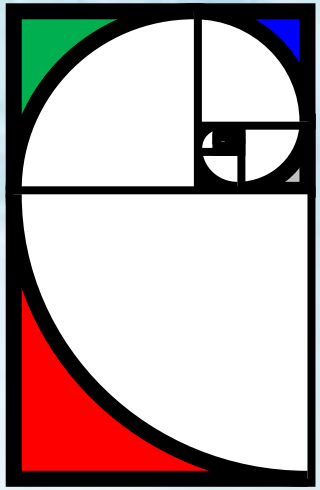
Estimating Uncertainty due to Stray Light in Spectroradiometric Measurements



Presented by: James E. Leland, Principal

Copia LLC

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Overview

I. Background: Stray Light Model of Zong et al.

II. Application to Estimating Uncertainty

III. Further Investigation: Thought Experiments

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I. BACKGROUND:

Stray Light Model of Zong et al.

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- Characterize Spectroradiometer
  - Measure multiple line sources at different wavelengths
  - Derive Line Spread Functions (LSF)
  - Interpolate to construct a distribution matrix (**A**)

$$\mathbf{Y}_{\mathbf{meas}} = \mathbf{A}\mathbf{Y}_{\mathbf{IB}}$$

- Stray Light Correction
  - Apply inverse transform ($\mathbf{A}^{-1}$) to measured spectrum

$$\mathbf{Y_{meas} = AY_{IB} = [I + D]Y_{IB}}$$

$$\mathbf{A^{-1} Y_{meas} = Y_{IB}}$$

II. APPLICATION:

Estimating Uncertainty due to Stray Light

Estimating Uncertainty due to Stray Light

- Adopt a "typical" **D** matrix*
- Apply **D** to both DUT and REF
- Calculate the quotient:

$$\mathbf{Y'}_{\mathbf{meas}}(\mathrm{DUT}) = \mathbf{Y}_{\mathbf{meas}}(\mathrm{DUT}) / \mathbf{Y}_{\mathbf{meas}}(\mathrm{REF})$$

- Apply assigned REF value as usual, e.g.

$$\mathbf{\Phi}_{\mathbf{meas}}(\mathrm{DUT}) = \mathbf{Y'}_{\mathbf{meas}}(\mathrm{DUT}) \cdot \mathbf{\Phi}(\mathrm{REF})$$

- Compare $\mathbf{\Phi}_{\mathbf{meas}}(\mathrm{DUT})$ to $\mathbf{\Phi}(\mathrm{DUT})$

**Note:* "Typical" D matrix can be scaled…

Spectrometer Readings [counts] for Given Source Spectra

GIVEN: $\mathbf{\Phi}(\mathrm{DUT})$, $\mathbf{\Phi}(\mathrm{REF})$

$\mathbf{R}$, $\mathbf{D}$

$$\mathbf{Y_{IB}}(\mathrm{DUT}) = \mathbf{R\Phi}(\mathrm{DUT})$$

$$\mathbf{Y_{IB}}(\mathrm{REF}) = \mathbf{R\Phi}(\mathrm{REF})$$

Stray Light Effect on Spectrometer Readings [counts]

$$\mathbf{Y_{meas} = AY_{IB} = [I + D]Y_{IB}}$$

$$\mathbf{Y_{meas} = Y_{IB} + DY_{IB}}$$

Stray Light Effect on Spectroradiometric Measurement

$$\mathbf{\Phi}_{\mathbf{meas}}(\mathrm{DUT}) = \mathbf{\Phi}(\mathrm{REF}) \cdot \mathbf{Y}_{\mathbf{meas}}(\mathrm{DUT})/\mathbf{Y}_{\mathbf{meas}}(\mathrm{REF})$$

*Also applies to:

irradiance, intensity, and radiance

Compare
Φ_{meas}(DUT) to Φ(DUT)

$$\Delta\Phi_{L_{rel}} = (\Phi_{L_{meas}} / \Phi_{L_0}) - 1$$

Also: Δx, Δy, etc.

III. FURTHER INVESTIGATION:

Thought Experiments

Thought Experiments

- Prioritizing Effort and Expense
  - Stray-light characterization & correction
  - State of the art vs. mid-range spectroradiometers
  - Expectations for low-end spectroradiometers

- Evaluating simplified stray light specifications
  - Reconciling different types of stray light standards
  - Proposing standard specifications?

Conclusion

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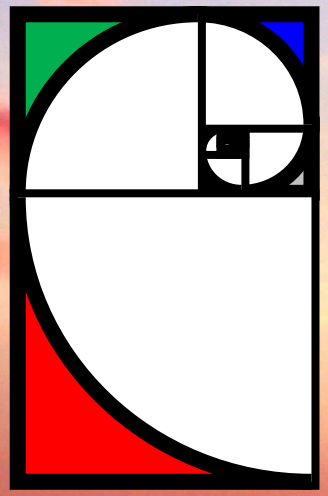
QUESTIONS?



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