractions **g:r:i** = 15:55:30; random dropout = 10% / 3% / 5%.

MEANING: Builds a deliberately irregular, band-imbalanced LSST-like sampling pattern.

COHERENT

Stable achromatic periodic modulation.

0.10-mag sinusoid + 0.03-mag harmonic; period 30–90 d; identical in g/r/i.

NATURAL

Structured variability with drifting amplitude/phase and colour dependence.

Amplitude/phase drift plus a chromatic cloud term; relative g:r:i response = 1.40:1.00:0.65.

NOISE

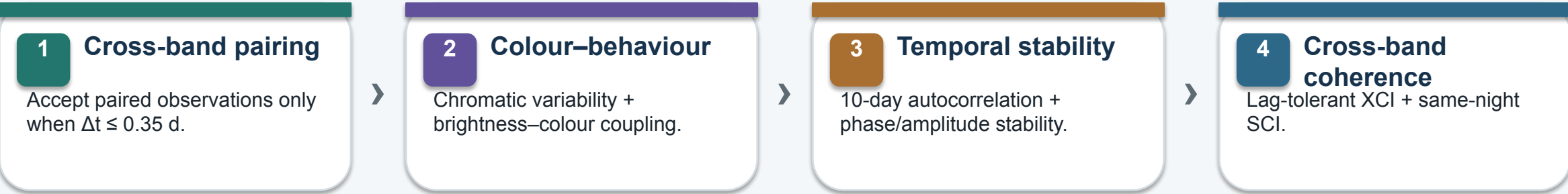
Constant source with measurement scatter only.

Photometric S/N = 10–50.

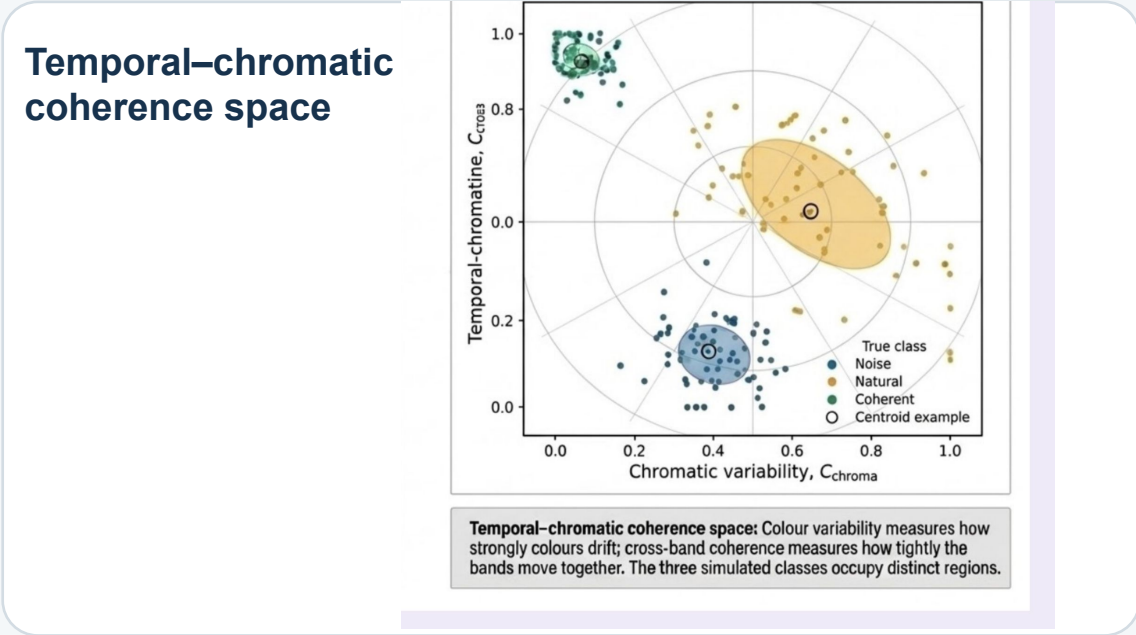
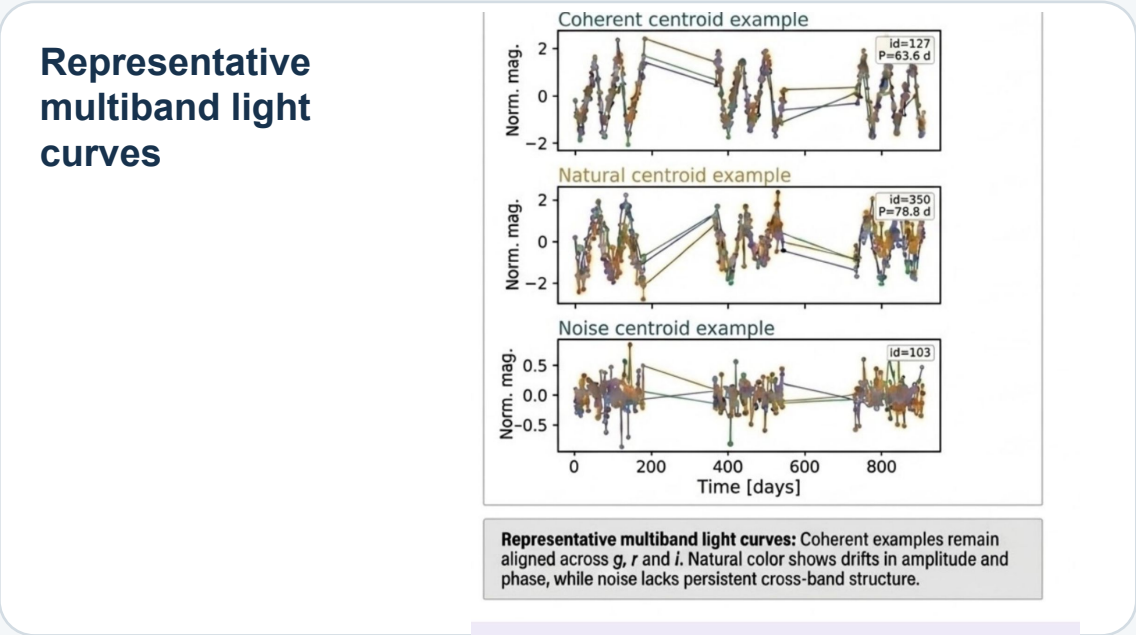
MATRIX RESULT: Creates three controlled regimes against which the diagnostics can be tested.

