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The AIRY Software Package v. 6.1

Dibris

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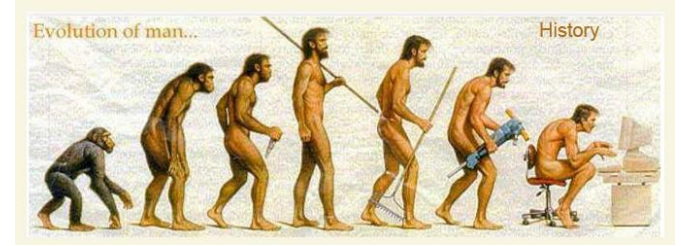DIBRIS - University of Genoa, Italy

LAGRANGE

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Outline

- A (very) short introduction to AIRY

- Panoramic view of the software

- Algorithms and methods for deconvolution

- Live demo (coffee break)

A (very) short introduction to AIRY

- AIRY (acronym for Astronomical Image Restoration for interferometrY) was born at the beginning of this millennium, after a brainstorming meeting (at the table of a pub -- ask Patrizia ;)

- The first paper was published in 2001 [1] and after 15 years we are at version 6.1 (online) and we are working at the version 7.0 (next SPIE)

- AIRY is a Soft.Pack. of the CAOS Problem Solving Environment (PSE), see [2]

- Written in IDL, it is made of 15 modules

[1] Correia, S., Carbillet, M., Fini, L., et al. 2001, in Astronomical Data Analysis Software and Systems X, 404

[2] Fini, L., Carbillet, M., & Riccardi, A. 2001, Astron Data Anal Softw Syst X, 238, 253

Panoramic view of the software

Simulation:	Deconvolution:
• OBJ • CNV • ADN	• PRE • PEX • DEC • CBD
Data analysis:	I/O and utility:
• ANB • FSM	• RFT + RSC • WFT + SIM • RTI • DSP

Input(s)

Output(s)

Seven example projects provided together with the code.

Deconvolution in AIRY

- The standard and well known algorithm Richardson-Lucy

- Methods for multiple-images: MRL, OSEM [3]

- Boundary effect corrections

- Accelerations and Regularizations for RL and MRL/OSEM

NEW! Scaled Gradient Projection (SGP, [4]): an accelerated version of RL (speed-up>10x).

NEW! Four different stopping rules.

[3] Bertero, M., & Boccacci, P. 2000, Astron Astrophys Suppl, 144, 181

[4] Bonettini, S., Zanella, R., & Zanni, L. 2009, Inverse Probl, 25, 15002

Deconvolution in AIRY

- (Strehl Constrained) Blind Deconvolution, based on [5]

NEW! Strehl Constrained Blind Deconvolution, based on [6,7]

- Extraction and extrapolation of the PSF

[5] Desiderà, G., & Carbillet, M. 2009, Astron Astrophys, 507, 1759,

[6] Prato, M., La Camera, A., Bonettini, S., & Bertero, M. 2013, Inverse Probl, 29, 5017

[7] Prato, M., La Camera, A., Bonettini, S., et al. 2015, New Astron, 40, 1
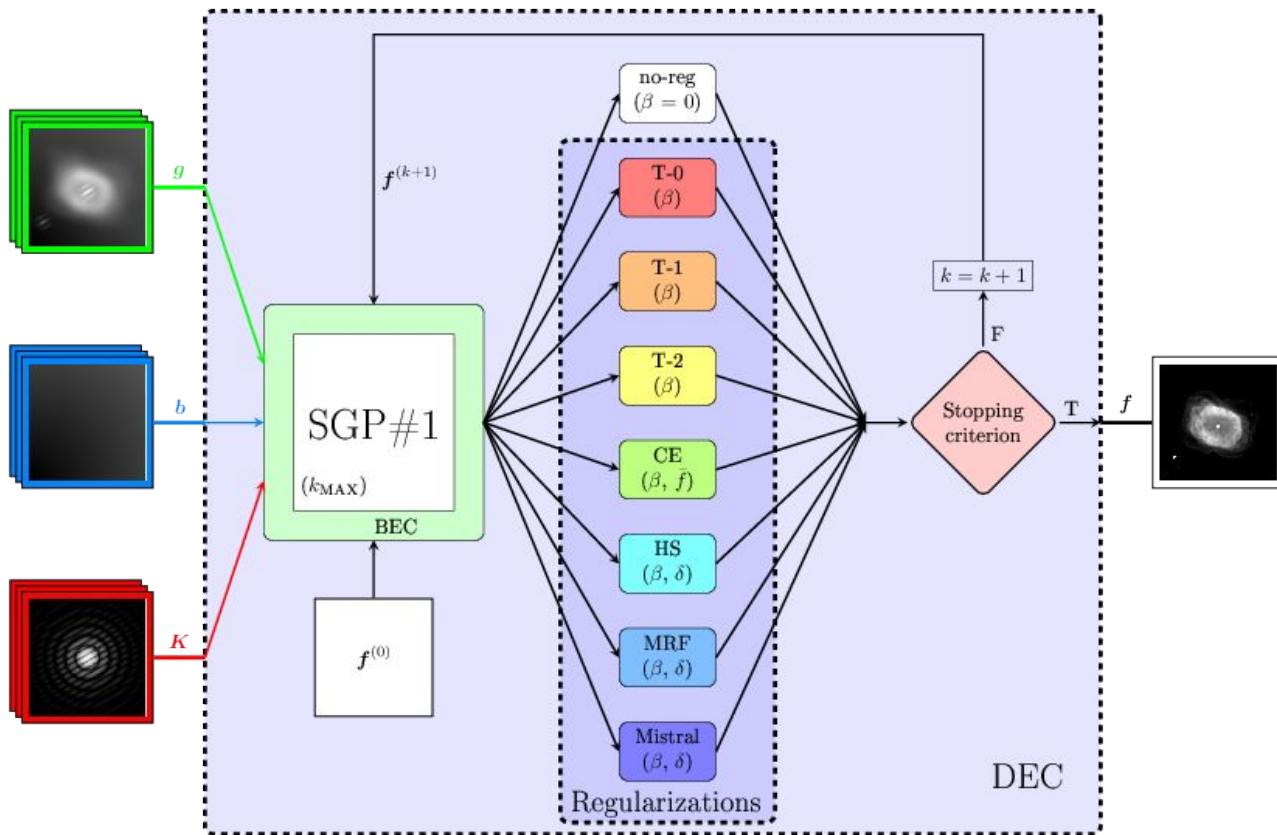
New algorithms (part 1)

