

Dataset Description:

This comprehensive, multimodal experimental dataset is designed to benchmark, evaluate, and demonstrate the performance of the **MSSR (Mean Shift Super-Resolution)** algorithm across diverse scientific domains. The dataset serves as a rigorous testing suite to validate the algorithm's capability to enhance spatial and spectral resolution, separate closely spaced peak profiles, and recover sub-diffraction features in both imaging and spectroscopic data.

All components of this dataset have been previously compiled and made available through the **Zenodo OpenAIRE database** under their respective persistent identifiers.

The dataset is divided into three distinct components:

1. Optical Microscopic Imaging Component (Argolight)

- **Application:** Validates MSSR's algorithmic performance in the spatial domain. The use of a standard **Argolight** calibration target provides stable, predefined sub-diffraction fluorescent patterns, making it the ideal benchmark to quantify lateral resolution enhancements and structural fidelity post-MSSR processing.
- **Source & Identifier:** This component is published in the Zenodo OpenAIRE database with the identifier: <https://doi.org/10.5281/zenodo.6848342>.
- **Instrumentation:** Zeiss LSM 880 Indimo Laser Scanning Confocal Microscope built on an AxioObserver platform.
- **Acquisition Settings:**
 - **Objective:** High-numerical-aperture Plan-Apochromat 63x/1.4 Oil DIC M27 lens using immersion oil with a refractive index of 1.518.
 - **Excitation & Emission:** Epifluorescence track utilizing a 405 nm Diode laser source (Diode 405-30) and a GaAsP/PMT descanned detector collecting a Bandpass (BP) range of 419.95 nm to 480.07 nm (centered emission ~450.01 nm).
 - **Scanning Domain:** Line-sequential scanning mode with 2x line averaging, a frame time of 10.07 seconds, a pixel dwell time of 2.05 μ s, and a digital zoom factor of 3.0x.
 - **Pinhole:** Configured precisely at 0.99 Airy Units (42.44 μ m physical diameter).
- **Image Geometry & Properties:**
 - **Dimensions:** 1024 x 1024 pixels (Single channel, single slice, XYZCT order: SizeC=1, SizeZ=1, SizeT=1).
 - **Physical Field of View:** 44.98 μ m x 44.98 μ m.
 - **Spatial Resolution:** Calibrated at 22.76 pixels per micron (giving an exact pixel size of 0.0439 μ m x 0.0439 μ m).
 - **Data Depth:** Unsigned 16-bit grayscale depth (**uint16**, Little-Endian byte-order) spanning a dynamic pixel intensity range up to 63,040 counts.

2. Astronomical Imaging Component (Carina Nebula)

- **Application:** Tests the MSSR algorithm's limits on real-world macroscopic imaging data characterized by varying signal-to-noise ratios, astronomical atmospheric distortion (seeing), and highly dense stellar fields. This component evaluates the algorithm's ability to deconvolve overlapping stellar point spread functions (PSFs) and resolve faint structures within nebulosities.
- **Source & Identifier:** This component is published in the Zenodo OpenAIRE database with the identifier: <https://doi.org/10.5281/zenodo.20519050>.
- **Instrumentation & Project:** Time-series photometry data acquired as part of *The Carina Time-Series Deep Field* project.
- **Observatory Setup:** Captured using the Dark Energy Camera (**DECam**) mounted on the **CTIO 4.0-m telescope** at the Cerro Tololo Inter-American Observatory.
- **Data Properties:** * **Filter System:** Deep astronomical imaging utilizing the **z-band** (SDSS filter system).
 - **Target Coordinates:** Centered on the Southern sky survey region of the Carina Nebula (RA 10:45:18, DEC -59:41:09).
 - **Format & Processing:** Resampled images provided in standard **FITS file** format and high-resolution **TIFF stacks** (processed using ImageJ), complete with astrometric calibration embedded via World Coordinate System (**WCS**) headers (Epoch/MJD 58554).

3. X-ray Spectroscopic Component (Molybdenum Spectra)

- **Files:** [Spectrum_1_Mo.txt](#), [Spectrum_2_Mo.txt](#), and [Spectrum_3_Mo.txt](#)
- **Format:** Standard EMSA/MAS Spectral Data File (Version 1.0)
- **Application:** Evaluates MSSR's ability to operate in the 1D domain to enhance spectral resolution and effectively resolve overlapping characteristic peak profiles (such as the overlapping M-series and L-series lines) from transition metals in noisy spectroscopic signals.
- **Source & Identifier:** This component is published in the Zenodo OpenAIRE database with the identifier: <https://doi.org/10.5281/zenodo.20561390>.
- **Experimental Parameters:** * **Material:** Molybdenum (Mo) target, monitored via characteristic labels at 0.193 keV and 2.293 keV.
 - **Instrumentation:** Scanning Electron Microscopy (SEM) integrated with an Oxford Instruments Energy Dispersive X-ray Spectroscopy (EDS) detector.
 - **Acquisition Settings:** 15.0 kV beam voltage, 1000.0x magnification, 29.0° elevation angle, and an active acquisition livetime of 240.0 seconds per spectrum.
 - **Data Grid:** 2048 points covering an energy range up to ~19.5 keV, calibrated precisely at 0.01 keV per channel.