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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 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 a further step. The procedure is applied to unprocessed images taken from older surveys.

1 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 readout noise, thermo-electrical cooling to -100° C, 2048×2048 pixels array, $13.5\,\mu$m 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 ($\sim 30^{\circ}$ 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 (see also [1] and references therein). The narrow-band filters ($\sim 15 - 40$ 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).

2 The reduction pipeline

A pipeline for the automated image processing has been developed in the IDL programming environment addressing the particular specifications and goals of the project. In its current form, it is able (*i*) to remove systematic artifacts that emerge from the equipment (i.e., the standard bias-subtraction and flat-fielding calibration), (*ii*) to remove random artifacts that arise from transients (e.g., cosmic rays, airplane and satellite tracks), (*iii*) to identify (stellar) Gaussian-spread point sources in the broad-band images, (*iv*) to align the narrow- and broad-band images based on the position of the brightest sources, (*v*) to estimate accurately the source point spread ("radius" in pixels) relied on the local sky background and intending to efficiently remove the stellar contamination from the narrow-band images, (*vi*) to implement robust smoothing techniques based on the nearest pixel neighbors by adaptively adjusting the radius of the sources spread, (*vii*) to perform precise astrometry and mosaic composition,

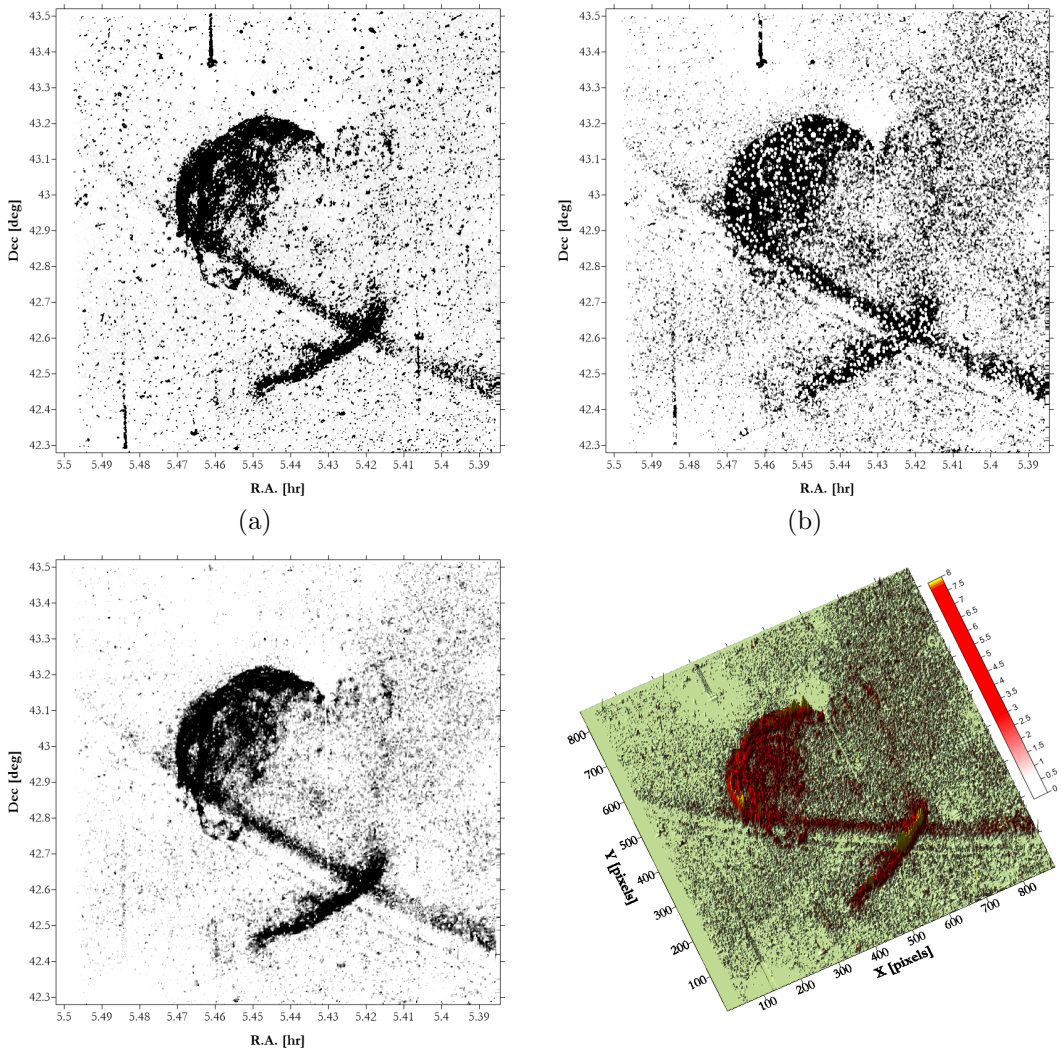

Figure 1: The raw image (a) with the identified point sources (b), the reduced image as inferred from the smoothing procedure (c), and its 3D reconstruction (d). The image depicts the VRO supernova remnant (G 166.0+4.3) obtained at Skinakas observatory ($\sim 1.2^\circ \times 1.2^\circ$ field of view, 886×856 pixels, [O III] 5010 Å filter).

(*viii*) to create output files suitable for a 3D image reconstruction, and (*ix*) to provide pixel-to-pixel flux measurements based on absolute photometry of standard field stars (Fig. 1).

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