In the last years we developed new methods for the restoration of the high dynamic range images:

1. **Jets from YSO** [8,9]: we developed Multi Component RL (MC-RL): an RL-based method able to separately reconstruct the point-like part and the diffuse part of the image.

2. **The images of Io** shown by Mario on Tuesday: recently (paper submitted to A&A) we extended SGP with:
   a. Eight different regularizations to SGP.
   b. Multi-Component SGP (MC-SGP)

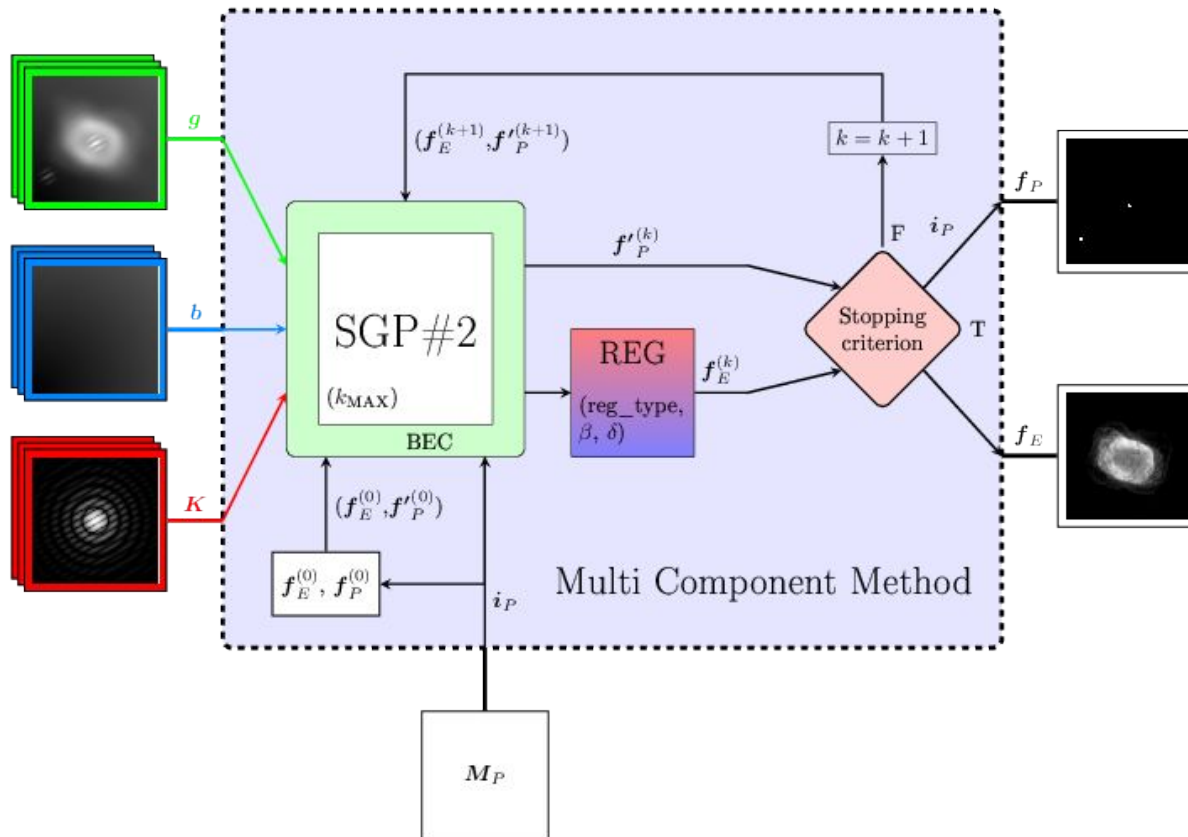[8] La Camera, A., Antoniucci, S., Bertero, M., et al. 2014, Publ Astron Soc Pacific, 126, 180

