Image reconstruction using the Manchester-Athens wide field camera reduction pipeline

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Abstract

The Manchester-Athens Wide Field Camera (MAWFC) is a joint project between the National Observatory of Athens and the Jodrell Bank Centre for Astrophysics of the Manchester University which aims to conduct a large-area sky survey with the aid of a customized camera and narrow-band filters properly designed for studying extended interstellar medium (ISM) structures in the optical emission lines of Hα, [O III], and Hβ. Here, we present the main steps of the automated image processing pipeline which, apart from the basic reduction (e.g., bias, dark, and flat-fielding calibration), intends to remove the stellar contamination from the narrow-band images by means of advanced detection and smoothing techniques, and to compose mosaics of pure large-scale ISM filaments as further step. The procedure is applied to unprocessed images taken from older surveys.

The instrument

The instrument consists of a multi-lens optical system and a filter box inside an aluminum tube, equipped with the CCD camera *Andor iKON-L* (back illuminated, low read out noise, thermo-electrical cooling to -100ºC, 2048×2048 pixels array, 13.5 μm pixel size). The optical tube is mounted on a *Paramount MEII* german equatorial mount, while a small refractor telescope with the *Starlight-Xpress* auto-guiding CCD has been installed off-axis for guiding. Among its innovations, the wide field of view (~30 deg diameter, ~1 arcmin angular resolution) offers a unique opportunity for studying (and discovering) extended interstellar medium structures with an only small number of individual pointings. The narrow-band filters (~15-40 Å bandwidth) will also allow a composition of the Hα to Hβ flux ratio maps for estimating the dust