X03a Noise-based galaxy detection and segmentation

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Because of the rich dynamic history of internal and external processes, galaxies display a very diverse variety of shapes or morphologies. Added with their low surface brightness (particularly for high-redshift galaxies) this diversity can cause various systematic biases in their detection and photometry. We introduce a new noise-based method to detect and segment galaxies deeply drowned in noise (Akhlaghi and Ichikawa 2015, arXiv:1505.01664, ApJS in press). It imposes statistically negligible constraints on the to-be-detected targets. We are able apply a sub-sky threshold (-0.5σ) to the image for the first time. This allows for very accurate non-parametric detection of the low surface brightness structure in the outer wings of bright galaxies or the intrinsically faint objects that remain below the commonly used thresholds ($> 1\sigma$). Both these targets play a crucial role in our understanding of galaxy formation. The false detections are identified and removed using the ambient noise as a reference, thereby achieving a purity (fraction of true to the total number of detections) of 0.86 as compared to 0.27 for SExtractor when completeness (fraction of true to total number of mock profiles) is 1 for a sample of extremely faint and diffuse identical mock galaxy profiles. The dispersion in their measured magnitudes is less by one magnitude. By defining the accuracy of detection as the difference of the measured sky with a known background of mock images, an order of magnitude less biased sky measurement is achieved. Contrary to the existing signal-based approach to detection, in its various implementations, signal-related parameters such as the image point spread function or known object shapes and models are irrelevant here.