

## M1/M2 Internship position

Deep learning for high-contrast reconstruction for studying circumstellar environments

**Key-words** – High-contrast image reconstruction, proximal algorithms, CNN

**Location:** CRAL, Observatoire de Lyon

9 Avenue Charles André, 69230 Saint-Genis-Laval, France

The unternship will require few missions (1-2 weeks) in UCLouvain, Belgium

**Advisors** : Maud Langlois & Nelly Pustelnik & Eric Tiébaud

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**When** : 4-6 month between february and september 2021.

**Context** – Polarimetric imaging is one of the most effective techniques for high-contrast imaging and characterization of circumstellar environments. These environments can be characterized through direct-imaging polarimetry at near-infrared wavelengths. The Spectro-Polarimetric High-contrast Exoplanet REsearch (SPHERE)/IRDIS instrument installed on the Very Large Telescope in its dual-beam polarimetric imaging (DPI) mode, offers the capability to acquire polarimetric images at high contrast and high angular resolution. However dedicated image processing is needed to get rid of the contamination by the stellar light, of instrumental polarization effects and of the blurring by the instrumental point spread function. In [1], we propose a reconstruction strategy to deconvolve the near-infrared polarization signal from circumstellar environments. This reconstruction method relies on variational techniques including weighted data fidelity term, smooth penalization, and additional constraints. The method improves the overall performances in particular for low SNR/small polarized flux compared to standard methods.

Following recent advances in deep learning for image restoration, the objective of this internship is to explore such framework in the context of high-contrast reconstruction for studying circumstellar environments. Using as a starting point the direct model and the algorithmic strategy provided in [1], we will unroll the iterations to fit a deep learning formalism as proposed in [2].

**Subject** – This internship is devoted to the design of a neural network for the specific task of high-contrast reconstruction for studying circumstellar environments:

- the design of the network;
- the design of a synthetic database to train and test our network;
- the comparison with standard unsupervised and other CNN alternative.

**Skills:** The candidate must have have skills in some of the following areas: Signal and Image Processing, Data science, Optimization, Machine Learning.

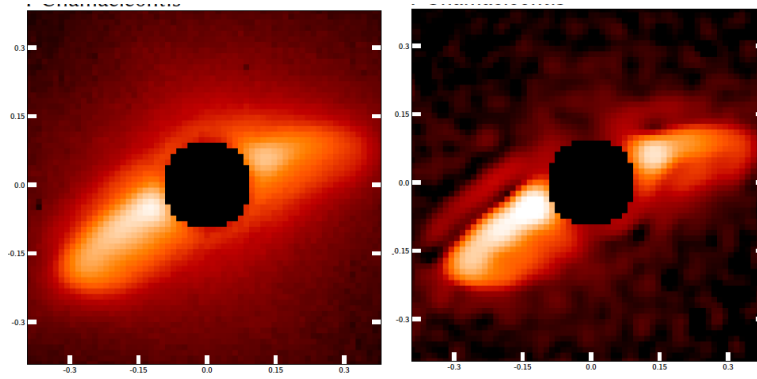


Figure 1: *Reconstruction of T Chamaeleontis [3] using RHAPSODIE [2].*

**Application:** Applicants must send by email a CV and a statement of interest to Maud Langlois and Nelly Pustelnik. For further information, candidate can contact us with questions related to this position.

**References:**

- [1] L. Denneulin, M. Langlois, E. Thiébaud, and N. Pustelnik, RHAPSODIE : Reconstruction of High-contrast Polarized Sources and Deconvolution for circumstellar Environments, submitted, 2020.
- [2] M. Jiu, N. Pustelnik, A deep primal-dual proximal network for image restoration, submitted, 2020. (PDF).
- [3] A. Pohl et al., New constraints on the disk characteristics and companion candidates around T Cha with VLT/SPHERE, *Astronomy & Astrophysics*, 605, 2017. (PDF).