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Revisiting the ejecta asymmetries in CasA with a novel method for component separation in X-rays

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In the X-ray emission of supernovae remnants, the shocked interstellar medium, the shocked ejecta and the synchrotron possess a different spatial and spectral signature, but are closely entangled. Extracting the intrinsic spatial and spectral information of the individual components from this data is a challenging task. Current analysis methods do not fully exploit the 2D-1D (x,y,E) nature of the data, as the spatial and spectral information are considered separately. Here we investigate the application of a blind source separation algorithm (the General Morphological Component Analysis ; GMCA) that jointly exploits the spectral and spatial signatures of each component in order to disentangle them. The performance of the GMCA on X-ray data is tested using Monte-Carlo simulations of Cassiopeia A-like toy models, designed to represent typical science cases. We find that the GMCA is able to separate highly entangled components in X-ray data even in high contrast scenarios, and can extract with high accuracy the spectrum and morphological maps of each physical component. Applying the algorithm to the deep Chandra observations of Cassiopeia A, we were able to produce detailed maps of the synchrotron emission at low energies (0.6-2.2 keV), and of the red/blue shifted distributions of a number of elements including Si, S, Ar, Ca and Fe K. These maps, besides highlighting the asymmetries of some elements distribution in the ejecta of Cassiopeia A, exhibit their spatial distributions with a level of details never attained before. We were also able to retrieve, for the first time, an image of the Oxygen distribution.