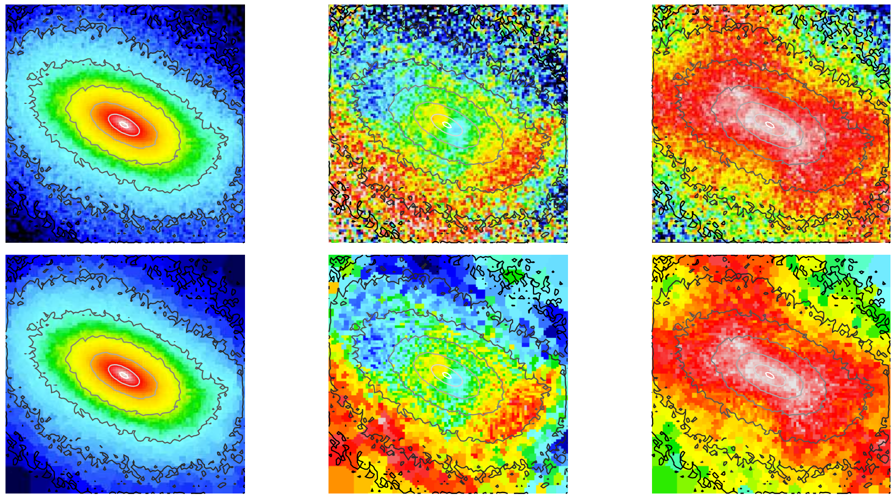

Fig. 8. Voronoi binning of N-body simulations: *Top panels:* From left to right are shown the surface brightness, the mean velocity and the velocity dispersion of a simulated merger remnant. *Bottom panels:* Same as in the top panels after adaptive binning to $(\mathcal{S}/\mathcal{N})_\mathrm{T} = 10$ (from [69]).

from the spectra during the bin-accretion stage [58]. Fig. 7 is a good example of the success of this approach.

N-body simulations: In the context of the ATLAS^{3D} project[4], Voronoi binned N-body simulations of galaxy mergers have been used by [69] to better visualize the kinematics of the remnants in the outer regions and compare them directly with integral-field observations (Fig. 8).

Standard images: Photometric studies of galaxies generally adopt ellipse-fitting techniques to analyze radial surface brightness profiles and colours of galaxies (e.g. [72]). However in cases where a symmetry along ellipses is not desired, one can Voronoi bin the images to study faint features in the data. Binning was used by [73, 74, 75] to study galaxy colours from HST/ACS observations of galaxies at intermediate redshift ($z \sim 0.5$). It was employed to look for star formation in the intracluster light of the Spiderweb system ([70], Fig. 9), to study colours of stellar shells in elliptical galaxies merger remnants [76] and to produce colour maps of early-type galaxies [77, 78]. An independent implementation of the Voronoi binning method, which uses a different bin-accretion algorithm, but the same CVT regularization stage, was applied by [71] to study the characteristics of Jupiter's UV auroral emission from HST/ACS images (Fig. 9).

Star counts: In [79] Voronoi binning was used to group stars counts, as observed with HST/ACS, in the halo of the spiral galaxy NGC 891, an edge-on galaxy considered to be an analogue of the Milky Way. A colour-magnitude

[4] http://purl.org/atlas3d

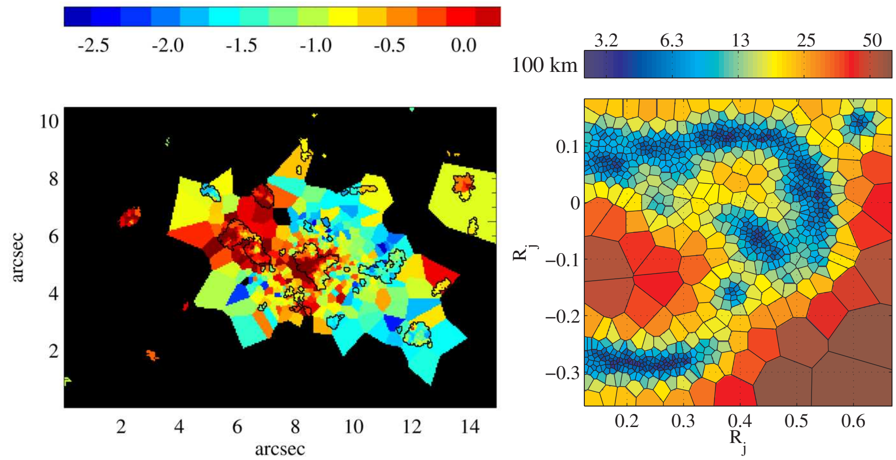

Fig. 9. Voronoi binning of images: *Left panel:* Slope of the UV spectrum of galaxies and intergalactic light of the Spiderweb system (from HST/ACS images). Galaxies are outlined in black. The Lyα flux peaks on the galaxy that lies ~ 3 arcsec west ($x \approx 11''$ arcsec in the figure) of the radio galaxy, which has the bluest colour compared to the other satellite galaxies (from [70]). *Right panel:* Image extracted from the polar projection of Jupiter's UV auroral emission from an HST/ACS image (from [71]).

diagram was constructed for the stars in each bin to study the variation of the metallicity in the halo. This allowed the authors to trace metallicity gradients at extremely faint surface brightness levels (Fig. 10).

General irregular data: To conclude this overview of applications of the Voronoi binning method, we show in Fig. 11 the usage of the technique to increase the $\mathcal{S}/\mathcal{N}$ of a generic map of two-dimensional quantities, not arranged in a regular grid. Here the coordinates represent the largest two principal components (PC), as obtained from PC analysis of a large set of spectra from the Sloan Digital Sky Survey. The figure quantifies dust effects as a function of the two PC, which are closely related to the strength of the 4000 Å break and to the equivalent width of the Balmer Hδ absorption line.

6 Conclusion

We summarized the motivations and criteria for an optimal binning of two-dimensional data. The ideal binning consists of a Voronoi tessellation described by a lattice of nearly hexagonal bins, which adaptively change their size according to the $\mathcal{S}/\mathcal{N}$ of the data. We described the main concepts of the Voronoi binning method, an algorithm that produces a tessellation satisfying the desired optimal criteria [1].