Deconvolution of images from adaptive optics

Laboratoire d’astrophysique de Marseille
Journée des doctorants
Summary

- Adaptive optics
- Deconvolution
- PSF issues
- How to solve these PSF issues
The Point Spread Function (PSF)

- Atmosphere is turbulent
- Mixes hot and cold air (e.g., fire)
- This blurs images
The Point Spread Function

- If objects are too close to each other, they are not resolved
Adaptive Optics

- Deformable mirror compensates atmospheric turbulence
- Reduces « blurring radius »
- Greatly improves imaging resolution
Observing above us

Asteroid

Satellite

Batman

Turbulent atmosphere

AO
Observing above us

Asteroid

Satellite

Turbulent atmosphere

Batman

AO
Imaging batman with AO

\[ i = o \ast h + n \]
Is it possible to retrieve Batman knowing its image?
Deconvolution

Star

Batman

Object

\( o_{\text{estimated}} \)

Image

\( i \)

\( h \)

Sharp edges

More visible details
Wrong PSF Deconvolution

Wrong PSF
Leads to wrong batman
My work: PSF parametrization

- Parameterize the AO corrected PSF
  - From 256 x 256 pixels to ~ 10 parameters
  - Physical parameters (turbulence strength)
  - Correlation with AO RTC (SPARTA)

**ZIMPOL PSF**

**Model**


*Fétick et al, in prep*
My work: Deconvolution

ESO Large Program (P. Vernazza)
Asteroid (4)Vesta

Observed
SPHERE Zimpol

Deconvolved
Parametric PSF

Truth
NASA Dawn
OASIS model

Fétick et al, accepted A&A
Credits: A. Drouard
• « STORM » Python library
  – AO PSF models
  – Optimization tools (optimpack lib from C)
  – Deconvolution
  – Compatible with MUSE, ZIMPOL and others...
• Ideal for astronomers & engineers
• Not suitable for children
That’s finished!
« Not all legos wear capes »
« But super-legos do »