extinction at Hα, which may be further contributed as an improved template for the calibration and interpretation of the cosmic microwave background (CMB).

The reduction pipeline

A pipeline for the automated image processing has been also developed in the IDL programming environment addressing the particular specifications and goals of the project. In its current form, it is able to perform (*i*) the standard bias, dark, and flat-fielding calibration, (*ii*) identification of stars (found with a Gaussian point spread function) in the continuum broad-band images, (*iii*) alignment of multiple narrow- and broad- band images, (*iv*) accurate point spread estimation ("radius" in pixels) relied on the local sky background (intending to efficiently remove the stellar contamination from the narrow-band images), (*v*) robust smoothing techniques based on the nearest pixel neighbors, (*vi*) precise astrometry, (*vii*) mosaic composition, and (*viii*) output files suitable for a 3D image reconstruction.
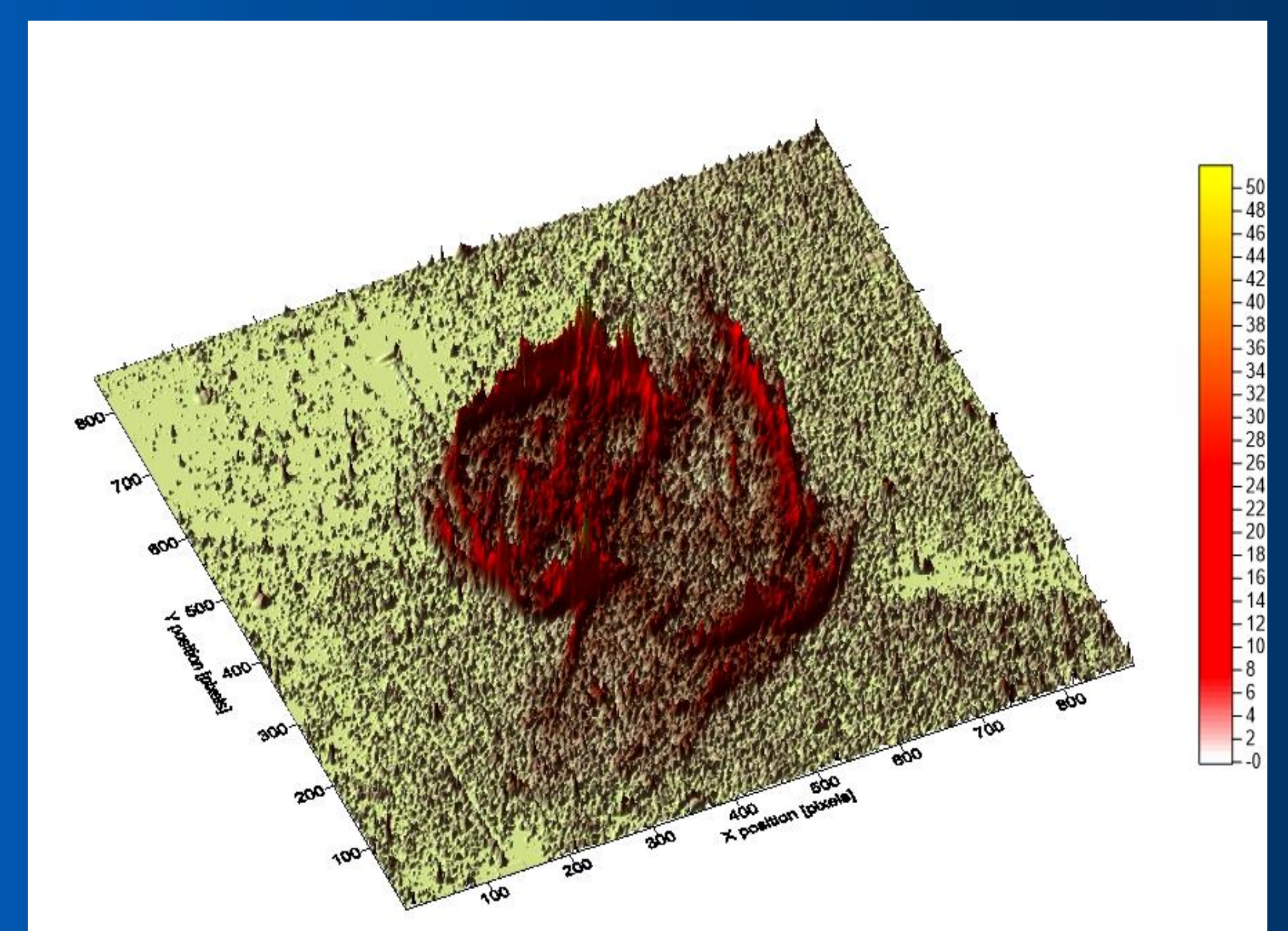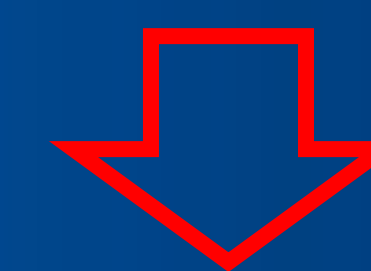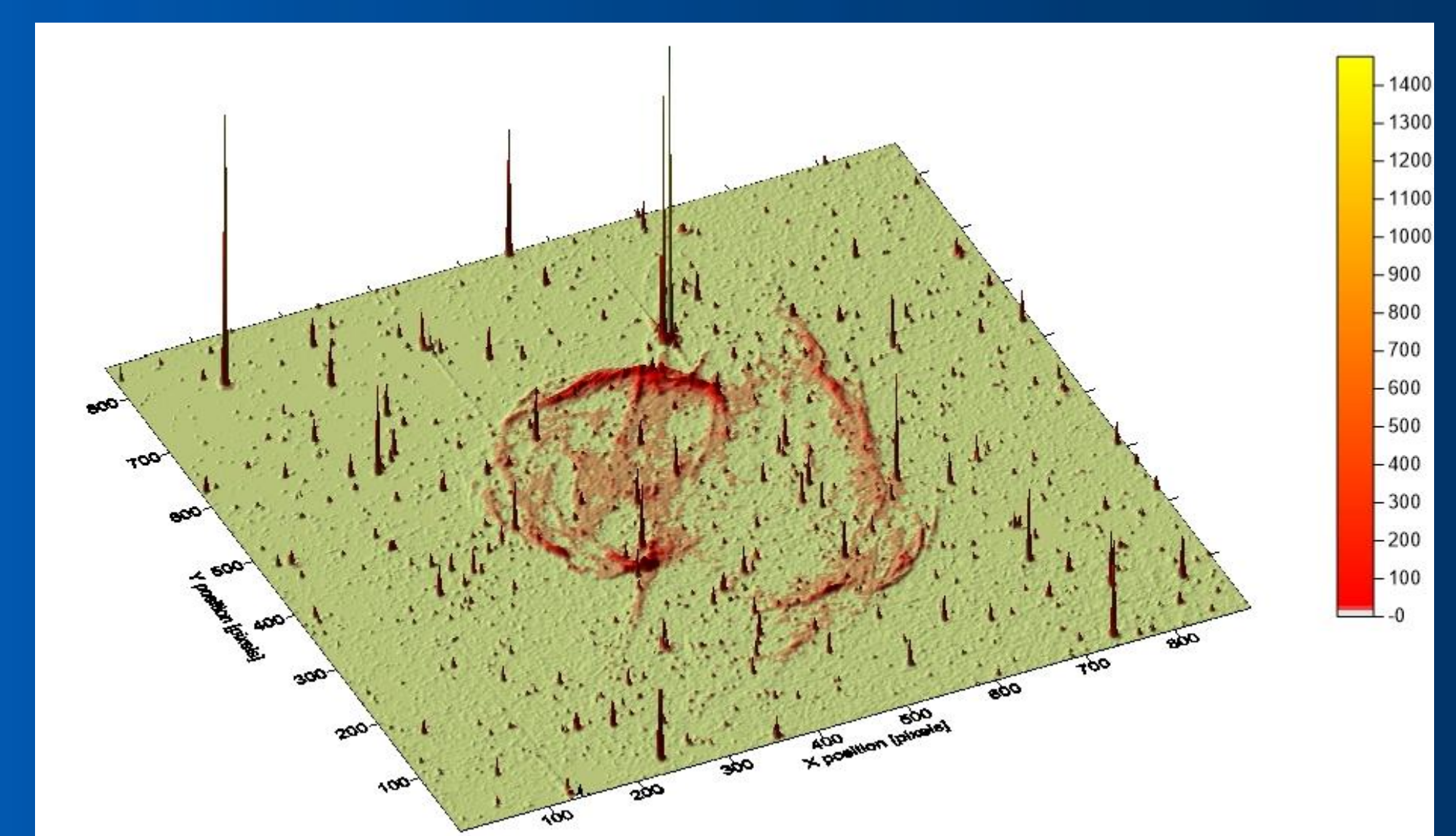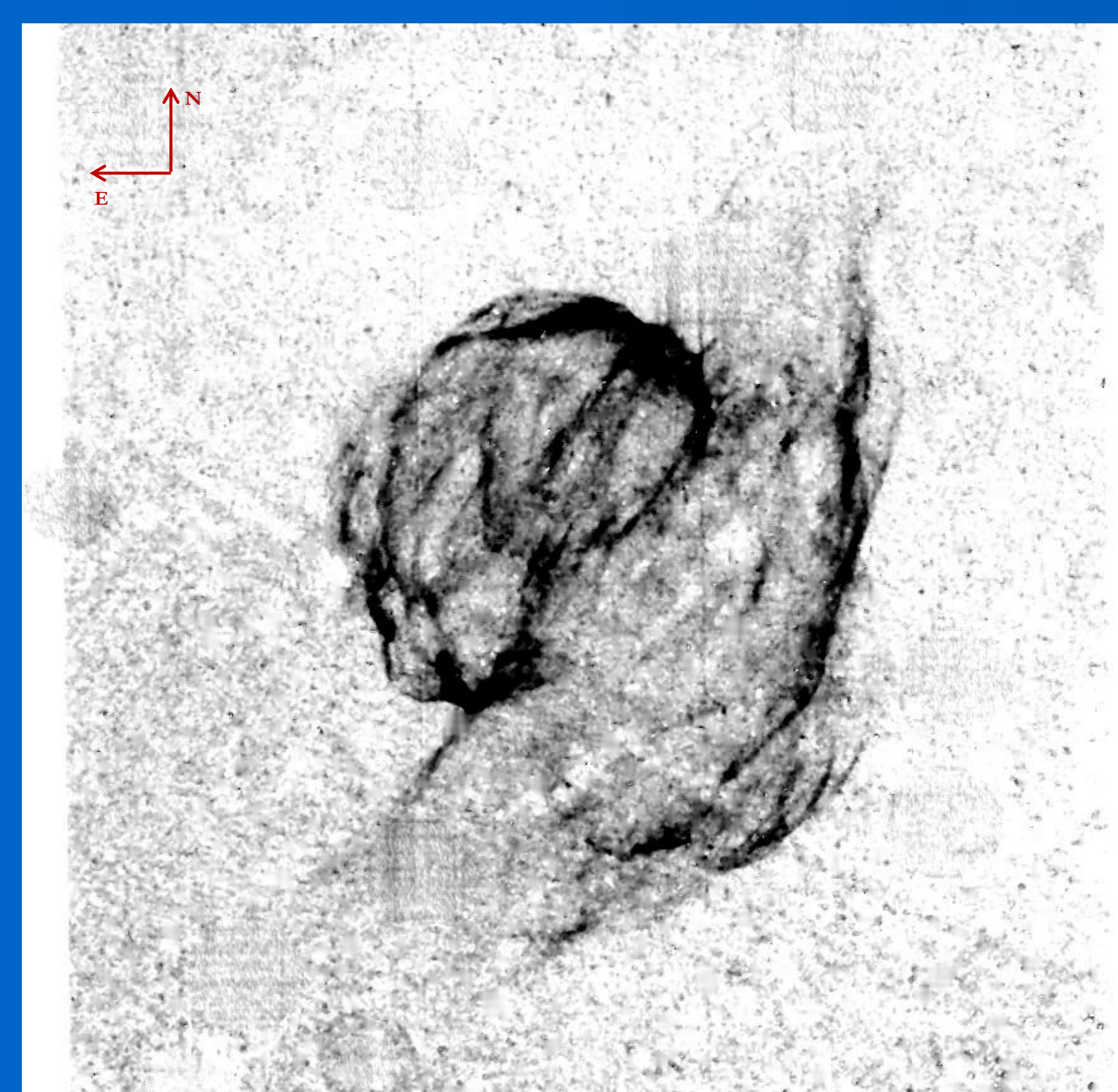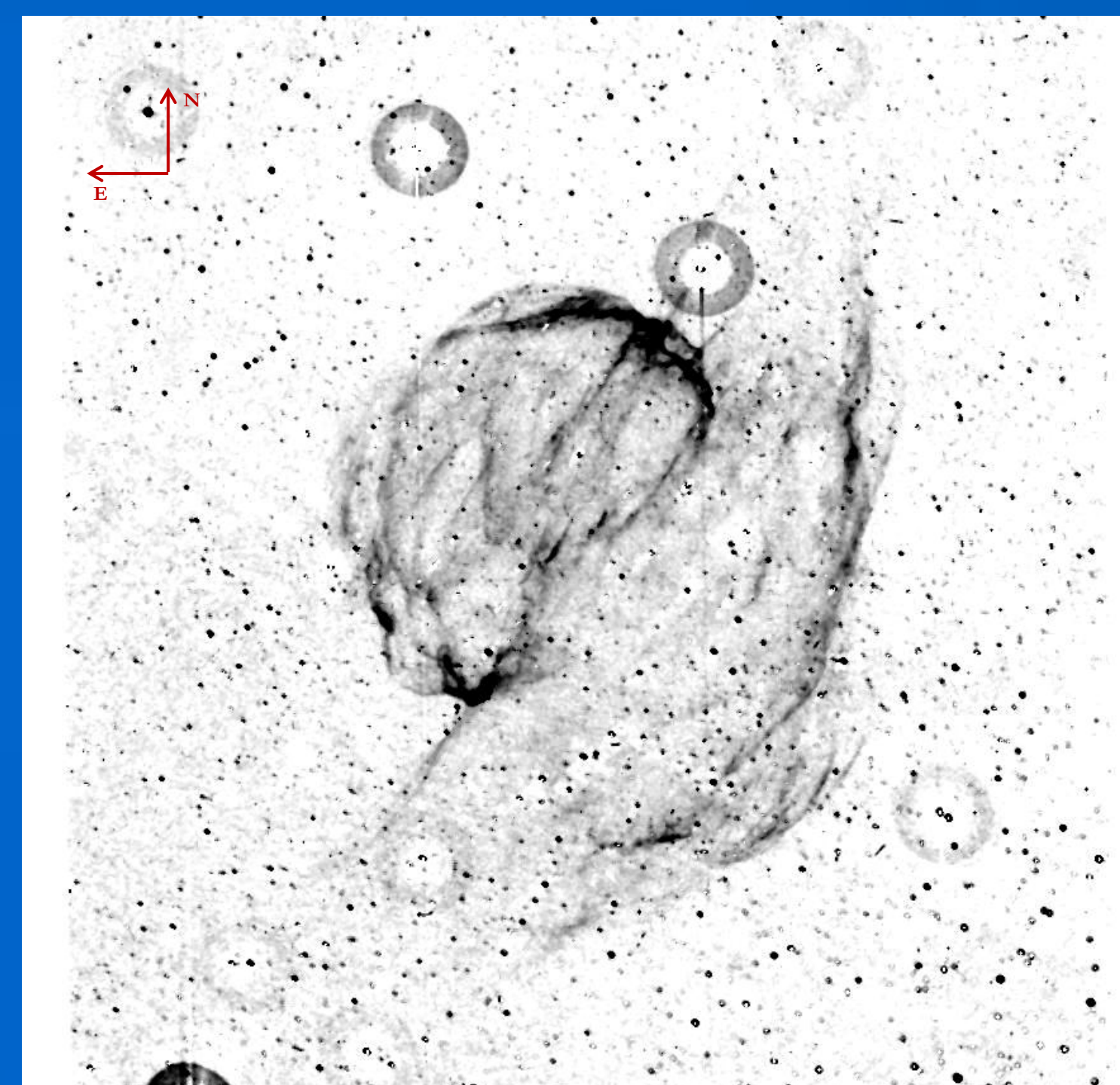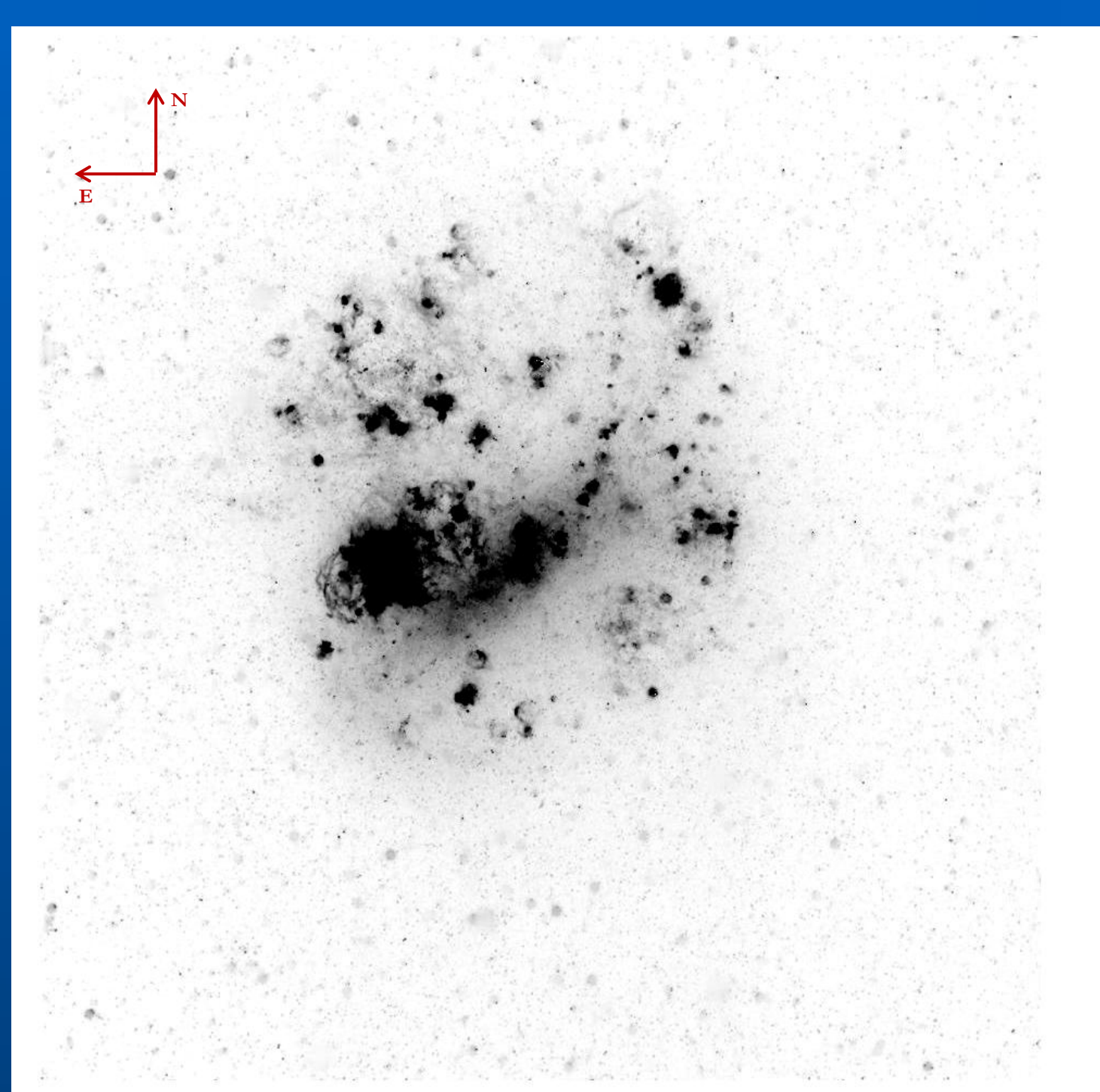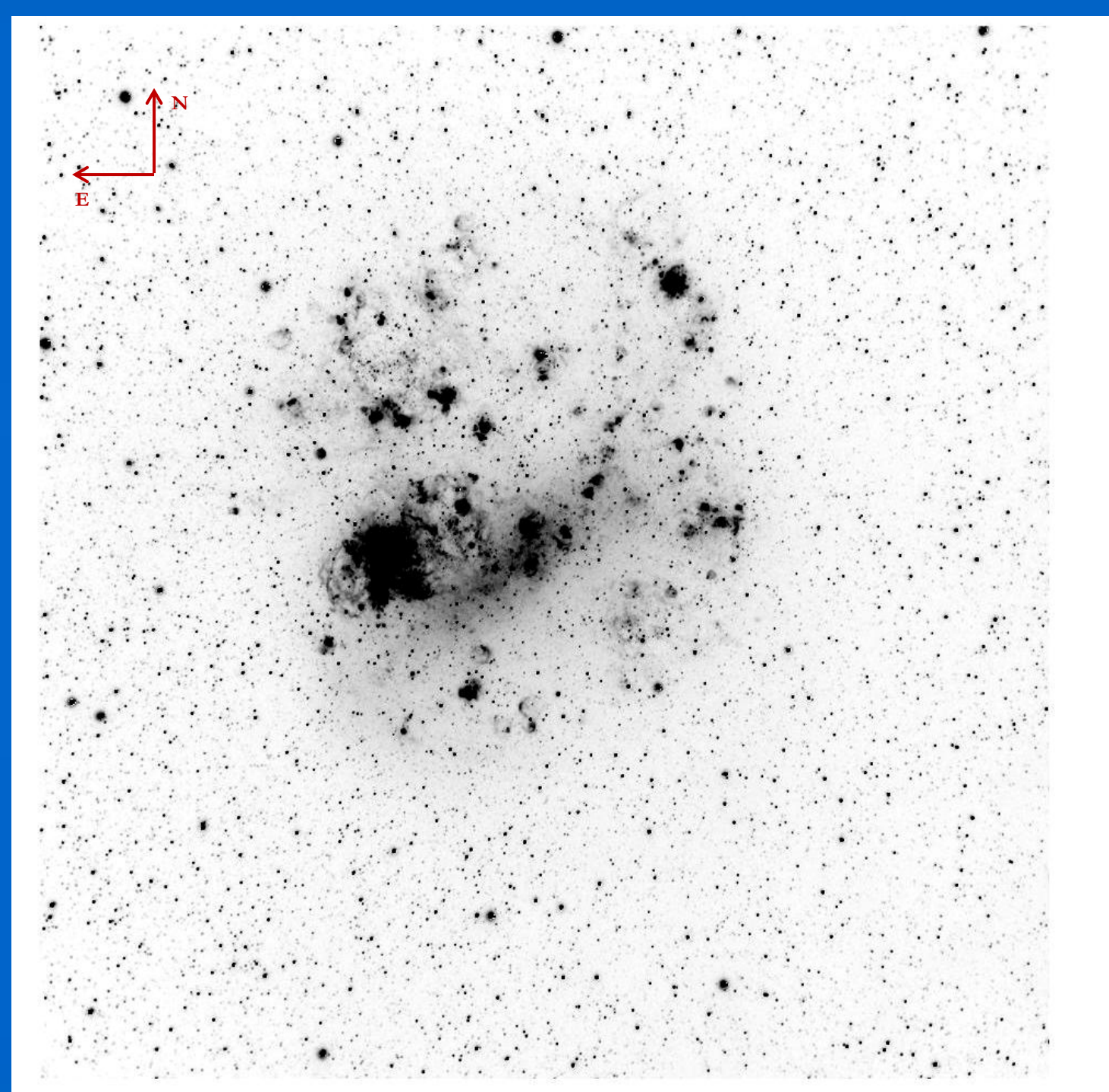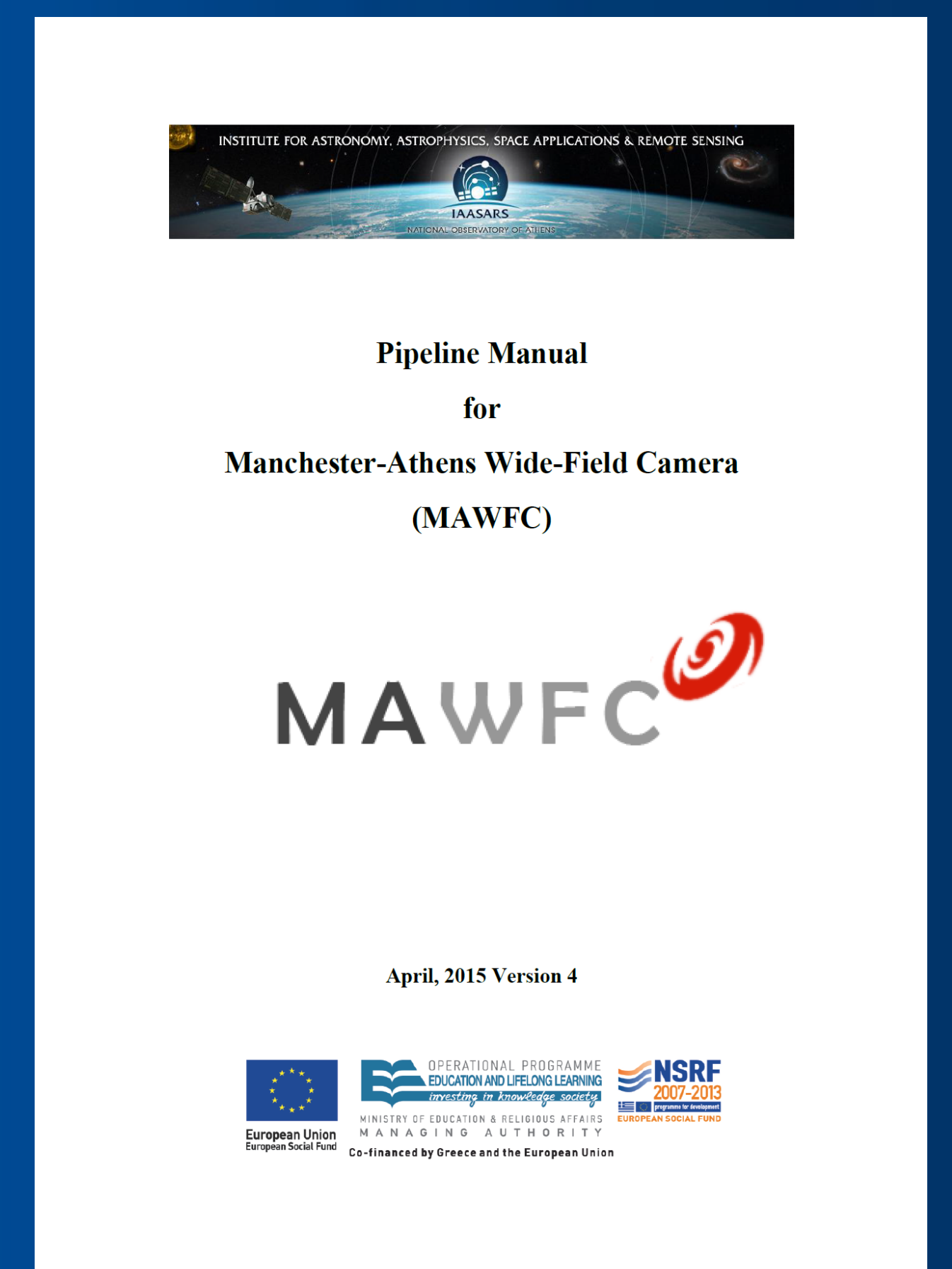
3D reconstruction of the raw and the reduced image
(The uncalibrated flux, in counts, is also pseudochromatically represented)

Large Magellanic Cloud
SHaSSA Survey
Field-of-View: ~13 deg x 13 deg
Image resolution: 1014 pxl x 998 pxl
Filter:Hα (~ 6563 Å)
Automatically processed: 6102 stars
Manually processed: 68 stars

VRO Supernova Remnant (G 166.0+4.3)
Skinakas Observatory
Field-of-View: ~1.2 deg x 1.2 deg
Image resolution: 886 pxl x 856 pxl
Filter:[S II] (~ 6735 Å)
Automatically processed: 2307 stars
Manually processed: 112 stars