# Data fusion methods for astrophysics – Application to observations of galaxies and interstellar medium

*– Master (2nd year) internship project –*

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## Abstract

**Context** – The astronomical data fusion method developed in [1, 2] combines the benefits of multispectral and hyperspectral images to enhance scientific interpretation of the data. Multispectral images have a high angular (spatial) resolution but are composed of few spectral bands, while hyperspectral images contain very detailed spectra (up to a few thousands spectral points) but measured at lower spatial resolution. The fused product, combining those images, reconstructs the observed scene at high spatial *and* spectral resolutions. The approach described in those papers consists in formulating an observation forward model of an imager and a spectrometer, providing respectively multispectral and hyperspectral images. The associated inverse problem is then derived and solved to obtain the fused product. So far, the performance of this method has been assessed on a synthetic yet realistic data set of the Orion Bar as observed by the James Webb Space Telescope, which will be launched in early 2021.

**Objectives** – The main objective of this internship is to apply the fusion method on real data from the Hubble space telescope (HST) [3] and the spectrometer MUSE [4], embedded on the Very Large Telescope, of the European Southern Observatory. First, the fusion method developed and tested on synthetic data in [1, 2] will be studied. Then, instrumental models of HST imagers and MUSE spectrometers will be derived and implemented. Finally, the fusion method will be tested on multi-band images (HST - Ultra Deep Field) and hyperspectral datacubes (MUSE) of galaxies and on real data of the Orion Bar.

## Keywords

Image fusion, inverse problem, optimization, spectral imaging, astrophysics.

## Profile & requirements

Master or engineering school students. The knowledge needed for this work includes a background in signal/image processing or equivalent (applied mathematics, astrophysics, instrumentation) and experience with Python and/or Matlab.

## Contact

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## References

[1] C. Guilloteau et al., *Simulated JWST datasets for multispectral and hyperspectral image fusion*, The Astronomical Journal, Volume 160, Issue 1, id.28, 13 pp. (2020).

[2] C. Guilloteau et al., *Hyperspectral and multispectral image fusion under spectrally varying spatial blurs–Application to high dimensional infrared astronomical imaging*, IEEE Transactions on Computational Imaging, Volume 6, 1362-1374, 2020.

[3] NASA, Hubble Space Telescope, http://hubble.stsci.edu

[4] ESO, Very Large Telescope, Multi Unit Spectroscopic Explorer (MUSE), https://www.eso.org/sci/facilities/develop/instruments/muse.html