Three controlled regimes — coherent, natural and noise — provide the testbed for the diagnostics.

From multiband light curves to a coherence diagnostic

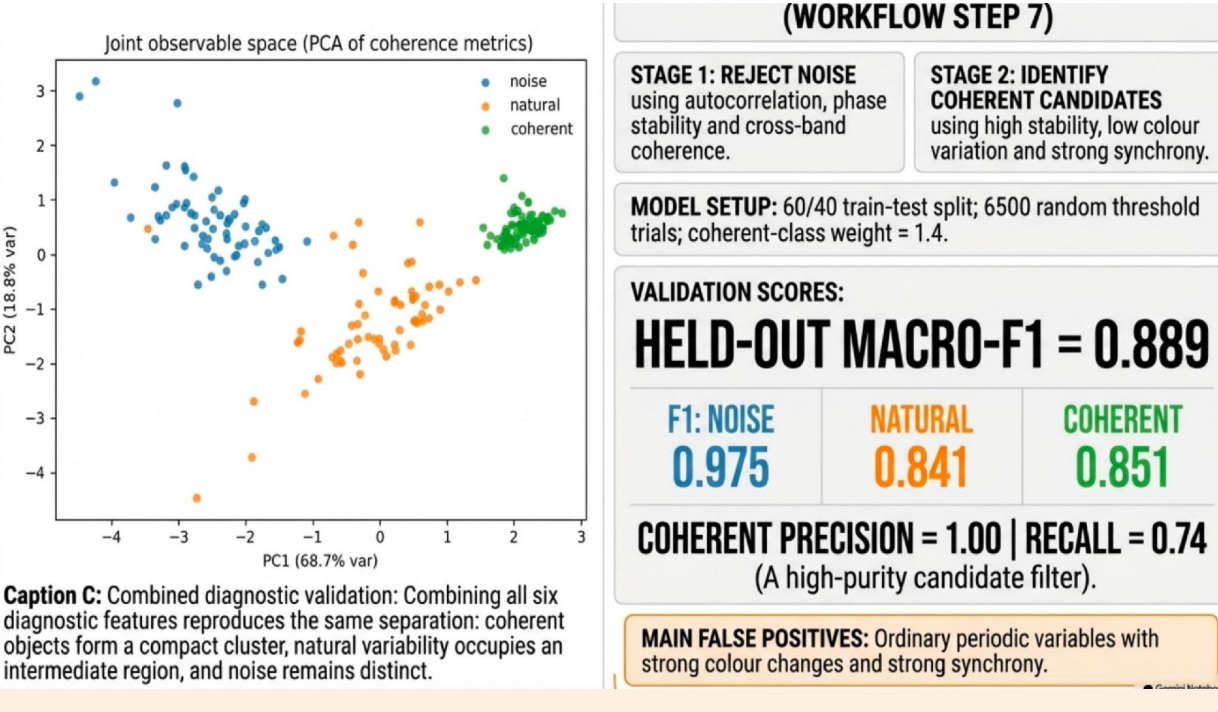


Key principle: coherent objects show **low colour drift** together with **strong cross-band synchrony**.



Coherence separates signal from noise — with high candidate purity

Independent combined-feature view



Caption C: Combined diagnostic validation: Combining all six diagnostic features reproduces the same separation: coherent objects form a compact cluster, natural variability occupies an intermediate region, and noise remains distinct.

Main false positives: ordinary periodic variables with strong colour changes and strong synchrony.

ACKNOWLEDGMENT

NJM acknowledges support from Europlanet 2024 RI grant number 871149.

ABK acknowledges funding provided by the University of Belgrade –

Faculty of Mathematics (contract 451-03-33/2026-03/200104).

Held-out validation

0.889 macro-F1

1.00
coherent precision

0.74
coherent recall

Class F1

Noise
0.975

Natural
0.841

Coherent
0.851

TAKE-HOME

A high-purity triage filter for follow-up: coherence isolates organised multiband behaviour from stochastic variability and noise.