CFALD v1.4

CFA-Luminance-Domain Luminance Extraction for OSC Data

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1. Overview

CFALD (CFA-Luminance-Domain) is a method for generating a binned luminance signal from one-shot colour (OSC) data before debayering.

Instead of forming luminance from an RGB image after demosaicing, CFALD operates directly on the CFA subs. Each sub is converted into a binned luminance representation and then stacked using a standard normalised stacking workflow.

The intent is simply to form luminance earlier in the pipeline and allow stacking to perform the averaging.

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2. CFA → Luminance Conversion

Each OSC sub contains an RGGB Bayer pattern. In CFALD, the CFA data is processed in 2×2 blocks:

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RGGB  →  MMMM
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Each **M** is the average of the four CFA samples in that 2×2 block.

This produces a luminance image that:

- remains on a 2×2 grid,
- is not collapsed to a single pixel,
- is derived directly from the CFA data.

The result is a **binned luminance sub** created prior to debayering.

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3. Stacking Behaviour

The CFALD luminance subs are stacked using **normalised stacking**, exactly as in any conventional astrophotography workflow.

During stacking:

- background and scale normalisation are applied,
- the 2×2 block structure naturally averages out,
- the final stacked luminance appears smoother than a binned 2x2-2x2 stack.

No special reconstruction step is involved. The averaging occurs through stacking, in the same way that stacking averages noise and structure in any binned or resampled data.

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4. Relationship to Green Luminance

CFALD is closely related to pre-debayer green luminance.

- Green luminance forms luminance using the two green samples in each RGGB block.
- CFALD generalises this by averaging **all four RGGB samples**.

Both approaches:

- operate on 2×2 CFA blocks,
- form luminance before debayering,
- rely on stacking to average the result.

In practice, once calibration is applied, both methods typically show **modest** SNR improvement rather than large gains.

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5. Calibrated vs Uncalibrated CFALD

CFALD can be applied in two distinct modes, which behave differently and serve different purposes.

5.1 Uncalibrated CFALD

In this mode, CFALD is applied directly to raw CFA subs **before** bias, dark, or flat correction.

Characteristics:

- Produces the strongest apparent SNR improvement
- Very effective at revealing faint structure
- Not suitable for classical calibration

Typical use:

- As a **structural or noise-suppression layer**
- Masked over galaxies, planetary nebulae, or faint extensions
- Used in combination with a fully calibrated RGB workflow

This mode prioritises signal visibility over photometric correctness.

5.2 Calibrated CFALD

In this mode, CFALD is applied after standard CFA-space calibration (bias, dark, flat), but still **before debayering**.

Characteristics:

- SNR improvement is smaller
- Produces a clean, stable luminance
- Fully compatible with normal processing workflows

Typical use:

- As a general luminance channel

- Combined with debayered RGB in an LRGB-style workflow

This mode trades the large apparent gain of uncalibrated CFALD for robustness and consistency.

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6. Practical Workflow (Condensed)

Calibrated CFALD (default)

1. Calibrate CFA subs (no debayer)
2. Convert each CFA sub: RGGB → MMMM
3. Stack CFALD luminance subs (normalised)
4. Process RGB normally
5. Combine CFALD luminance with RGB

Uncalibrated CFALD (selective use)

1. Convert raw CFA subs: RGGB → MMMM
2. Stack CFALD luminance subs (normalised)
3. Use as a masked structural layer over calibrated RGB

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7. What CFALD Provides

CFALD typically produces:

- a clean, well-behaved luminance,
- reduced demosaic-related blur and noise compared to RGB-derived luminance,
- behaviour consistent with other binned-luminance workflows.

Any improvement seen relative to a debayered luminance comes from forming luminance earlier and allowing stacking to perform the averaging.

8. Summary

CFALD is a straightforward pre-debayer luminance workflow:

> **Each CFA sub is binned from RGGB to MMMM, then stacked normally to produce a luminance.**

It is closely related to green luminance, generalised to all CFA samples, and is most useful when treated as a practical luminance-generation tool rather than a reconstruction method.