[9] Antoniucci, S., La Camera, A., Nisini, B., et al. 2014, Astron Astrophys, 566, A129

New algorithms (part 1)

New algorithms (part 1)

New algorithms (part 2)

- The MC-SGP is not enough in the case of Io-like images: we need a further step in order to reconstruct both the surface and the volcanoes.

- We developed a **multi-step method** consisting in:
  a. First (regularized) deconvolution
  b. Identification of the positions of the volcanoes/hot-spots (i.e. the point-like part of the object)
  c. After MC-SGP deconvolution, we only keep the surface of Io (i.e. the diffuse part)
  d. Final SGP deconvolution, with a background made of the surface + the standard background.

New algorithms (part 2)
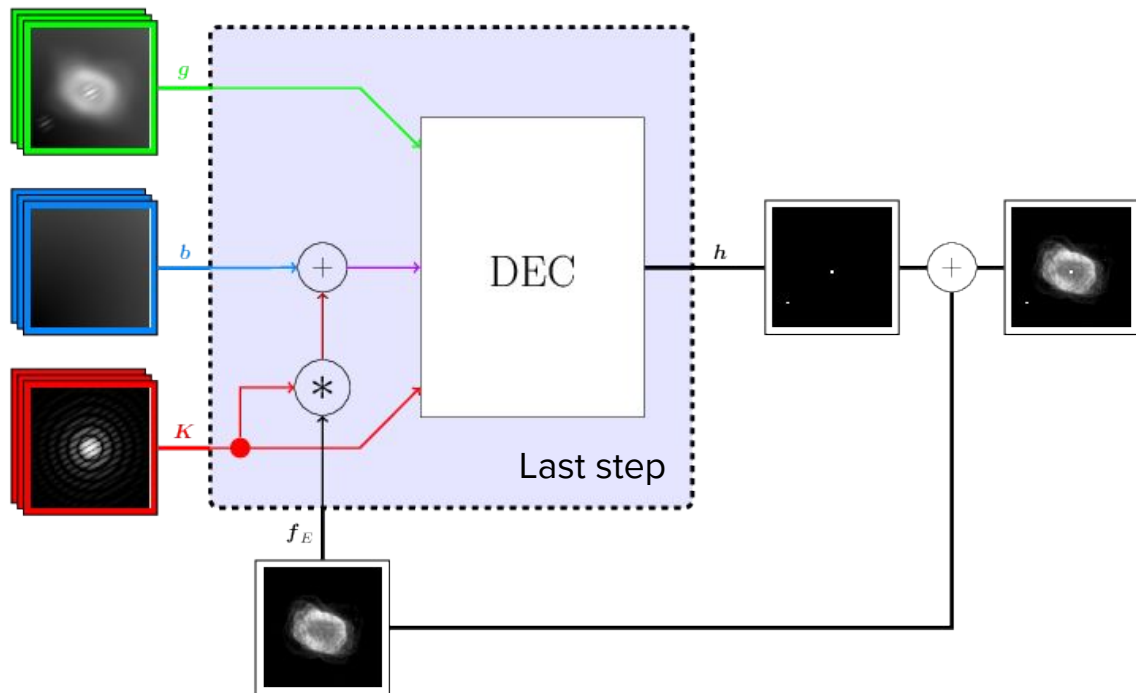
Towards AIRY v. 7.0

In the next version of AIRY (foreseen for this summer, after the SPIE Conf.), you can find:

- The renewed module DEC with the 8 different regularization algorithms for SGP

- The brand-new Multi-Component Deconvolution (MCD) module (with both MC-SGP and MC-RL)

- Multi-step method procedure (an example project for each step)

AIRY v. 6.1 demo

What you need:

- IDL (tested on 7.* and 8.*)

- CAOS PSE system from http://lagrange.oca.eu/caos

- AIRY Soft. Pack. from http://www.airyproject.eu/ (go to the Software page)

Works on Windows 10, Mac OS X, and Linux

Thanks for your attention!